RARE AND ENDANGERED SPECIES OF CONNECTICUT AND THEIR HABITATS

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and

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STATE GEOLOGICAL AND NATURAL HISTORY SURVEY
OF CONNECTICUT

THE NATURAL RESOURCES CENTER
DEPARTMENT OF ENVIRONMENTAL PROTECTION

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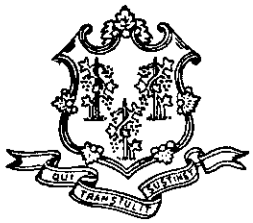

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FOREWORD

The program leading to this publication represents the first phase of a major effort by the Natural Resources Center to develop a modern systematic inventory and understanding of the biota of Connecticut and to apply this in land-use planning. This initial effort has two components: a comprehensive update of Connecticut's endangered, threatened, and rare species list, and the identification of the major habitat conditions and ecoregions that support these species. The future of this program is the refinement of the species list, the investigation of the subhierarchal make-up of the ecoregions, and the expansion of our resource knowledge leading to proper stewardship of Connecticut's natural resources.

The text provides the reader with a basic understanding of the what, why, and where of the rare species of Connecticut. It establishes the concept of ecoregions as natural geographic divisions, each based on similar ecological interrelationships between land, climate, and biota. The identification of eleven ecoregions in Connecticut has brought about the integration of the diverse resource data collected and collated in the Natural Resources Center (i.e. geology, soil, hydrology, topography, and biology). Finally, it provides up-to-date information on the rare species in Connecticut and relates their distribution in the eleven ecoregions to the habitat necessary to maintain their presence.

This study has been published in the Report of Investigations series of the Connecticut Geological and Natural History Survey because its present form is considered an interim document for purposes of eliciting responses from readers, as well as to provide the latest accounts on the changing status of many species. Any additional information, species distribution, nesting records, habitats, and historical accounts to make the final document as complete and comprehensive as possible would be greatly appreciated. The reader, however, should bear in mind that this effort is aimed at identifying only the rare species and their habitats which are of more than local or regional interest and concern, with the hope of preserving and managing these vital resources for the future. Also, we ask that this document be used as a tool to better understand our environment and not as a "shopping list" for one's personal collecting interests.

Hugo F. Thomas, Director
The Natural Resources Center

Rare and Endangered Species of Connecticut and Their Habitats

by

Joseph J. Dowhan and Robert J. Craig

INTRODUCTION

What Is a Rare Species?

An object is considered rare or uncommon depending on how often it is encountered and/or its value to the observer. Rarity is often a relative and highly subjective concept and can be defined only in relation to the abundance of something else. The more scarce an object becomes, the more it is valued as a rarity (Krieger, 1973). Using the above concepts, a rare species may be simply defined as one which has a much lower frequency of occurrence within a given area than other species of the same genus, related genera, or related taxa[1] within that area (Andrewartha and Birch, 1954; Mayr, 1963). Such species, or taxa, are not often seen in the wild, even by experts, and are unlikely to be encountered on casual trips (Goff and others, 1975).

Within a geographic area, a species may be classified as rare, local, or rare and local. Rare species are those which occur sparingly, either as a very few scattered individuals or in small groups, at several widely separated localities over a relatively large area. Local species occur at only a very few, generally isolated localities where, however, individuals may be common to abundant. Species which are both rare and local occur as only a few individuals in each of a very few, well isolated localities throughout their range (Stebbins, 1942; Drury, 1974).

In this report, a rare species is defined as one that occurs in very small numbers or populations, or in both, relative to other related taxa in Connecticut, and thus is seldom observed in broad-scale surveys in the state--it thus includes all three of the above classifications. Consideration is given here only to native species and their native populations in the state, and, in the case of birds and other migratory vertebrates, resident breeding populations or regular migrants which are rare throughout most of their range; rare accidentals and alien species are not included.

Some species have probably always been rare in Connecticut and in other parts of their range, in many instances because of narrow specialization

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[1] A taxon (pl. taxa) is a taxonomic unit or category of any rank, whether genus, species, subspecies or variety.

to a restricted habitat, about which more will be said later, or some geological event which has served to geographically isolate populations from each other. Others are rare in the state because they are at or near the limits of their geographical range. Most such species, which appear to be in no immediate or foreseeable danger of extirpation in the state, are referred to here as State Rare species or taxa. In general, although few in number or populations, their breeding populations are relatively stable--or in some instances even increasing--and their habitats are, at present, not restricted by man's activities nor threatened with destruction by him. Because of their scarcity, however, their populations could become threatened with extinction if their habitats were destroyed or diminished in quantity or quality by unrestricted and unplanned development or pollution. They are certainly species whose populations should be monitored for the effects of future changes.

Of the greatest and most immediate concern are those rare taxa which are in immediate or foreseeable danger of extinction throughout all or a major part of their geographic range. Many such species and subspecies of vertebrates have been identified by both federal and international governmental agencies and have been designated in the United States as U. S. Endangered and U. S. Threatened species (U. S. Dept. of Interior, 1973, 1974, 1976a). Species and subspecies of fish, reptiles, amphibians, birds, and mammals so designated are under the protection and jurisdiction of the U. S. Fish and Wildlife Service, Department of the Interior, under provisions set forth in the Endangered Species Act of 1973 (Public Law 93-205). Plant taxa identified by the Smithsonian Institution as U. S. Endangered and U. S. Threatened (Smithsonian Report, 1975; U. S. Dept. of Interior, 1975b, 1976b) have not yet received any official protected status. Scientists at the Smithsonian have recommended that, at present, the individual states establish means of preserving and safeguarding these species from extinction, rather than doing so through federal legislation and enforcement. Species of plants and animals whose populations are endangered or threatened with extinction in Connecticut and which are also rare or local throughout a major portion of their ranges, but which have not been designated as U. S. Endangered or U. S. Threatened species are, in this report, termed State Endangered species. An additional group of species, which are currently undergoing a long-term decline in their populations in Connecticut, and are already rare or approaching rarity, are here designated as State Declining species or taxa. Indeterminate taxa are those whose population status are poorly known at this time. More information is needed on these species. (For further definitions and a summary of categories, see Appendix.)

Why Are Some Species Rare?

There are many "kinds" of rare species and many different events and mechanisms by which they are produced (Griggs, 1940; Drury, 1974). Some are rare because of natural events, and others because of man's activities. Among the natural causes of rarity, such major geological and climatic events as volcanism, sea-level rise and flooding, glaciation, fire and erosion, and others, have been the cause of extinction or rarity of a great many species throughout geologic time. In some instances, these events

have led to the geographic isolation of formerly widespread and diverse taxa. Interbreeding and gene flow between such isolated populations is seriously reduced or even eliminated, or is restricted to the individuals of a single population. As a result, there is a loss of genetic variability, a "genetic depletion" (Stebbins, 1942) or "species senescence" (Fernald, 1925; Griggs, 1940; Cain, 1944). Many of these depleted species, through loss of biotypes (closely related variants of the same taxon), are highly specialized and restricted to rather rare and often highly unstable habitats, such as mountain tops, sand dunes, and flood plains, quite often in association with other rare species (Griggs, 1940; Smithsonian, 1975).

Several different kinds of naturally occurring rare species are found in Connecticut, many of which are quite rare or local in their statewide distribution. Endemics, or those species restricted to very small geographic areas, are extreme examples of geographically isolated and range-limited taxa. The entire geographic range of some endemic species may consist of only a single state, or part of a state, or even a few hundred square yards on a mountainside or a beach. Many endemics are also narrowly restricted to very specific habitat types (Mason, 1946). Endemic taxa have been hypothesized as representing either very young species which have not yet spread very far beyond their geographic center of origin (Cain, 1944), or very old and genetically depleted species whose ranges have contracted from formerly more widespread geographic areas (Fernald, 1925; Mosquin, 1971). Several endemic plant taxa are entirely restricted to the state of Connecticut, although only one, *Prunus gravesii*, has retained the rank of species; all others are of subspecific rank. Several other species are endemic to southern New England as a whole. No endemic animal taxa are known for Connecticut. Relicts, or relics, are those taxa occurring as remnants of a formerly more widespread and abundant population in a given area, and which, as a result of changed environmental conditions, have since become restricted to small, isolated localities or pockets of favorable soils or local climatic conditions outside the present major range of the species. "Glacial relicts"--those species of formerly greater distribution and abundance in glaciated areas during or sometime immediately after the last Ice Age (Pleistocene) and which have since become isolated following the retreat of the continental glacier--are among the most notable of relict species occurring in the state. A number of plants and animals of generally more common occurrence farther north are restricted to acid peat bog habitats in the state and include such species as Black Spruce (*Picea mariana*), Labrador Tea (*Ledum groenlandicum*) and several species of moths. Habitat-restricted, or habitat-limited, species are those taxa which although geographically widespread, may be local or common in their occurrence within an area depending upon the distribution and abundance of their essential habitat. An essential habitat type, for example, may occur abundantly in some parts of a species' range and there the species is common. Elsewhere the same habitat may be extremely scarce and spotty in its distribution, and so correspondingly are those species restricted to it. On a world-wide basis, habitat-restricted species constitute the majority of naturally occurring rare taxa. In general, they are narrowly specialized to unique and/or limited habitat types and may be physiologically or morphologically adapted, or both, to extreme conditions such as unstable soils, toxic compounds, extreme drought or temperatures, frequent inundation, etc. In many cases, however, this is at the expense of competitive abilities. As a result, such species

are generally very susceptible to competition from more vigorous and competitive species, a factor which has been implicated in having caused the extirpation of others. Competition among species is as ruthless as competition in the business world; between two plants it may take the form of competition of roots for water or nutrients, between two bird species for nesting sites, or between two mammalian predators for prey species. Overpredation, overgrazing and natural diseases, among other factors, may also have played a role in bringing about natural rarity or extinction of certain species.

A large number of Connecticut's rare species are peripheral species, or those taxa which reach their geographic range limits within the state; their major centers of distribution are beyond its borders. These range-limited species are therefore generally more common outside Connecticut, nearer the center of their ranges. Populations and subpopulations of these taxa may be contiguous with the major range of the species, or may occur as isolated outliers or disjuncts from the main population centers. The rarity of these range-limited or peripheral species is due to a complex of factors, including the absence of suitable habitats, availability of appropriate foods or quantity of food, presence of host species, and physiological tolerance limits of the species itself. Such environmental factors as winter-minimum and summer-maximum temperatures, length of daylight, amount of rainfall, and length of the frost-free season, are important "limiting factors" in the distribution of many species of plants and animals. For birds, vegetation structure may be more important in influencing distribution than, for instance, temperature. Also, near the margins of a species' range, different competitors and predators are encountered than in the center of its distribution--these may exert a strong effect on the abundance and distribution of a species. In general, there is a "filter effect" with increasing distance from the center of a taxon's distribution; the greatest densities are in the center and the lowest densities at the margins of the species' range, with no or only accidental representation of the species beyond its range (Andrewartha and Birch, 1954). Several bird species have only recently expanded their breeding ranges to include Connecticut, and although they are currently rare in the state, such species may be expected to become more common in the state in the future.

In spite of Nature's awesome cataclysmic forces such as earthquakes, upthrusting of mountains, tidal waves, and volcanoes, her extinction abilities pale in comparison with those of *Homo sapiens*. At present, very few species are threatened by natural forces (Melville, 1970). Paleontologists estimate that, in the million years preceding the appearance of man, about one thousand species of vertebrates became extinct as a result of natural causes--about one species per thousand years (Congressional Record 115, 1969). The arrival of Stone Age hunters from the Eurasian land mass into the New World via the Bering Land Bridge some 15,000 years ago is believed to have brought about the extinction of at least 31 genera of large North American mammals, including ground sloths, glyptodonts, camels, the horse, saber-toothed cats, the mammoth, and the mastodon (Martin, 1973). An explosive population growth of the new human arrivals, coupled with their extensive overkill of species that had not yet evolved defensive behavior, resulted in a decimation of the North American megafauna within a few thousand years.

Some may be skeptical of this interpretation of evidence from the paleontological record. However, there is also historical evidence from the more recent past regarding the extirpative activities of man. From the time of Christ to about 1800 A.D., approximately one mammalian species became extinct every 55 years in the world (U. S. Congress, Senate Report, 1969). In the United States, between 1600 and 1850, two species of mammals and three species of birds became extinct. In the last 125 years, with the coming of modern technology, about 57 species of birds, mammals, and fish have become extinct in the United States--about one species every two years. The current worldwide vertebrate extinction rate is estimated at one to two species annually (Congressional Record 120, 1974). This increase of more than a thousand-fold over the natural extinction rate dramatically underscores the role of man as a formidable agent of extinction and destruction. The historical record of human-caused extinctions and rarities is far less complete for plants, but may be expected to be of at least the same order of magnitude as animal species. According to recent statistics, unless the present rate of extinction caused by humans is abated, the United States alone will irreversibly lose some 10 percent of its biota, both plant and animal, by the year 2000 (Congressional Record 120, 1974).

Throughout the world today, by far the greatest threat to rare species is the wholesale quantitative and qualitative loss or degradation of natural habitats. A species' habitat is the physical and biotic environment where it is adapted to live and which contains all its survival needs. It includes, but is not limited to, land and water area, physical structure and topography, flora, fauna, climate, human activity, and the quality and chemical content of soil, water, and air (U. S. Dept. of Interior, 1975a). Species that require very specialized habitats are especially threatened by the habitat-modifying and destructive activities of man.

During the Colonial period, the clearing of forests for cropland, pasturing, charcoaling, and timber began the systematic and massive destruction of woodland and forest habitats. (The last virgin tract of timber in Connecticut, in Colebrook, was cut down in 1912.) Many species of the original virgin forest have probably been lost and the ranges of others contracted.

Urban and suburban development has destroyed many natural habitats by burying them with asphalt and macadam, by excavation and construction, by removal of soil from some areas and filling in of others, and by the replacement of native flora and fauna with a host of exotic and weedy species. The drainage and filling in of bogs, swamps, and marshes for purposes of insect pest control or to make them suitable for housing developments or industrial parks have taken a drastic toll of many wetland plant and animal species. For instance, orchids have suffered considerable losses from these activities in Connecticut and elsewhere (Denslow, 1941). Coastal marshes have been ditched, dammed, dredged, filled, excavated, poisoned with insecticides, buried in garbage, impounded, thermally stressed, cut off from vital sediments and waters, built on, hunted in, mowed, and burned. It is a wonder that any coastal marsh biota remain at all. The web of highways over the land has played a major role, not only in outright destruction of habitat and individuals, but in dissecting important natural

biological corridors and contiguous areas of wild land where wide-ranging large vertebrates and even small mammals can travel, hunt, and interbreed successfully (Oxley and others, 1974).

Pollution of the air and water, chiefly by industrial wastes and emissions from automobiles, has brought about significant decreases in environmental quality in the past 50 years. The virtual absence of pollution-sensitive lichens in urban areas of the state, especially in the southwestern coastal region, attests to the biological seriousness and extent of air pollution in that part of Connecticut. Along the shore of Long Island Sound, oil spills and industrial effluents have locally affected wildlife, shellfish, finfish, benthic invertebrates, and aquatic plants (Thomson and others, 1971; Beckley, 1974). Persistent organochlorine pesticides and PCB's, closely related chemicals, are present in most of the major waters of Connecticut, including Long Island Sound, and also in many terrestrial ecosystems. These compounds have been implicated in fish kills and substantial population declines of eagles, ospreys, falcons, and hawks (Ames and Mersereau, 1964; Dustman and others, 1971; Snyder and others, 1973).

Fertilizers and animal wastes leached from agricultural lands along rivers and streams can result in increased eutrophication rates and subsequent degradation of clear-water habitats. In addition, fertilizing of terrestrial habitats has favored the more nutrient-demanding and competitive species, often at the expense of those which are restricted to soils low in nutrients, such as many species of bogs and barrens (Melville, 1970). In some areas, the indiscriminant use of herbicides and arbocides along powerline rights-of-way and roadsides threaten rare species in and near these areas (Meijer, 1973), although it is certainly not the cause of their rarity. Insecticides kill rare insects as well as common ones. They also have adverse effects on rare plants through loss of pollinators (Smithsonian, 1975).

Direct exploitation and destruction of individuals through hunting, trapping, and collecting, have brought about the rarity of some species and the extinction of several others in this state and elsewhere. With some notable exceptions, in this country it has been more of a problem in the past than at present. Over the past 200 years North America has lost a disproportionately larger number of species than any other land area of comparable size, in a great many instances due to unrestricted and large-scale commercial exploitation and destruction of individuals (Greenway, 1967). In little over a century billions of Passenger Pigeons (*Ectopistes migratorius*) were totally extirpated and tens of millions of Bison (*Bison bison*) were brought to the brink of extinction largely as a result of commercial shooting and trapping. The bounty hunting of Eastern Cougar (*Felis concolor cougar*), Black Bear (*Ursus americanus*), and Eastern Timber Wolf (*Canis lupus lycaon*) during the Colonial period, and the shooting of shore and wading birds for market in the 19th Century, caused the almost complete extermination of these species, both in the state and elsewhere, until they were finally protected by law (Sage and Bishop, 1913; Goodwin, 1935). Once such massacres were brought to a halt through federal legislation population recoveries of many of the affected species were remarkably rapid (Leedy, 1961; Palmer, 1975).

The impact of egg collecting--a popular hobby at one time--is not known, but undoubtedly it hastened the decline in populations of some already threatened species of birds. The capture of certain vertebrates for unusual pets by collectors of exotic animals continues to be a major threat to some rare species even in Connecticut (for example, the Bog Turtle, *Clemmys muhlenbergii*). Rarely do these captured animals survive or reproduce in captivity. It is an even greater problem in other parts of the world where exotic endangered species are eagerly sought for their pelts by furriers or by pet collectors. Many of these species have fortunately been given protection by various federal and international agencies, although poaching and illegal transport is still a major problem (Congressional Record 115, 1969).

Plant taxa, too, have suffered heavily from exploitation by private and commercial collectors (Jenkins, 1975; Smithsonian Report, 1975; Gosnell, 1976). *Franklinia alatamaha*, a beautiful shrub related to the Asiatic Camellia, was first discovered near the Altamaha River in Georgia in 1765 (Harper and Leeds, 1937). Because of its great demand as an ornamental shrub, specimens were commercially collected in such abundance that in 1790(2) it was seen for the last time in the wild (Harper and Leeds, 1937; Fernald, 1940). As a group, the Cacti are perhaps the most exploited and endangered group of plants in the United States today, owing to their great demand in the exotic plant trade (Benson, 1965; Smithsonian Report, 1975). Some populations of Cacti have been reduced to only a few individuals and are imminently threatened with extinction in the wild.

In Connecticut, Trailing Arbutus (*Epigaea repens*) and the Climbing or Hartford Fern (*Lygodium palmatum*) were extensively collected in the 19th Century for decorative purposes and, as a result, were nearly decimated before they were finally protected by State law in 1869 (Eaton, 1893; Graves and others, 1910). Although Trailing Arbutus has since made a remarkable recovery, the Hartford Fern has not fared as well. It still remains a rather rare and local species, threatened today more by habitat destruction rather than by plant collectors. Ginseng (*Panax quinquefolius*), once a common woodland herb, and Golden Seal (*Hydrastis canadensis*) were vigorously collected commercially for their roots in Connecticut and throughout their ranges during the same period, accounting for their present-day rarity (Fernald, 1950).

A new major threat to the native flora comes from the forays of terrarium cultists and "wild-flower" gardeners through Connecticut's woodlands in pursuit of plants both common and rare. These plants rarely survive in terraria or gardens. If this intensive collecting of wild native species continues, it is almost certain soon to cause unfavorable changes in the population status of several species. It is an irresponsible practice which should be immediately discouraged.

Man's accidental and purposeful introduction of foreign species of plants and animals into North America, and their subsequent naturalization

(2) Jensen (1975) and the Smithsonian Report (1975) list this date as 1803.

here, have resulted in the displacement of many native American species and a takeover of substantial areas of natural habitat by these aliens. Released from natural controls which held their populations in check in their native lands, such species as the House Sparrow (*Passer domesticus*), Starling (*Sturnus vulgaris*), Carp (*Cyprinus carpio*), Norway Rat (*Rattus norvegicus*), and Japanese Honeysuckle (*Lonicera japonica*) are but a few examples of aggressive foreign species that have brought about major displacements, range contractions, and population reductions of many native species of birds, fish, mammals, and plants in the New World (Fernald, 1940; Minckley and Deacon, 1968). (Here one may also mention as a parallel situation the displacement of the native American Indians by Europeans over the past three centuries.)

In Connecticut, at least one-fourth of the total flora, 30 percent of the fish fauna, 7 percent of the mammals, and 4 percent of the birds of the state are alien. In many instances these aliens make up a disproportionately large percentage of the total biomass or numbers of individuals in a given area. Many of these introductions were purposeful. In contrast, only about 8 percent of the total United States flora is alien, an indication of the intensity of human impact on the biological landscape in the Northeast. On many oceanic islands such as Hawaii, introduced species have been directly linked to the extirpation of a great many native species (Greenway, 1967; Fosberg, 1975). However, excluding introduced diseases, the aliens that have invaded the mainland of North America are not known to have been directly responsible for the extirmination of any native species, although they have certainly greatly affected the population status of many. The long-term effects of these invaders on indigenous plant and animal populations in Connecticut and elsewhere have, however, not been thoroughly evaluated.

Introduced diseases and pest infestations have been responsible for the decline and inevitable extinction of certain native species. Perhaps the most notable of these is the Chestnut Blight (*Endothia parasitica*). Accidentally introduced from eastern Asia in the early part of this century, it has brought about the virtual elimination of mature Chestnut trees from the forests in eastern North America that they once dominated (Moss, 1973). Dutch Elm Disease, introduced on sawtimber imported from Europe, similarly threatens the American Elm (*Ulmus americana*) today. The fate of these two noble tree species is still an open question at this time.

In some parts of the world, unattended or feral domesticated animals, including dogs, cats, pigs, and goats, have caused rather marked population reductions and even extinction of some native species. Goats, for example, have had a devastating effect on the flora of the Hawaiian Islands and continue to threaten certain species on some islands in spite of an intensive goat-eradication program conducted by the National Park Service (Fosberg, 1975). House cats, when free to roam, can be highly destructive to nesting birds, although in continental areas their significance in causing the rarity of native birds is relatively local and probably negligible on a state or national level. It is possible, however, that their depredations may, in some situations, tip the scales unfavorably for species whose populations have already reached seriously low numbers. The random destruction of even one or two individuals of a very rare species' breeding population

could have dire consequences on the survival of that species. It may be argued that such species will probably become extinct sooner or later, regardless of what kills it. However, the issue is whether or not domesticated animals should be allowed to roam freely at the expense of the indigenous species.

In contrast to his destruction of native flora and fauna, some of man's activities actually benefit certain rare species by providing refuges for them--several taxa can exist in Connecticut today only because of human activities. Hayfields, pastures, and, to a lesser extent, airport fields and golf courses provide nearly all the breeding habitat of several typically prairie-nesting bird species, including Vesper Sparrow (*Pooecetes gramineus*), Grasshopper Sparrow (*Ammodramus savannarum*), Savannah Sparrow (*Passerculus sandwichensis*), and Upland Sandpiper (*Bartramia longicauda*).

Why Do We Preserve Rare Species?

Although aesthetic value is a factor, most arguments for the preservation of rare species center around the possible uses of such taxa for food, medicine, and natural products. The extinction of any species means the irretrievable loss of unique genetic material that cannot be duplicated and narrows man's future options for his own use of the environment.

The total number of crop species in the world is rather small and they have originated in relatively restricted areas. Intensive breeding and hybridization programs over the centuries have resulted in the loss of many of the wild ancestors of domesticated food species and their disease-resistant characters. The preservation of wild gene pools (genetic reservoirs of variation and information) in primitive populations is essential to the development of new and resistant strains of crop plants, domesticated animals, and other economically important species (Berry, 1969; Frankel, 1970; Melville, 1970, Jenkins, 1975; Smithsonian Report, 1975).

In addition, many believe that every species--plant or animal--is important to conserve because it may in the future yield some as yet undetermined or undiscovered food, medicine, or anti-cancer drug, or some other product which may ultimately prove to be of enormous benefit to mankind. For example, the blood of the Horseshoe Crab (*Limulus polyphemus*) is currently being investigated as a possible tool in diagnostic medicine; a molluscide has been extracted from Pokeweed (*Phytolacca americana*) which may be used on disease-carrying snails, and viruses are being used to control mosquito vectors (Melville, 1970; Chapman, 1974).

Such anthropocentrism commonly leads to a choice of the species to be preserved on the basis of their relative human value. If a rare species is not good to eat, will not cure our diseases or enrich our lives, is not pleasing to our senses, or is not economically important, many preservationists fear that it will not be considered worth concerted efforts to preserve--or not as much so as species with purportedly greater human value. We share this planet with a great many species whose evolutionary history preceded by millions of years man's rather recent emergence. Within the ecosphere

they are neither richer nor poorer biologically than man; they are as well adapted and as significant as our species. It would be regrettable if we were to preserve species solely on the basis of their present or future economic or aesthetic importance to us. They have survived the rigors of natural selection throughout their evolutionary existence and if their continued existence appears imperiled, particularly as a result of man's activities, we should intervene to prevent their extinction.

Peripheral populations of species, those at the limits of their geographic ranges, are important reservoirs of biological diversity. With increasing distance from a species' geographic center of distribution, environmental conditions become generally less favorable. As a result, populations tend to become geographically isolated, restricted in habitat, and less dense, and the species may become rare or local within the peripheral zone (Andrewartha and Birch, 1954; Mayr, 1963). As mentioned earlier, many of Connecticut's rare species are peripheral species of mostly local occurrence in the state. Isolation and low density can, in turn, limit the amount of gene flow, or exchange of genetic information between populations, especially in those species which are more or less sedentary. Many peripheral populations exhibit less individual genetic variability than do central populations as a result of this limited input of genetic information, although this is also due, in part, to the relatively few "founders" of each marginal population and subsequent inbreeding. Where coupled with less than optimal environmental conditions, limited gene flow and genetic variability may lead to marked genetic differences from the central population and in such a way enable peripheral populations to acquire new and different characteristics more readily than central populations, such as the ability to withstand temperature extremes, pollution, or unusual soil types (Cook, 1961; Mayr, 1963; Berry, 1971). These locally adapted peripheral populations may serve as the advance front of a species' geographic extension, as well as in the evolutionary development of new species (Raven, 1964). They are also of great significance to man in providing an important source of genetic variation used in developing new strains of economic plants and animals. Characteristics such as wilt resistance and frost hardiness in crop and garden plants are mostly derived from peripheral populations adapted to extreme environmental conditions at their range limits. Nurseries and seed farms commonly use local populations of native species since they are most suited to the climatic and soil conditions of the region. Rare peripheral populations thus contribute considerable genetic and ecologic diversity to the species as a whole (Mayr, 1963). Because of their small size and isolation, however, they are particularly susceptible to extinction (Hooper, 1971).

In addition to genetic diversity, the preservation of biological diversity is of paramount importance to ecosystems. Ecologists have long stressed the significance of species diversity, the number of different species in an ecosystem. Accordingly, the more diverse an ecosystem is (the more species it contains), the more resistant it will be to environmental perturbations. Diverse systems purportedly function with a higher degree of reliability than do less diverse ones, presumably because of functional overlaps among many coevolved species (MacArthur, 1955; Pimentel, 1961; Odum, 1971; the Nature Conservancy, 1975). In contrast, simplified,

man-dominated systems, such as croplands and forest plantations, generally are highly unstable and functionally unreliable. According to traditional diversity-stability theories, the loss of one or a few species, through disease or other disturbance, in a species-rich habitat is less destructive to its structure and function than the same event in a simpler, less diverse system--unless, of course, the species removed are "key" or dominant ones. Although many of the traditional views concerning the relationship between diversity and stability are currently in dispute (Goodman, 1975; Murdoch, 1975), it does appear that removal of species from an ecosystem can be highly detrimental, though perhaps for reasons different than formerly supposed.

It is probable that, in any ecosystem, several species are expendable--they could be removed without adversely affecting the system as a whole. This is particularly true in trophic levels (stages of a food chain) which contain a number of ecologically similar and overlapping species. Moreover, such "expendable" species are likely to be the least abundant, or rare, members of a trophic level (Hooper, 1971). The problem is the identification of which species can be removed safely. For example, if a species is removed from a particular ecosystem, which of the remaining species will suddenly undergo a change in population status from that of a rare member to a dominant one? Which one will become a serious pest when a previously unidentified predator or competitor is removed from the system? Which species will disappear because another one is removed because of some unknown symbiotic relationship? Without detailed information on the interrelationships between all environmental factors and organisms within an ecosystem, we cannot predict the consequences of the loss of any species, rare or otherwise. Because of our ignorance in these matters, the most prudent policy is to maintain natural levels of diversity within natural systems (Murdoch, 1975).

Of even greater significance than number of species are the kinds of species present and their interactions within an ecosystem. The full complex of co-adapted species plays a greater role than mere numbers of species in making natural ecosystems more stable than artificial or simplified ones (Murdoch, 1975).

Some rare species are valuable indicators of environmental quality, their presence or absence indicative of various sorts of pollution of air, water, and soil (Doughty, 1974; the Nature Conservancy, 1975). For example, lichens are extremely sensitive to high sulfur-dioxide levels in the air; their extinction or survival in a region can be used as an indicator of ambient levels of SO_2 (Gilbert, 1970). The effect of pesticides on the reproductive success of birds of prey is well known and can be used to monitor the presence of these harmful chemicals in aquatic and terrestrial ecosystems. While some species have decreased, many species' populations and individuals have increased in numbers in response to the degradation of natural habitats; among them are Norway Rats (*Rattus norvegicus*) and Herring Gulls (*Larus argentatus*) in the vicinity of garbage dumps and urban slums (Doughty, 1974). On the positive side, the sudden increase of a previously rare species may also be a harbinger of improved environmental quality.

To conclude, rare species offer excellent opportunities for scientific

and educational studies, including investigations of the genetic differences between central and peripheral populations, the causes of rarity, management of rare species, niche separation, and the effects of introduced species on rare species. In addition, concentrations of rare peripheral species are prime areas for educational studies because many of the habitats which the species occupy are typical of ecological conditions hundreds of miles away.

How Do We Preserve Rare Species?

Until restricted by federal and state laws, market gunning and bounty hunting were significant factors in the decline of a number of species. Without these laws it is almost certain that many more species would have joined the ranks of the extinct. However, even before the populations of many species began to decline because of large-scale hunting and collecting, the destruction of natural habitats proceeded with such an incredible speed and thoroughness that by 1820 over 75 percent of the original forests had been removed in Connecticut alone (Hawes, 1923), and the filling and draining of wetlands had begun. The decline and eventual extinction of the Passenger Pigeon (*Ectopistes migratorius*) by unrestricted shooting was preceded by a massive destruction of habitat and the resulting loss of food and nest sites. The Heath Hen (*Tympanuchus c. cupido*), Carolina Parakeet (*Conuropsis c. carolinensis*), and Wild Turkey (*Meleagris gallopavo*) followed the same road to extinction (Greenway, 1967). It is evident that the preservation of species solely by the protection of individuals is not possible without the protection and management of their habitats.

The key to species preservation today is habitat preservation. This does not mean that the existing protection of certain rare species should be abolished or that other species should not be afforded protected status if it is established that such measures are essential. It should be recognized, however, that, in most instances, the destruction of individuals by hunting or collections is no longer a major factor in causing rarity or is, at least, far less significant than the insidious and indiscriminant destruction of habitats and environmental pollution. Efforts should be made to identify the localities and habitat types that are essential to the survival and maintenance of breeding populations of rare species and to preserve and manage these areas. Without adequate knowledge of the major factors involved in a species' rarity and an understanding of its habitat requirements, the promotion of legislation to protect individuals is, in most instances, unnecessary and unwise. We could find ourselves "protecting" a species from a non-existent exploiter only to find it perishing instead as a result of the loss of its critical feeding, breeding, or resting habitat, or some other factor. In the case of those species threatened by pesticide accumulations or other chemical pollutants, the removal of these toxic substances from the environment is of much greater importance to the survival of those species than regulations concerning the shooting or collecting of individuals.

The selection and successful management of rare-species preserves is rapidly developing into a rather sophisticated science, borrowing heavily from the lessons of island biogeography, wildlife management, and plant

ecology. The term "management" is critical because merely "protecting" a habitat may not ensure its ability to preserve a rare species. The dynamic nature of ecosystems is such that certain habitats may quickly change in structure and composition in time if left undisturbed. Unlike wildlife management, which has developed a number of important tools that can be readily applied to the management of nongame species, the management of rare plant species suffers from a lack of tools and a dearth of information on the life histories and the management of these species.

It is necessary to learn: (1) Why is the species rare? What is its historical record of abundance? (2) What are its life history, habitat, and food? (3) What are the optimal conditions required for ensuring the survival and maintenance of the species? (4) How does it disperse and interbreed between populations? What natural or man-made barriers prevent its dispersal? The necessity for these kinds of detailed information should be an impetus to studies of rare plants and animals in this state. The paucity of available information necessitates intensive studies and monitoring of many rare species and is almost certain to involve the collection of individuals of some species by scientists. This should be regulated but not to the degree that such collections are prohibited.

Criteria that should be considered in the selection and management of rare-species preserves include: (1) the minimum area required for survival of the rare species under consideration; (2) the availability, dispersion, and adequacy of critical resources; (3) habitat diversity; (4) the shape of the area; (5) spacing of the area with respect to other such areas and to the surrounding habitat types; (6) land use within and surrounding the area; (7) the presence of alien competitors, predators, grazers, or feral animals; (8) the preservation of gene flow; and (9) the dynamics of the community, including developmental stages (Preston, 1962; Terborgh, 1974; Diamond, 1975).

Finally, there are those species whose numbers have become so low that they are in grave and imminent danger of extinction unless intervention by artificial propagation, cultivation, or rearing under specially controlled conditions is begun. Cultivation or management of rare species in wildlife refuges, zoos, botanical gardens, and university greenhouses and pens may be the only recourse remaining to preserve these species. Such efforts, however, should only be carried out with the intent of reintroducing the species into its natural habitat (Jenkins, 1975). These propagation programs must be closely regulated and operated in cooperation with and under the strict supervision of appropriate federal and state agencies. The collection by unauthorized amateurs or commercial enterprises of rare species of plants or animals for artificial propagation and cultivation should be condemned and, indeed, dealt with under existing regulations concerning the taking of protected animals.

There are many dangers inherent in raising rare species in captivity or under cultivation. Pampering of individuals, for instance, by supplying a superabundance of nutrients or by the elimination of natural competitors, may in a few generations remove hardy wild genes from the captive population, making successful reintroduction into the wild more difficult. Moreover, in breeding programs there is the tendency to select for a particular characteristic, thought to be important or attractive, which may be of little

survival advantage and perhaps even a liability in the wild. Individuals in captivity, especially plants, may have as neighbors other species which they do not encounter in the wild, thus increasing the possibility of chance hybridization and resultant loss of the "pure" wild genetic stock. Maintenance workers in botanical gardens have been known to mistake the herbicide for the insecticide; in the case of a rare plant species such a mistake could be disastrous. Then, too, budgetary problems or a change in policy or management could cause a specimen to be neglected or forgotten (Fosberg, 1975). Most importantly, the critical survival needs of a species are best provided in that species' natural habitat. Many species simply cannot live outside their natural habitat and attempts to transplant or rear them in captivity are met with consistent failure. "Cultivation or artificial propagation... is not an acceptable alternative to *in situ* perpetuation of species. Preservation of a species' future cannot be assured in this way. Artificial propagation is a last resort and is done always with the ultimate objective of reestablishing the species in its natural habitat" (Smithsonian Report, 1975, p. 25).

CRITICAL HABITATS

The distributions of species are determined by a number of environmental and historical factors, although, in general, they are primarily a function of climatic tolerances and availability of suitable habitats. The effects of climatic and edaphic (soil) factors on the physiology of individuals is beyond the scope of this report; however, these tolerances are often clearly reflected in the distributions of species in relation to major climatic regions and habitat types. In this and the following section on ecoregions, the distributions of rare species in Connecticut are discussed with respect to "critical habitats" and "ecoregions," or "bioclimatic regions." The role of biotic factors in determining species' distributions, which is often highly significant, including the effects of interspecific competition, disease, predation, and human activities, has already been discussed in previous sections and is later included in species' descriptions.

Many taxa are rare and local because they find suitable habitat conditions in few localities. The habitats that these rare species require for their survival may be termed "critical habitats." The importance of habitat preservation and management in the preservation of rare species was emphasized in the preceding section. A critical habitat may consist of the entire spatial environment or any portion thereof provided that it contains those constituent elements necessary to the needs and survival of the species under consideration. Those vital needs relevant in determining "critical habitat" for a given species include: (1) space for normal growth, movements or territorial behavior; (2) nutritional requirements, such as food, water, minerals; (3) sites for breeding, reproduction, or rearing of offspring; (4) cover or shelter; and (5) other biological, physical, or behavioral requirements (U. S. Dept. of Interior, 1975a).

Many such "critical habitats" in Connecticut frequently contain several rare species in the same spatial environment. In the course of the present investigation on the distribution of rare species in the state, we often encountered significant clusterings or associations of rare species within specific habitat types or complexes of adjacent habitats. Like the species they harbor, many of these habitats are themselves rare and local in their occurrence, and generally limited in areal extent in the state. In addition, a number of them are threatened by various activities of man. Habitats of unusually high species diversity and/or biological productivity are also important gathering sites of rare species. The recognition and location of unique and productive ecosystems as critical habitats of greater than local concern and interest have been a major part of our studies on rare species in the state.

"Critical habitats" may serve as refuges for rare species or as research and educational laboratories for the investigation of genetic, evolutionary and ecological problems. Extremely productive and diverse areas may function as reservoirs of species capable of restocking depleted sites and can support vast numbers of such transient species as migrant birds.

The selection and designation of the following Connecticut "critical

habitat" types, or localities of similar physical and biological characteristics, were made on the basis of whether or not such habitat types and complexes generally contained assemblages of rare taxa, or were highly productive, unique, or species-rich habitats of limited areal representation in the state. It should be recognized that the designation of "critical habitat" is only one part of a more comprehensive Natural Areas inventory which, in addition to habitats of rare and endangered species, includes areas of scenic beauty, historic interest and outstanding representatives of more common habitat types. The classification and recognition of "critical habitat" types aids in identifying actual and potential sites of rare species aggregations in need of monitoring, preservation and/or management as important natural areas.

Bird-Breeding Islands in Long Island Sound

These offshore islands are surfaced by bedrock outcrops and/or glacial till materials ranging from large boulders to sand. In places the vegetation is scant. The proportions of open ground, herbaceous cover, and woodland vary, and all have been modified to some extent by the action of wind and waves. There are well developed coastal-woodland or scrub-forest communities on some of the larger undeveloped islands.

These relatively isolated islands are important because they support some of the few breeding colonies or rookeries of coastal birds in the state, including herons, egrets, ibises, terns, gulls, and plovers (McRoy, 1974). Of critical importance is the freedom from human disturbance and terrestrial predators during all or a major part of the avian breeding season, which usually extends from April through early July.

Examples: Norwalk Islands (Norwalk and Westport); Thimble Islands (Branford); and Faulkner's Island (Guilford).

Coastal Sand Beaches and Dunes

Relatively undisturbed sand beaches, spits, tombolos, and barrier islands, abutting or proximal to the mainland, are critical coastal habitats in the state. They are composed of materials chiefly derived and transported from nearby mainland sources. Although some areas contain varying proportions of pebbles, cobbles, coarse shells, and even larger fragments, the predominant material is medium-to-coarse sand, deposited and modified by wind and/or wave action. The landscapes vary from small, narrow, and morphologically simple ones to rather extensive beach-and-dune complexes, consisting of broad intertidal zones, berms, dunelets, dunes, and back-dune overwash and aeolian sand flats. Where sand is abundant and wind exposure moderate, sand dunes, rarely more than six feet high, may develop (Nichols, 1920).

These sand beaches and dunes are important breeding habitats of

Calcareous Habitats

In Connecticut, calcareous (calcium-rich or limy) rocks, chiefly calcitic and dolomitic marble, and the soils formed from them are essentially restricted to the western valley regions from the Massachusetts line at Salisbury and North Canaan south to Ridgefield. The upper reaches of the Housatonic River are largely underlain by these rock types. The valleys are part of the great Northeastern Lime Belt that extends from the Lake Champlain region southward through the western parts of Vermont, Massachusetts, and Connecticut and into parts of eastern New York State (Dale, 1923; Moore, 1935). In Connecticut the belt is divided into northern, central, and southern marble valley regions, partly based on differences in the physical and chemical properties of the underlying marble, and partly because the valleys are separated from each other. There are small, isolated localities of marble and limestone elsewhere in the state, of little regional significance. Both dolomitic marbles, those consisting of magnesium carbonate and calcium carbonate, and calcitic marbles, those made up essentially of calcium carbonate, commonly occur in the same general area (Rodgers and others, 1956, 1959).

In contrast to the predominantly acidic and relatively infertile soils of the remainder of the state, those derived from limestones and marbles are generally quite fertile, rich in such nutrients as available calcium and magnesium, and only slightly acid to neutral. They are exceptionally fine agricultural soils, among the best in Connecticut for dairy farming, both as pastureland and for growing silage and grain crops. Most of the usable land in the marble region is under cultivation; it contains very little natural vegetation and few natural habitats.

Thus there is a paucity of all sorts of natural calcareous habitats in the state. Of special significance are those areas which are critical to the preservation of certain rare plant and animal species. Especially important are marble ridges and ledges, caves, calcareous wetlands, and marl lakes and ponds.

Marble ridges and ledges. The exposed faces of marble ridges projecting above the surrounding terrain or in deep, river-cut ravines in calcareous rocks along the Housatonic and other rivers are of biologic as well as aesthetic interest. They are relatively limited in distribution and in some places are threatened by quarrying.

Where present, soils are commonly thin or confined to rock crevices. Here, ferns, including several rare or local species, are especially abundant, as are a number of other plant species that are restricted to or prefer these habitats.

Examples are Point of Rocks and Great Falls area (Canaan); and Bull's Bridge area (Kent).

Marble caves. Solution caves in limestone and marble, although not as

well developed nor as abundant as in the Karst regions of Kentucky and Tennessee, are of local occurrence and importance in the northern and central marble valleys of Connecticut.

The cave fauna of the state is very poorly known. It could prove to be quite interesting, especially with regards to bats and other troglodytes, including invertebrates and salamanders. The Indiana Bat (*Myotis sodalis*), a U. S. Threatened species, not recorded from the state for many years, possibly still exists in such caves, together with several other rare Connecticut bats.

In many areas of the United States, caves and their unique faunas are threatened by amateur spelunking; it is not known to what degree this is true in Connecticut.

Calcareous wetlands. In the western marble valleys, many calcareous swamps and marshes support a lush and diverse flora distinct from that in nearby acidic areas. A number of Connecticut's rare plants are restricted to these habitats and several others, found sparingly elsewhere, are common to locally abundant within these wetlands. Owing to the lushness of the vegetation and the abundance of insects, both game and nongame species of birds, including some rare Connecticut species, are attracted to these areas.

Because much of the immediate surroundings are being farmed, these wetlands are threatened by fertilizer run-off, trampling by cattle, flooding for use as farm ponds, and other dangers.

Examples are Beeslick Pond (Salisbury); Robbins Swamp (Canaan); and State Line Swamp (Salisbury).

Marl lakes and ponds. The majority of Connecticut's lakes and ponds, like most New England ones, are acidic or "soft" waters. In the calcareous regions, however, such bodies of water are commonly basic and are referred to as "hard" waters or marl lakes. Crusts of calcium carbonate or marl commonly coat the surfaces of aquatic plants, and some deposits of this material are more than 100 feet thick.

Many of these bodies of water contain an assemblage of unique aquatic plants, particularly members of the genus *Potamogeton* (Pondweeds), common in the Midwest where calcareous deposits are more extensive but relatively rare in New England. Several plant species in these lakes are found nowhere else in the state, as are also some fishes. Certain algal species, especially *Chara*, are quite abundant at times and are believed to play an important role in marl formation (Nichols, 1915).

These habitats, because of their scarcity in the Northeast, are important as a unique and limited habitat type.

Examples are Twin Lakes (Salisbury); and Mudge Pond (Sharon).

ECOREGIONS: A NATURAL SYNTHESIS OF LAND, CLIMATE, AND BIOTA

In spite of its small size--5,090 square miles, or 3,205,760 acres--Connecticut contains a remarkable diversity of landscapes and biota. Over a distance of less than 60 miles, from the sea-level shoreline of Long Island Sound to the high elevations (2,300+ feet) of northwestern Connecticut, striking differences are readily observable in topographic relief, climate, vegetation, birds, and even butterflies. Differences in regional climatic factors, including temperature, snowfall, and the length of the growing season, associated with differences in elevation and distance from the ocean, are reflected in the unequal distribution and abundance of many plant and animal species, particularly those which are at or near their range limits in the state.

Many species are common throughout the state and thus may be viewed as "typical" members of the Connecticut flora and fauna. However, most range-limited species are confined to or abundant in only one or a few areas in the state. These peripheral species are excellent indicators of regional climatic conditions and their presence or absence can be used to differentiate "biogeographic zones" in the state.

It is a curious fact, mentioned by Nichols (1913) and others with respect to Connecticut, that many peripheral species with similar central areas of geographic distribution tend to be associated together in the peripheral parts of their ranges. In Connecticut, such species are found either in the same habitat or in the same general geographic area and are otherwise quite rare in the state. For example, several species characteristic of the Atlantic and Gulf coastal plains reach their northern range limits in the southeastern corner of Connecticut, near the coast, generally in the same or similar types of habitats, and are not found elsewhere in the state. A number of boreal or northern species, on the other hand, reach their extreme southern range limits in the state's northeastern upland areas. Southwestern Connecticut appears to be a major distributional area for southern Piedmont species at their northern range limits, while the highland plateaus and summits in the extreme northwestern corner of the state are characterized by a number of Appalachian Mountain species which, for the most part, are restricted to this area of the state.

This association of certain regions and landscapes with significant clusterings of rare "indicator" species can be used to describe the distribution of rare species in the state according to natural regions where they are restricted or preferential as a result of conducive habitat conditions. The use of natural regions as a reference is an advantage over the usual method of merely listing the towns where a species has been collected. Most such lists chiefly reflect the geographic sampling biases of the investigators, rather than the actual occurrence of species. Using regional distribution, it is possible to determine the potential distribution of most species.

Following closely the ideas and investigations of various scientists in Quebec, Ontario, British Columbia, and the Maritime Provinces, and their concepts of "Forest Site Regions" (Hills, 1954), "Land Regions" (Lacate, 1969; Jurdant and others, 1975), "Bio-physical Regions (Kowall

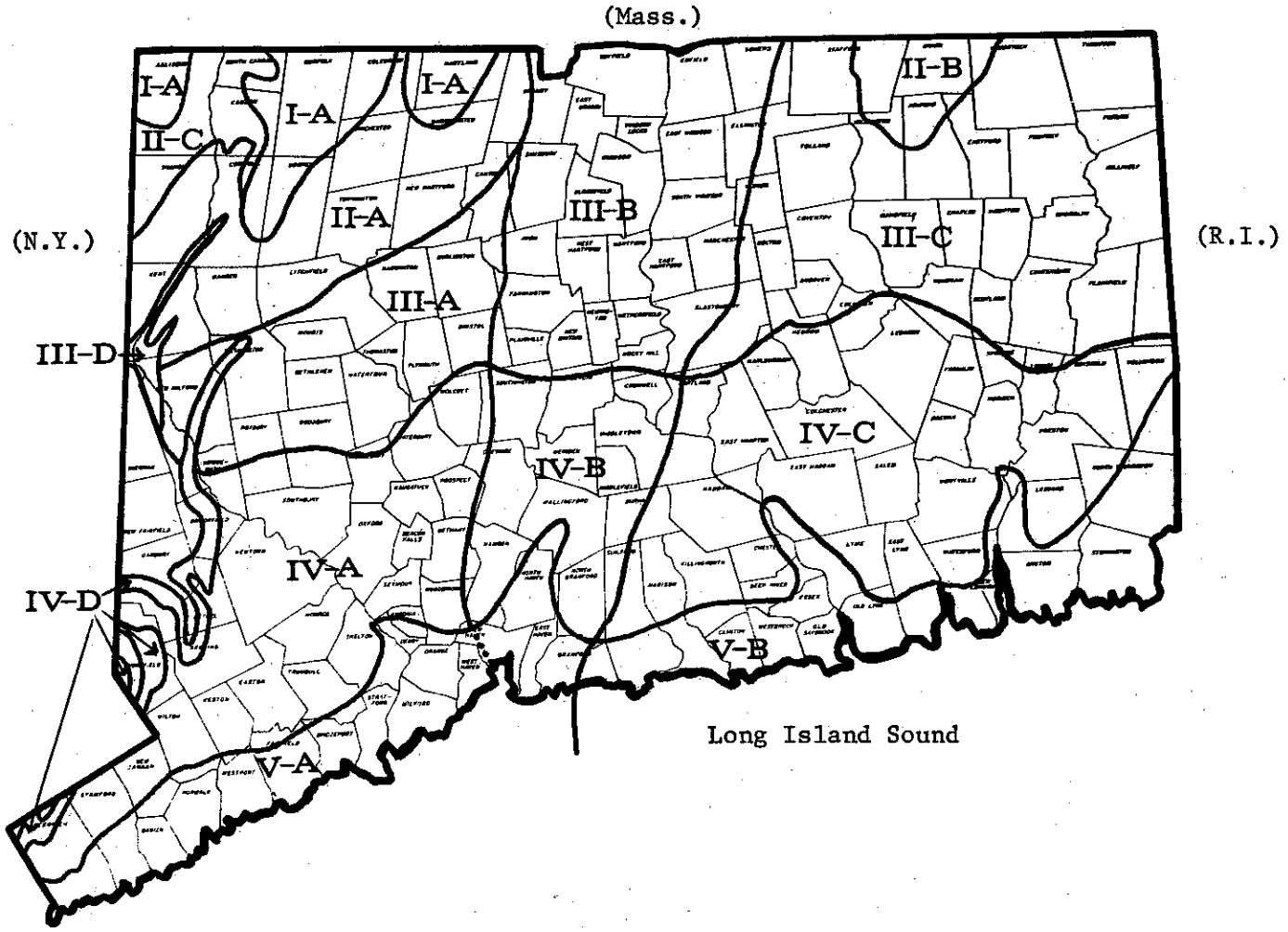

Fig. 1. Ecoregions of Connecticut

I. Northwest Highlands-Northern Hardwoods zone
   A. Northwest Highlands ecoregion

II. Northern Uplands-Transitional Hardwoods zone
   A. Northwest Uplands ecoregion
   B. Northeast Uplands ecoregion
   C. Northern Marble Valley

III. Northern Hills-Central Hardwoods-White Pine zone
   A. Northwest Hills ecoregion
   B. North-Central Lowlands ecoregion
   C. Northeast Hills ecoregion
   D. Central Marble Valley

IV. Southern Hills-Central Hardwoods zone
   A. Southwest Hills ecoregion
   B. South-Central Lowlands ecoregion
   C. Southeast Hills ecoregion
   D. Southern Marble Valley

V. Coastal Hardwoods zone
   A. Western Coastal ecoregion
   B. Eastern Coastal ecoregion

and Runka, 1968), and "Ecoregions" (Loucks, 1962), similar areas of Connecticut were grouped into a number of natural land regions, or "ecoregions," adopting the name and general meaning of the term according to Loucks (1962).

As used in this publication, an ecoregion is an area characterized by a distinctive pattern of landscapes and regional climate as expressed by the vegetation composition and pattern and the presence or absence of certain indicator species and species groups. Each ecoregion has a similar interrelationship between landforms, local climate, soil profiles, and plant and animal communities. Furthermore, the pattern of development of plant communities (chronosequences and toposequences) and of soil profile is similar on similar physiographic sites (Hills, 1954). Ecoregions are thus natural divisions of land, climate, and biota. Further subdivisions of each ecoregion, within a hierarchal scheme of land classification, into districts, systems, types, and phases are possible, based on finer distinctions in vegetation, soil, geology, and geomorphology, and their relative homogeneity throughout an area. These subdivisions are especially useful in forestry, wildlife management, land planning, and natural-resource monitoring and management.

We have divided the state into eleven major ecoregions based on the above definitions and concepts (fig. 1). In addition, three smaller geologic subregions--the marble valleys-- are presented here as divisions of three major ecoregions based on their geological differences. The relationship of major forest vegetation zones, or areas of similar associations of forest tree species, and ecoregions is depicted. In differentiating and delineating these regions we have used information from a number of sources. Some of the more important are: the "life zones" of Merriam (1899); the avifaunal regions of Hoffman (1910) and Forbush (1927); the butterfly faunal regions of Scudder (1889); the mammalian faunal regions of Goodwin (1935); the phytogeographic regions of Nichols (1913); and the forest-zone regions of Westveld (1956) and Egler and Niering (1965). In addition, species distributions were compiled from published ranges and locations, from herbarium and museum collections, and from information provided by various individuals. Climatic maps and summaries, chiefly those of Kirk (1939) and Brumbach (1965), were computed and interpolated. Major physiographic patterns and regions are based on U. S. Geological Survey topographic maps and follow those of Wright (1933) and Fenneman (1938). Information on the bedrock geology of the state and of each region was obtained primarily from the Preliminary Geological Map of Connecticut (Rodgers and others, 1956) and from a number of quadrangle geologic maps published by the Connecticut Geological and Natural History Survey and the U. S. Geological Survey. Soils information was obtained from the National Cooperative Soils Survey of the Soil Conservation Service, U. S. Department of Agriculture. Finally, our own field studies served as an additional source of information and checking of data.

The number, areas, shapes, and the sharpness of boundaries of the Connecticut ecoregions as presented here are preliminary and require more information and considerable refinement. As proposed, they are subject to criticism, but, to quote Egler (1947, p. 388): "Whether or

not an extent of land is one zone, several zones, or several sub-zones is purely a matter of opinion, and the degree of subdivision depends upon its usefulness for purposes of scientific description."

We believe that the proposed preliminary ecoregions offer a useful means of describing and understanding the distribution and interrelationships of the biota and physical landscapes of Connecticut, especially so with regard to rare species.

THE ECOREGIONS OF CONNECTICUT

Northwest Highlands Ecoregion (I-A)

An interior highland, lying more than 45 miles from the coast, characterized by plateaus of high average elevations with a variably hilly landscape and locally mountainlike terrain.

This region, a southern extension of the Berkshire and Taconic plateaus, is the highest and most rugged land in Connecticut, with average elevations of more than 1,250 feet and extensive areas above 1,500 feet. It contains the highest point in the state--2,380 feet above sea level. Its maximum topographic relief, nearly 1,000 feet, is in the western part of the region, adjacent to the Northern Marble Valley. Relief is also high along the Farmington River in the eastern part of the region.

The bedrock is primarily metamorphic: gneisses and schists of Precambrian and Paleozoic age, complexly folded into north-trending belts. Soils are developed on glacial till in the uplands and on local deposits of stratified sand, gravel, and silt in the valleys.

Mean annual temperature for the region is approximately 46°F. The climate is generally cool, with an average winter temperature of 24°F., monthly mean minimum temperature for the coldest month of 12°F., and a mean annual minimum temperature of about -20°F. The seasonal snowfall accumulation is the highest in the state, averaging 90 inches. Length of the frost-free season is about 140 days. Average summer temperatures are generally cool, about 66°F. Monthly mean maximum temperature for the warmest month is 80°F. The daily, seasonal, and annual temperature fluctuations are greater than those of any other region of the state. Prevailing winds are northwest year-round, in contrast to other parts of the state, where southwest winds prevail from May to October. The average annual precipitation is 50 inches.

The major forest vegetation of the region on well-drained soils is Northern Hardwoods-Hemlock-White Pine. Dominant or characteristic tree species are Sugar Maple (*Acer saccharum*), Beech (*Fagus grandifolia*), Yellow Birch (*Betula lutea*), White Pine (*Pinus strobus*), and Hemlock (*Tsuga canadensis*). White Ash (*Fraxinus americana*) and Black Cherry (*Prunus serotina*) are frequent associates. Except on very dry sites, Oaks (other than Northern Red Oak, *Quercus rubra*) and Hickories (*Carya* spp.)

are conspicuously absent or at least scarce. Moosewood (*Acer pensylvanicum*) is a common understory tree. The early phases of old-field "succession" or vegetation development on bare soil are dominated by White Pine and Paper Birch (*Betula papyrifera*). Excellent descriptions of the vegetation types of this region are contained in Egler (1940). Spruce bogs, cool shaded ravines, and exposed mountain summits are significant biologic habitats, harboring many interesting montane and boreal plant species that are quite rare elsewhere in the state. Some of the rare boreal or northern plant species that reach their extreme southern range limits in this region are: Balsam Fir (*Abies balsamea*), Dwarf Scouring-rush (*Equisetum scirpoides*), Lesser Miterwort (*Mitella nuda*), and Kidney-leaved Violet (*Viola renifolia* var. *brainerdii*). Montane species rare in Connecticut, although characteristic of the Appalachians as a whole, occur only in this region of the state and include Red Spruce (*Picea rubens*), Three-toothed Cinquefoil (*Potentilla tridentata*) and Common Wood-Sorrel (*Oxalis montana*). In addition, many sedges (*Carex* spp.) reach their southern range limits here and occur nowhere else in the state.

Characteristic breeding birds include the White-throated Sparrow (*Zonotrichia albicollis*), the Blackburnian Warbler (*Dendroica fusca*), and other species similar to those occurring in the Northeast and Northwest Uplands. One of Connecticut's rare amphibians, the Northern Spring Salamander (*Gyrinophilus p. porphyriticus*), is also found here. The Fisher (*Martes pennanti*) is believed to occur in this region, although its current status is still unknown.

Northwest Uplands Ecoregion (II-A)

An interior upland, 35-40 miles from the coast, characterized by a variably hilly landscape of high average elevation with local areas of considerable topographic relief and rugged hills.

Elevations are generally above 1,000 feet, reaching a maximum of almost 1,500 feet in a few local areas. The maximum topographic relief, about 1,000 feet, is in the western part, adjacent to the Northern and Central Marble valleys and, to a lesser extent, along several river valleys in the central part of the region and, east of there, adjacent to the North-Central Lowlands region.

The bedrock is primarily metamorphic: Paleozoic gneisses and schists, complexly folded into north-trending belts. Soils are developed on glacial till in the uplands and on local deposits of stratified sand, gravel, and silt in the valley areas.

The mean annual temperature is about 47.5°F. Winter temperatures are cooler, averaging 26°F., and seasonal snowfall greater (60 inches) than in any other region except the Northwest Highlands. The monthly mean minimum temperature of the coldest month is 14°F. Mean annual minimum temperature is -15°F. The length of the frost-free season averages 150 days. Average summer temperature is 68°F., and the monthly mean maximum summer temperature of the warmest month is 81°F.

The major regional forest vegetation occurring on mesic sites is Transition Hardwoods-Hemlock-White Pine. The region as a whole was formerly known as the White Pine Zone (Westveld, 1956). Dominant "transition hardwoods" of this region include Northern Red Oak (*Quercus rubra*), Basswood (*Tilia americana*), White Ash (*Fraxinus americana*), and Black Birch (*Betula lenta*). Included also are tree species of the Northern Hardwoods zone, such as Sugar Maple (*Acer saccharum*), Beech (*Fagus grandifolia*), and Yellow Birch (*Betula lutea*), as well as southern and midwestern species more characteristic of the Central Hardwoods zone, such as White Oak (*Quercus alba*), Black Oak (*Quercus velutina*), Shagbark Hickory (*Carya ovata*), and Bitternut Hickory (*Carya cordiformis*). White Pine (*Pinus strobus*) and Hemlock (*Tsuga canadensis*) are also frequent and locally dominant. The early phases of old-field vegetation development are dominated by White Pine. Several northern shrub species, such as Hobblebush (*Virburnum alnifolium*) and Mountain-Winterberry (*Ilex montana*), are near their southern range limits in the state here. A number of other northern bog and forest species reach their extreme southern range limits in the cooler habitats of this region, especially in Black Spruce bogs. Some rare plant species of the region are Bog Rosemary (*Andromeda glaucophylla*), Marsh Willow-Herb (*Epilobium palustre*), Canada Violet (*Viola canadensis*), and Stiff Club-moss (*Lycopodium annotinum*).

Characteristic breeding birds include Yellow-rumped Warbler (*Dendroica coronata*), Magnolia Warbler (*Dendroica magnolia*), Hooded Merganser (*Lophodytes cucullatus*), Common Loon (*Gavia immer*), Winter Wren (*Troglodytes troglodytes*), and other birds also found in the Northwest Highlands and Northeast Uplands.

A rare Connecticut mammal of this region is the Deer Mouse (*Peromyscus maniculatus*). The Eastern Woodrat (*Neotoma floridana*) is probably also present.

Northeast Uplands Ecoregion (II-B)

An interior upland, 40-50 miles from the coast, characterized by a variably hilly landscape with the highest elevations of eastern Connecticut.

Elevations are generally above 700 feet, reaching a maximum of over 1,300 feet near the Massachusetts border. There is considerable topographic relief (400-500 feet) adjacent to stream systems in the interior part of the region.

The bedrock is primarily metamorphic: Paleozoic gneisses and schists, complexly folded into north-trending belts. Soils are developed on glacial till in the upland areas and on local deposits of stratified sand, gravel, and silt in the valleys.

The mean annual temperature is 47.5°F. The average winter temperature is about 26°F., with a monthly mean minimum winter temperature for the coldest month of 16°F. Mean annual minimum temperature is approximately -15°F. Seasonal snowfall accumulation is about 60 inches. The frost-free

season is generally 150 days. The average summer temperature is 68°F., with a monthly mean maximum summer temperature of 82°F. The average annual precipitation is 43 inches.

The major forest vegetation type on well-drained soils is Transition Hardwoods-Hemlock-White Pine, a transition forest zone between Northern Hardwoods and Central Hardwoods. Characteristic "transition hardwoods" include Northern Red Oak (*Quercus rubra*), Basswood (*Tilia americana*), White Ash (*Fraxinus americana*), and Black Birch (*Betula lenta*). Northern Hardwoods species common in this region are Sugar Maple (*Acer saccharum*), Beech (*Fagus grandifolia*), Yellow Birch (*Betula lutea*), and Paper Birch (*Betula papyrifera*). Central Hardwoods species include White Oak (*Quercus alba*), Black Oak (*Quercus velutina*), Shagbark Hickory (*Carya ovata*), and Bitternut Hickory (*Carya cordiformis*). White Pine (*Pinus strobus*) and Hemlock (*Tsuga canadensis*) are frequent and locally dominant. White Pine dominates early phases of old-field vegetation development. Important biologic habitat types include cool forests, ravines, and acid spruce bogs. Several rare Connecticut plant species of generally northern distribution, which are at or near their southern range limit here, are the Northeast Rose (*Rosa nitida*), Rhodora (*Rhododendron canadense*), Large Round-leaved Orchis (*Habenaria macrophylla*), and several Sedge species (*Carex* spp.). Other rare plants include Spike-Rush (*Eleocharis equisetoides*), Peck's Bulrush (*Scirpus peckii*), and Two-flowered Bladderwort (*Utricularia biflora*).

Some characteristic breeding birds of this region are the Golden-crowned Kinglet (*Regulus satrapa*), Black-throated Blue Warbler (*Dendroica caerulenscens*), and Red-breasted Nuthatch (*Sitta canadensis*). Other birds commonly associated with the Northwest Highlands and Uplands regions are also found here.

The Northern Flying Squirrel (*Glaucomys sabrinus*) has been recorded in this region.

Northwest Hills Ecoregion (III-A)

An interior upland, 25-40 miles from the coast, characterized by a moderately hilly landscape of intermediate elevation, with narrow valleys and local areas of steep and rugged topography.

Elevations generally are 750-1,000 feet, with a maximum of over 1,200 feet. The greatest relief, over 700 feet, is adjacent to the Central and Southern Marble Valleys to the west and to a lesser extent, along the Shepaug and Naugatuck rivers in the central part of the region and in the area to the east, adjacent to the North-Central Lowlands region.

The bedrock is primarily metamorphic: Paleozoic gneisses and schists, complexly folded into north-trending belts. Soils are developed on glacial till in the uplands and on local deposits of stratified sand, gravel, and silt in the valleys.

The mean annual temperature is 48°F. The average winter temperature

is 27°F., with the monthly mean winter temperature of the coldest month of 17.5°F. Mean annual minimum temperature is -10°F. Seasonal snowfall accumulation averages 50 inches. The average frost-free season is 155 days. The average summer temperature is 71°F., with a monthly mean maximum summer temperature of 84°F. for the warmest month. Average annual precipitation is 45 inches, with wide variations over the region as a whole.

The major regional forest vegetation is Central Hardwoods-Hemlock-White Pine. The region was formerly referred to as the Oak or Mixed Oak region (Bromley, 1935). Characteristic dominants on well-drained soils include Red Oak (*Quercus rubra*), White Oak (*Quercus alba*), Black Oak (*Quercus velutina*), Shagbark Hickory (*Carya ovata*), Pignut (*Carya glabra*), and Bitternut Hickory (*Carya cordiformis*). Chestnut (*Castanea dentata*) was formerly a major tree species in this forest zone until the Chestnut Blight (*Endothia parasitica*) decimated its populations in the 1920's. Stump sprouts of Chestnut are still common everywhere. Black Birch (*Betula lenta*), White Ash (*Fraxinus americana*), and several other Oaks (*Quercus* spp.) are frequent associates. White Pine (*Pinus strobus*) and Hemlock (*Tsuga canadensis*) are frequent and locally abundant to dominant. Abandoned fields are generally dominated by White Pine, Red Cedar (*Juniperus virginiana*), and/or Gray Birch (*Betula populifolia*). White Pine reaches the southern limit of its occurrence in old fields in this region. Critical biologic habitats include old-growth forests and Black Spruce bogs. Some characteristic rare plants are New England Grape (*Vitis novae-angliae*), Hairy Wood-Mint (*Blephilia hirsuta*) and Wiegand's Wild Rye (*Elymus wiegandii*).

The avifauna of this region is found over much of the state and includes such species as the Ovenbird (*Seiurus aurocapillus*), Wood Thrush (*Hylocichla mustelina*), Rufous-sided Towhee (*Pipilo erythrophthalmus*) and Eastern Wood Pewee (*Contopus virens*).

The Slimy Salamander (*Plethodon g. glutinosus*), a rare Connecticut amphibian, reaches its eastern range limit here.

North-Central Lowlands Ecoregion (III-B)

A broad interior lowland, lying from 25 miles to more than 50 miles from the coast, characterized by extensive floodplains and lowland areas adjacent to the major rivers and interspersed with prominant north-trending ridge systems.

Elevations are generally 50-250 feet above sea level, reaching a maximum of almost 950 feet on several of the rock ridges. On the west-facing scarps of the ridges is the maximum topographic relief, nearly 700 feet.

The bedrock is sedimentary and igneous (red-brown sandstones and dark basalts) of Triassic age, in layers tilted to the east. The trap-rock ridges, erosion-resistant basalt layers, form an almost continuous belt of north-trending upland through the central and western parts of

(*Ammospiza caudacuta*), Orchard Oriole (*Icterus spurius*), and Carolina Wren (*Thryothorus ludovicianus*).

Western Marble Valley Subregions (II-C, III-D, IV-D)

Interior valleys and lowlands 200 feet to over 700 feet below the surrounding upland plateaus, with major drainage systems in most of the valleys; characterized by extensive flood plains and lowland areas adjacent to steep valley walls rising to the upland areas; isolated hills and local areas of rugged topography in the valleys.

Valley-floor elevations range from 250 feet to just above 500 feet, and the maximum relief of more than 700 feet occurs between valley floors and uplands.

The bedrock is primarily metamorphosed limestone (marble) of Paleozoic age, together with other metamorphic rocks of similar age, in north-trending belts. The valleys reflect the more rapid weathering of carbonate rocks relative to the more resistant schists and gneisses which underlie the adjacent uplands. There are three distinct subregions: Northern Marble Valley (II-C), Central Marble Valley (III-D), and Southern Marble Valley (IV-D) (fig. 1). Soils are developed on glacial tills in higher areas and on extensive deposits of stratified sand, gravel, silt, and some clay. Some of the soils reflect the calcium-rich bedrock that underlies the valleys.

The climate of each of these subregions probably does not differ significantly from that of the ecoregion in which it occurs; however, substantive data is lacking. Because of the drainage of cold air from the surrounding uplands, the valleys are often pockets of severe cold or frost.

The "climatic" vegetation of each valley is similar to that of the surrounding ecoregion, ranging from Transitional Hardwoods-Hemlock-White Pine in the Northern Valley to Central Hardwoods-Hemlock in the Southern Valley. The fertility of the calcium-rich soils is expressed in the lushness and floristic composition of much of the vegetation. A number of putatively calcicolous plant species are apparently restricted in the state to these valleys, although some are also found on trap rock in the Central Lowland regions. As a result of the intensity of agricultural use of the fertile soils in these valleys, natural calcareous habitats are either scarce or rapidly diminishing. Calcareous wetlands, alluvium, ledges, ridges, and caves are biologic habitats significant in the state as a whole, which occur in these subregions. Many of these habitats are threatened by human activities. Some of the rare plant species found in these valley subregions are Spreading Globe-flower (*Trollius laxus*), North American Wall Rue (*Asplenium cryptolepis*), Narrow-leaved Spleenwort (*Athyrium pycnocarpon*), Arbor Vitae (*Thuja occidentalis*), Dwarf Birch (*Betula pumila*), Purple Cress (*Cardamine douglassii*), Seneca Snakeroot (*Polygala senega*), Meadow Horsetail (*Equisetum pratense*), Bur Oak (*Quercus macrocarpa*), and Sweet Coltsfoot (*Petasites palmatus*). Many

midwestern Pondweeds (*Potamogeton* spp.) occur here in marl lakes and ponds and are found nowhere else in the state; a number of them are rare throughout New England.

The avifauna of each subregion is similar to that of the surrounding ecoregion.

The Bog Turtle (*Clemmys muhlenbergii*), characteristic of calcareous wetlands, occurs in these valleys. The Indiana Bat (*Myotis sodalis*) may also occur in limestone caves in these valleys, as it does farther north in the same marble belts in Vermont and Massachusetts.

THE RARE-SPECIES LISTS

How and Why Were They Developed For Connecticut?

The compilation of Connecticut's rare species was begun in response to a growing public concern about the preservation of rare species and their habitats and the need for consideration of them in overall land-use planning. The lack of a clear understanding of the intrinsic value of biological components in natural systems and the lack of reliable and usable information have resulted in biological considerations, other than those connected with agriculture and game management, to traditionally play a relatively minor role in land-use planning. As a consequence, our environment has suffered an impoverishment of native species and natural habitats, with a resultant biological simplication of the landscape. Such a loss of diversity may have far-reaching consequences to the stability of the natural ecosystems with which our own lives are intricately interwoven.

The candidates for the list were chosen by an orderly selection process. First, all published information on the flora and fauna of Connecticut, starting with the oldest published records and continuing up to the most recent, were thoroughly studied. This identified the native species which at one time or another had been indicated to be "rare" or "local." Introduced species and "accidentals" were excluded. By this means, we were able to identify those species which had not been recorded in many years and to follow the changing status of several species, as their habitats decreased or increased, or as they were exploited or protected. Next, all major herbarium and museum collections in Connecticut and the surrounding regions were examined for distributional information, verification of identification, and other data. At the same time, we contacted persons familiar with the flora and fauna of the state, scientists, university professors, knowledgeable amateurs, members and directors of various biological organizations, and government wildlife and forestry officials. These people provided additional data and numerous helpful suggestions. Finally, our own limited field investigations over the past year have clarified the status of several species.

During this process, the status of many species changed; several were added to the list, others deleted. As more information became available, the retention of a species on the list was subjected to a more critical review. In some instances the nativeness of a species in the state or at some of its localities has been the subject of much debate. Our final judgment in these matters has not always been in agreement with our colleagues. The authors accept full responsibility for any errors in such cases. Perhaps the most complete and most recent information on any taxonomic group is that concerning birds; this is due in no small way to the remarkable efforts of the state's professional and amateur ornithologists. Available information on plants is poorest and most outdated. Lists of rare invertebrates and nonvascular plants are planned for the upcoming year.

We believe that the present list is a reasonably complete compilation of the indigenous taxa of vascular plants and vertebrates that may be con-

sidered "rare" or "local" in the state, relative to other taxa. By no means is this report to be considered a "final" product; it must certainly be viewed as only the beginning of what we hope will be a continuing appraisal of the biological resources of the state. We anticipate and will welcome comments on those species and habitats proposed for protection and/or management. Suggested additions, reports of omissions, information on the habitats and distribution of species, nesting records, and historical accounts are also welcome. It is hoped that these lists can be revised and updated on a regular and frequent basis. Information should be forwarded to the authors in care of the Connecticut State Geological and Natural History Survey, Natural Resources Center, Connecticut Department of Environmental Protection, State Office Building, Room 561, 165 Capitol Avenue, Hartford, Connecticut 06115.

The primary purpose of the lists is to aid federal, state, and municipal governments, as well as private conservation groups, in identifying significant biologic habitats and communities of rare species which deserve special consideration in any land-use proposals which threaten to destroy or modify them. In addition they may be of use in the preparation of Environmental Impact Statements. The lists also identify habitats and communities endangered by existing land uses. It is hoped that publication of the lists will lead to the recognition of many other biologically unique and important habitat areas, now unrecognized and unconsidered by planners and conservation groups. Once identified, these areas may be used in a multitude of programs: outright protection and management by federal or state biologists, cooperative management by state and town agencies, nature-education areas and trails, or university research. Each site must be thoroughly evaluated for the greatest benefit to rare species, including their role in environmental education.

By providing up-to-date information on the rarer species and their distribution in the state, the lists will also help the current systematic inventory of the state's flora and fauna. They may also serve as a baseline for future monitoring of species' population changes in response to such factors as changing environmental conditions and introduced species.

Introduced species which have been "successfully" transplanted and naturalized in Connecticut are not included in the lists, regardless of their present status in the state.

The attractiveness of a species has played no role in determining its inclusion in the lists. The lists are not a compendium of exquisite wildflowers or pretty birds, or objects that we may consider rare because they are beautiful. Many species of sedges, grasses, sparrows, and salamanders on the lists are not attractive enough to warrant a second look by most of the people fortunate enough to glimpse them in the wild.

A species is included only if the numbers of individuals and/or populations are extremely low or experiencing a long-term decline in numbers relative to other species <u>in the state as a whole</u>.

It is fervently hoped that the lists do not serve as a "shopping list," or in any way encourage people to pick or collect rare species

for display in their gardens, terrariums, herbariums, or household zoos, or to sell commercially.

Currently in the state there are several lists of "rare" flowers and birds--so called "no pick lists"-- which have been prepared by garden clubs and conservation groups for public information and to protect certain species. The lists that we have prepared are not meant to compete with, supercede, or diminish the importance of these other lists. Most of them deal with local or regional areas, and contain many species that are not especially rare or uncommon over the state as a whole.

In contrast to these regional and local lists, our lists deal exclusively with the rare species and their habitats which are of more than local or regional interest and concern. Because peripheral species are included in the state lists and because certain habitat types are rare in Connecticut, although common elsewhere, the state lists contain many species that are not included in the federal lists of rare species. In the same way, certain regions and towns in the state may include as rare species those which are relatively frequent or even common over the state as a whole, although rare in their areas. Conversely, in some regions of the state, species that are rare in the state as a whole are locally common. It was the recognition of these pockets of rare species, particularly peripheral populations and habitat-limited species, that allowed us to define several distinct bio-geo-climatic zones in the state, which we have referred to as "ecoregions" or natural land regions and which are discussed elsewhere in this report.

RARE AND ENDANGERED VASCULAR PLANTS OF CONNECTICUT

Scientific names and arrangement of families are presented according to Fernald (1950), unless otherwise noted. Genera and species are listed alphabetically within each family. In those instances where the current acceptable name differs from that of Fernald, the name as presented in Fernald is placed in parentheses immediately following the current name. Common names used here are those most widely accepted and in use in the state or region. In many instances, so-called "common names" are merely Anglicized translations of the scientific names.

Habitat information on each species applies to Connecticut only. The distribution of each species in the state is indicated by ecoregions (fig. 1) rather than by town or actual locality. In those cases where no ecoregion is given, the species may generally be assumed to be widely distributed over the state or without any particular affinity to one region or another.

Dates at the end of each species' description refer to the time when the plant is usually in flower in Connecticut, or, for the ferns and horsetails, when the spores are mature. In the case of members of the family Cyperaceae, or Sedge family, where fruits are important in the identification of species, the dates refer to the fruiting period.

Information on the current status of vascular plants in Connecticut is quite poor, being both out of date and incomplete. Although many more references were consulted, the following major published references were used extensively in helping to determine the past and present status of many of the rare plant species candidates listed in this report. In addition, the members of the faculty and staff at the University of Connecticut, Yale University, and Southern Connecticut State College provided considerable information on rare plants.

Berzelius Society, 1878, A catalogue of the flowering plants and higher cryptogams growing without cultivation within thirty miles of Yale College: Berzelius Soc., New Haven.

Bishop, J. N., 1885, A catalogue of all phaenogamous plants at present known to grow in the state of Connecticut: Rep. Sec. Conn. Board Agric. 1884-5, Hartford.

Czar, Jonathan, 1958, A catalog of the grasses of Connecticut: Master's thesis, Univ. of Conn., 93 p.

Driggs, A. W., 1901, Notes on the flora of Connecticut: Conn. School Document No. 198, Hartford.

Fernald, M. L., 1950, Gray's manual of botany: New York, American Book Co., 1632 p.

Gleason, H. A., 1952, The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada: New York, Hafner Publ. Co., Inc., 3 vols.

Graves, C. B., Eames, E. H., Bissell, C. H., Andrews, L., Harger, E. B., and Weatherby, C. A., 1910, Catalogue of the flowering plants and ferns of Connecticut: Connecticut Geol. Nat. History Survey Bull. 14, 569 p.

Harger, E. B., Graves, C. B., Eames, E. H., Weatherby, C. A., Woodward, R. W., and Bartlett, C. H., 1930, Additions to the flora of Connecticut (first supplement to Bull. 14): Connecticut Geol. Nat. History Survey Bull. 48, 94 p.

Hitchcock, A. S., 1950, Manual of the grasses of the United States: Washington, D. C., U. S. Gov. Printing Office, 1051 p.

Seymour, F. C., 1969, The flora of New England: Rutland, Vt., Charles E. Tuttle Co., 596 p.

Smithsonian Institution, 1975, Report on endangered and threatened plant species of the United States submitted to the 94th Congress, 1st session, House Document no. 94-51, Washington, D. C., U. S. Gov. Printing Office, 200 p.

U. S. Department of the Interior, Fish and Wildlife Service, 1975b, Threatened or endangered flora or fauna: review of status of over 3000 vascular plants and determination of "critical habitat": Federal Register (40 FR 27823-27924).

Upham, A. W., 1959, The flora of Windham county: a check list: Connecticut Geol. Nat. History Survey Bull. 91, 87 p.

It should be noted here that *Panicum aculeatum* Hitchc. & Chase, a Panic Grass, and *Cypripedium arietinum* R. Br., the Ram's-head Ladyslipper, both of which have been indicated by the Smithsonian (1975) and the U. S. Department of the Interior (1975b) as U. S. Threatened Plant Species occurring in Connecticut, have not to our knowledge been authenticated by voucher specimens from Connecticut. They are thus excluded from the following list, although their presence in the state remains a distinct possibility.

Habenaria blephariglottis (Willd.) Hook — White Fringed Orchis

Declining. Historically probably always a rare and local species of sphagnous bogs in the state. Several former localities of this orchid have disappeared in recent decades, particularly in Hartford County, where wetlands drainage and filling have been responsible for the loss of many wetlands. August.

Habenaria ciliaris (L.) R.Br. — Yellow-fringed Orchis

Declining. Near the northern limit of its range. Occurs locally in acid swampy woods, wet thickets, borders of dry sandy woods, and cemeteries in central and southern Connecticut. Becoming increasingly rare in northern parts of its range. Mid-July to August.

Habenaria dilatata (Pursh) Hook. — Leafy White Orchis

Rare. At the southern limit of its range. Grows in wet meadows, acid sphagnum bogs, and wet woods in the Northwest Highlands and North-Central Lowlands regions. June-July.

Habenaria macrophylla Goldie — Large Round-leaved Orchis

Indeterminate. At the southern limit of its range. A northern species of rich, old-growth forests, especially under pines. Formerly occurred in the Northwest Highlands and Northeast Uplands regions. Not recently reported. June-July.

Habenaria orbiculata (Pursh) Torr. — Round-leaved Orchis

Rare. At the southern limit of its major range, occurring only locally southward in the Appalachian highlands. Grows in dry-to-moist rich woods and forests in north-central and western Connecticut. June.

Isotria medeoloides (Pursh) Raf. — Small Whorled Pogonia

U. S. Endangered. A woodland orchid of very rare and local occurrence throughout its relatively restricted range. Grows in dry, rich woods, frequently under Beech trees. Remains dormant underground for periods up to 20 years or more before sending up a flower stalk. Not recently collected in the state, but believed extant. Found primarily in the Coastal and Southeast Hills regions. Mid-May to mid-June.

RARE AND ENDANGERED FISHES OF CONNECTICUT

Common names, scientific names and arrangement of families are presented according to Bailey (1970). Genera and species are arranged alphabetically within each family.

Habitat information on each species is primarily for Connecticut. Species' distributions in the state, when well known, are indicated by ecoregion (fig. 1) or major river system. The introduction of non-native fishes over the past 100 years in the state has been of such magnitude that it has been impossible in some cases to determine whether or not a species and its populations are truly indigenous to the state. As a result, in most instances we have been extremely conservative in the choice of candidates for inclusion in the present list of rare fishes. Even then, the native status of such species as the Burbot (*Lota lota*) and Round Whitefish (*Prosopium cylindraceum*) is still open to question.

The following major published references on Connecticut fishes were used in determining the present status and habitats of those fishes listed in this report, along with many other sources, especially faculty and departmental staff at both the University of Connecticut at Storrs and the Fish and Water Life Unit of the Connecticut DEP.

Bailey, R. M., ed., 1970, A list of common and scientific names of fishes from the United States and Canada (3rd ed.): Amer. Fish. Soc., Comm. on Names of Fishes, Spec. Publ. no. 6, 150 p.

Berrien, P. L., 1967, Distributions of the siluriform through pleuronectiform fishes found in the freshwater of Connecticut: Master's thesis, Univ. of Conn., 96 p.

Carlander, K. D., 1969, Handbook of freshwater fishery biology: Ames, Iowa State Univ. Press, v. I, 752 p.

Eddy, S., and Underhill, J. C., 1974, Northern fishes (3rd ed.): Minneapolis, Univ. of Minn. Press, 414 p.

Keller, W. T., 1968, Distributions of the cyclostome through cypriniform fishes found in the freshwater of Connecticut: Master's thesis, Univ. of Conn., 91 p.

Scott, W. B., 1967, Freshwater fishes of eastern Canada (2nd ed.): Toronto, Univ. of Toronto Press, 137 p.

Thomson, K. S., Weed, W. H., III, and Taruski, A. G., 1971, Saltwater fishes of Connecticut: Connecticut Geol. Nat. History Survey Bull. 105, 165 p.

Thorpe, L. M., 1942, Fishery management *in* A fishery survey of important Connecticut lakes: Conn. Bd. of Fish. and Game, Connecticut Geol. Nat. History Survey Bull. 63, p. 15-68, 289-295, 299-335.

Whitworth, W. R., Berrien, P. L., and Keller, W. T., 1968, Freshwater fishes of Connecticut: Connecticut Geol. Nat. History Survey Bull. 101, 134 p.

PETROMYZONIDAE (LAMPREY FAMILY)

Lampetra lamottei (LeSueur) American Brook Lamprey

Indeterminate. A strictly freshwater and nonparasitic lamprey of small brooks and streams. In Connecticut its distribution and habits are poorly known; it has been found only in the Connecticut River watershed. Young lampreys (ammocoetes) live buried in the bottom mud of small clear streams and are very vulnerable to pollutants and siltation. Adults are rarely seen except when congregating for spawning in the spring. The adults do not feed and die soon after spawning.

ACIPENSERIDAE (STURGEON FAMILY)

Acipenser brevirostrum LeSueur Shortnose Sturgeon

U. S. Endangered. An anadromous (i.e., lives in saltwater as an adult, spawns in freshwater) species formerly collected in the Connecticut River. Its present status in the state is unknown. There has been considerable dispute in recent years regarding its supposed endangered status throughout its range. The Shortnose Sturgeon is a bottom dwelling fish which feeds on small plants and animals intermingled with mud. It is highly susceptible to water pollution. Only limited spawning areas are available in the state. Spawns in the spring.

Acipenser oxyrhynchus Mitchill Atlantic Sturgeon

U. S. Threatened. Anadromous along the Atlantic Coast, small numbers of these bottom-feeding fish are reported each year in the Connecticut River and occasionally in other major rivers in the state. Only limited spawning areas are available for this species in Connecticut. Formerly more common in Long Island Sound in historical times, the decline of the Atlantic Sturgeon in Connecticut has been largely attributed to dams, although water pollution has also been implicated. Spawns in June and July. The young are found in estuaries and around the mouths of rivers.

SALMONIDAE (SALMON FAMILY)

Prosopium cylindraceum (Pallas) Round Whitefish

Indeterminate. Primarily a species of northern lakes where it generally frequents shallow waters. Feeds chiefly on invertebrates and plankton. In Connecticut its known distribution is limited to a single lake in the Northern Marble Valley. Spawns in autumn.

OSMERIDAE (SMELT FAMILY)

Osmerus mordax (Mitchill) — Rainbow Smelt

Indeterminate. An anadromous species of coastal streams and estuaries, the Rainbow Smelt has limited known spawning areas in the state. Spawning usually takes place in freshwater or brackish water in late winter or early spring. It is essentially predaceous, feeding on a variety of invertebrates and small fish, and occasionally plant matter.

GADIDAE (CODFISH FAMILY)

Lota lota (Linnaeus) — Burbot, Eelpout

Indeterminate. Characteristically a fish of northern waters, this species is known in Connecticut only from one museum specimen and one fisherman's report. A voracious fish of deep freshwaters of large rivers and lakes, it commonly spends the day under the shelter of stones and undercut banks in summer. It is predaceous on other fish. The Burbot is the single freshwater representative of the Codfish Family in North America. The spawning season of this species is from November to March and takes place in shallow waters of lakes and streams.

COTTIDAE (SCULPIN FAMILY)

Cottus cognatus Richardson — Slimy Sculpin

Rare. Primarily a northern species of spotty distribution in North America. Its distribution and life history in Connecticut are not well known. The Slimy Sculpin inhabits relatively clear and cold freshwaters of rocky streams and headwaters, particularly those with vegetation. Its food preferences are varied. Spawning takes place in spring.

RARE AND ENDANGERED REPTILES AND AMPHIBIANS OF CONNECTICUT

Scientific names, common names, and arrangement of families are presented essentially according to Schmidt (1953) and Conant (1975). Genera and species are arranged alphabetically within each family.

Habitat information on each species applies to Connecticut only. Species' distributions in the state are indicated by ecoregions (fig. 1) rather than by town or actual locality unless the species is widely distributed over the state or shows no particular affinity for one region or another.

Information on the past and current status of rare Connecticut herptiles was obtained from a number of sources, including published references, museum specimens from the University of Connecticut and Yale University, and field notes and observations of several amateur and professional herpetologists in the state. Selected references include:

Babbitt, L. H., 1937, The amphibia of Connecticut: Connecticut Geol. Nat. History Survey Bull. 57, 50 p.

Campbell, C. A., 1974, Survival of reptiles and amphibians in urban environments *in* Wildlife in an urbanizing environment: Amherst, Univ. of Mass., Planning and Resource Develop. Series 28, p. 61-66.

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CHELYDRIDAE (SNAPPING, MUSK, AND MUD TURTLE FAMILY)

Clemmys muhlenbergii — Bog or Muhlenberg's Turtle

U. S. Threatened. At the eastern limit of its relatively restricted geographical range. It inhabits open-canopied swamps, tussocky marshes and wet meadows traversed by clear, slow-moving streams with muddy bottoms. The Bog Turtle is in serious danger of extinction throughout its range as a result of both loss of its rather specialized habitat and the collection of individuals for sale in the pet trade. It is apparently restricted to the western border of the state, where it appears to be closely associated with calcareous wetlands in the Western Marble Valley regions.

Emydoidea blandingi — Blanding's Turtle

Indeterminate. Essentially a Midwestern turtle, the Blanding's Turtle is extremely localized and disjunct in its distribution in the East. Individuals are only very rarely encountered in Connecticut and no native populations have ever been located. However, since indigenous populations are known to occur in nearby Massachusetts, New York, and New Hampshire, it is not improbable that they may occur as natives in Connecticut. These turtles are largely aquatic, inhabiting lakes and marshy or boggy areas.

Kinosternon subrubrum subrubrum — Eastern Mud Turtle

Indeterminate. Possibly at the northern limit of its range. Its occurrence in southwestern Connecticut is still a matter of some dispute and the presence of any indigenous breeding populations has yet to be confirmed. The Mud Turtle inhabits shallow water with soft muddy bottoms and abundant aquatic vegetation, like that found in many small ponds, marshes, ditches, and wet meadows. It also occurs at the upper edges of tidal marshes.

SCINCIDAE (SKINK FAMILY)

Eumeces fasciatus — Five-lined Skink

Rare. The Five-lined Skink--New England's only lizard--has always been rare and local in Connecticut. Although known to occur in several locations in the southwestern part of the state, few individuals have ever been collected for confirmation. It inhabits moist woodlands where stumps and rotting logs are abundant and damp rocky areas (talus) with numerous crevices.

COLUBRIDAE (COLUBRID SNAKE FAMILY)

Opheodrys aestivus — Rough or Keeled Green Snake

Indeterminate. Possibly at the northernmost limit of its range in Connecticut, although common in southeastern United States. The Keeled Green Snake is principally a climbing snake which typically frequents dense growths of shrubs and low trees overhanging streams and lake margins. It is occasionally aquatic. Several individuals were reported many years ago from a single Connecticut locality, but none have been seen since. It may indeed prove to be extinct in Connecticut.

Opheodrys vernalis vernalis — Eastern Smooth Green Snake

Declining. A species of grassy areas such as pastures and lawns, the Smooth Green Snake, or Grass Snake, has declined greatly in Connecticut in recent years. It has been suggested that the power lawn mower may be responsible for its decline.

Storeria occipitomaculata occipitomaculata — Northern Red-bellied Snake

Rare. Very few individuals of this snake have ever been found in Connecticut, probably due in part to its extremely secretive nature and dimunitive size. The Red-bellied Snake is rather localized in its distribution throughout its range, being most abundant in mountainous and upland forests, and occasionally near open woods and boggy areas.

VIPERIDAE (PIT VIPER FAMILY)

Crotalus horridus horridus — Timber Rattlesnake

Declining. Once widespread and numerous, the Timber Rattlesnake has been completely extirpated in many areas of the Northeast. Its present distribution in Connecticut is extremely restricted, occurring in only a few localized areas in the central and northwestern parts of the state. Human disturbances have contributed significantly to its decline and rarity. Its preferred habitat is mostly heavily wooded upland areas with south-facing rocky ledges, although individuals will migrate to lower ground during dry periods. Contrary to widely held opinion, it is a rather shy and retiring snake.

PROTEIDAE (MUDPUPPY FAMILY)

Necturus maculosus maculosus — Mudpuppy

Indeterminate. A very large, aquatic salamander occurring most commonly in large permanent bodies of warm, turbid water, including slow-moving rivers and lakes. It has been found in a few rivers in central and western Connecticut, although it is apparently quite rare. The Mudpuppy is basically a midwestern species at the eastern limit of its range in Connecticut. It has been suggested that the Mudpuppy has been introduced in the state. However, it is common and native to the nearby Hudson River system and it is not improbable that it is indigenous to Connecticut.

PLETHODONTIDAE (LUNGLESS SALAMANDER FAMILY)

Gyrinophilus porphyriticus porphyriticus — Northern Spring Salamander

Rare. Locally occurring throughout its range, the Spring Salamander typically inhabits cold, swift-flowing mountain streams and clear springs in the Appalachians and Adirondacks. Most records of this salamander in Connecticut are from the northwestern part of the state.

Hemidactylium scutatum — Four-toed Salamander

Indeterminate. Although apparently widely distributed over the state, it is rarely reported. It is extremely secretive and difficult to locate, and may, in fact, be more common than is currently believed. It occurs under rocks, leaf litter, or rotting logs in wet boggy areas and marshy borders of ponds. Its supposed close association with Sphagnum (peat) mosses in other parts of its range does not appear to be true in Connecticut.

Plethodon glutinosus glutinosus — Slimy Salamander

Rare. Found under rotting logs and forest leaf litter, the Slimy Salamander inhabits very moist woods, especially wooded ravines and hillsides. Western Connecticut is the northeastern limit of its geographical range.

PELOBATIDAE (SPADEFOOT TOAD FAMILY)

Scaphiopus holbrookii — Eastern Spadefoot

Rare. Probably always a very rare local species. Although several colonies have been destroyed, the Spadefoot Toad is now known to occur only in a single locality in Connecticut in the North-Central Lowlands region. Typically inhabiting sandy soils in wooded areas, it breeds near these areas in kettle holes or other temporary pools following torrential rainfalls. Much of its life is spent below the ground, a factor which contributes to the lack of sightings in the state.

RARE AND ENDANGERED BIRDS OF CONNECTICUT

Common names, scientific names and arrangement of families are presented according to the Checklist of North American Birds, and supplements (A.O.U., 1957, 1973). Genera and species are arranged alphabetically within each family.

Habitat information on each species is for Connecticut only, unless such information is not well known or readily available. Species' distributions in the state are indicated by ecoregions (fig. 1) rather than by town or actual localities, unless the species is widespread over the state or shows no particular affinity to any one region.

The current status of rare Connecticut birds was determined from a number of different sources, although in large part from information generously provided to us from members of various bird clubs and Audubon chapters in the state, and from the faculty and staff members of several educational institutions in Connecticut. The following published references were among the many used for this report in determining the past and present status of the state's avifauna.

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GAVIIDAE (LOON FAMILY)

Gavia immer — Common Loon

Rare. An aquatic bird of quiet, secluded lakes and ponds of northern New England, New York, and Canada, in Connecticut the Common Loon is at the southern limit of its breeding range. Although a fairly common winter resident in the waters of Long Island Sound, it is and probably always has been a rare and sporadic breeder in the state. Breeding sites in the southern portion of its range, including Connecticut, are threatened by development and recreational use of lakeshore areas.

ARDEIDAE (HERON FAMILY)

Ardea herodias — Great Blue Heron

Rare. Although regularly occurring over the state throughout the year in fresh and salt waters of ponds, shores, marshes, swamps, and estuaries, nesting localities of these birds are quite rare. The Great Blue Heron appears to have always been a rare breeder in the state. Exactly why this is so is not well understood, but may be related to its requirements for seclusion and intolerance of human disturbance. Recent breeding sites are in the Northwest and Northeast Uplands regions.

Botaurus lentiginosus — American Bittern

Declining. An inhabitant of inland cattail and bulrush marshes and, less frequently, salt marshes. Once a common breeder in Connecticut, its present scarcity here and in other portions of its range has been attributed to habitat destruction and perhaps other factors. Pesticides and possibly PCB's, which the Bittern accumulates through its diet of fish, appear to be important factors in its decrease.

Bubulcus ibis — Cattle Egret

Rare. Originally an Old World species, the Cattle Egret has dramatically extended its breeding range into the New World. The first North American nesting record was in Florida in 1953; the first Connecticut breeding occurred in 1971. Breeding is currently restricted to the Western Coastal region. However, at its present rate of increase this species may be expected to become more common in the future. Cattle Egrets often feed in grassy areas, cultivated fields, pastures, and fresh and salt water marshes. They usually nest colonially in deciduous woods.

Casmerodius albus Great or Common Egret

Rare. Like the Little Blue Heron, the Great Egret was nearly extirpated during the late 1800's and early 1900's by plumage hunters. They have since made a remarkable recovery as a result of protection. It is a relatively new breeder in the state. Known breeding colonies in Connecticut are still quite rare and these are restricted to the Western Coastal region. It commonly feeds in swamps, coastal marshes and mud-flats, and usually nests colonially in deciduous woods.

Florida caerulea Little Blue Heron

Rare. The Little Blue Heron is usually a colonial nester and is most often observed along coastal marshes and mud-flats. Approaching its range limit in Connecticut, this southern wading bird has been expanding its breeding range northward in recent years. Few breeding records are currently known for Connecticut and these are from the Western Coastal region. Plume hunters greatly reduced its numbers in the late 19th Century, but it is now protected by federal law.

Nyctanassa violacea Yellow-crowned Night Heron

Rare. Chiefly southern in its distribution, the breeding range of this heron has been extending northward in recent years and is currently near its northern range limits in Connecticut. Primarily a coastal marsh and swamp feeder, the Yellow-crowned Night Heron nests in trees, shrubs, or on the ground in the Western Coastal region.

THRESKIORNITHIDAE (IBIS FAMILY)

Plegadis falcinellus Glossy Ibis

Rare. Like several of the herons and egrets, the Glossy Ibis is a relative newcomer to Connecticut and, as such, is currently only a very rare, local breeder in the Western Coastal region. It is near the northern limit of its breeding range. Ibises most commonly occur in coastal marshes where they feed, usually nesting colonially in low trees and shrubs. Like the Cattle Egret, it may be expected to increase its numbers in the state in the near future.

ACCIPITRIDAE (HAWK AND EAGLE FAMILY)

Accipiter cooperii Cooper's Hawk

State Endangered. At one time a common hawk of deciduous and coniferous woodlands in the eastern United States, the Cooper's Hawk has declined drastically throughout large portions of its range in recent years. This decline is believed to be the result of pesticide poisoning and human disturbance. Cooper's Hawk, which preys on birds, accumulates pesticides through its food chain. These substances have affected its reproductive ability. While now rare in the East, it is still a regular breeder in the southwestern United States.

Accipiter gentilis Goshawk

Rare. At the southern limit of its breeding range in Connecticut, this northern forest hawk typically inhabits coniferous forests and areas remote from human activities. In recent years the Goshawk has expanded its breeding range southward. This expansion may be related to decreases in populations of the Cooper's Hawk during the same period, suggesting competitive interaction between these two woodland hawks. Its increase is potentially threatened by falconers and shooting in some areas.

Accipiter striatus Sharp-shinned Hawk

Declining. Formerly a regularly breeding hawk in Connecticut, it has declined seriously both in the state and in other portions of its range. This is believed to be a result of human disturbance and pesticide poisoning. No recent breeding records for the state are known, although the extreme elusiveness of the Sharp-shinned Hawk may allow it to escape detection during this season. It nests primarily in coniferous forests.

Buteo lineatus Red-shouldered Hawk

Rare. After a decline of several decades, the Red-shouldered Hawk now appears to be on the increase. Once a common breeder in the state, particularly in wooded river bottoms and swampy areas, the reasons for its initial decline are not well understood, although pesticides have been implicated. Creation of new habitats by increased beaver activity may partially account for the present increase of this hawk.

Circus cyaneus Marsh Hawk, Northern Harrier

Declining. This bird has declined markedly in Connecticut and other portions of its range, probably the result of both habitat destruction and pesticide poisoning. In Connecticut it is primarily a bird of coastal, brackish, and salt marshes, inland fresh-water marshes, shrub swamps, and upland meadows. Unlike most eastern hawks, the Marsh Hawk nests on the ground or in low bushes.

Haliaeetus leucocephalus Bald Eagle

U. S. Endangered. Characteristically a bird of seacoasts, large remote lakes, and river shores. In recent decades the Bald Eagle has suffered a drastic decline throughout significant portions of its range, largely as a result of shooting, egging, removal of nest trees, urbanization, persistent pesticide pollution, and possibly PCB pollution. These chemicals, which are accumulated through its diet, have affected the Eagle's reproductive success. The Bald Eagle formerly bred in more remote portions of Connecticut.

PANDIONIDAE (OSPREY FAMILY)

Pandion haliaetus — Osprey

State Endangered. Less than 30 years ago the Osprey was a locally abundant breeding bird along the Connecticut Coast, especially near the mouth of the Connecticut River and east to Stonington. In recent years, this bird has been nearly eliminated as a breeder in Connecticut, as well as throughout much of eastern United States. Pesticides and possibly PCB's, which the Osprey accumulates through its diet of fish, have been held responsible for its decline because of the adverse effects of these chemicals on egg success. The decline of the Osprey population in Connecticut has been approximately 95 percent in 30 years; only small remnants of the coastal population persist in the state today, and these are restricted to the Eastern Coastal region. There are recent indications, however, that the Osprey may be recovering.

FALCONIDAE (FALCON FAMILY)

Falco peregrinus anatum — American Peregrine Falcon

U. S. Endangered. Native breeding populations of the Peregrine Falcon have been completely extirpated throughout the eastern United States as a result of a number of man-caused perturbations, including egging, collection of young by falconers, shooting both for "sport" and by pigeon fanciers (pigeons were a favorite prey of falcons in urban areas), road construction, and, of greatest significance, contamination of the environment with pesticides. Formerly nesting on high, rocky cliffs in the Central Lowlands regions of Connecticut, it now occurs in the state only as a fall and spring migrant. Through a cooperative program between Cornell University and the U. S. Fish and Wildlife Service, genetic stocks of Peregrines closely related to former eastern populations are now being artificially reared and later released in several northeastern states. Preliminary results are thus far encouraging.

RALLIDAE (RAIL FAMILY)

Coturnicops noveboracensis — Yellow Rail

Rare. An extremely shy and secretive small bird, the Yellow Rail is only very rarely observed in the wild. It breeds mainly in southern Canada, where it occurs in fresh-water marshes, meadows, and moist hayfields, but is apparently rare throughout its range. It occurs in Connecticut as an extremely rare migrant, most often being observed in the marshes of the Connecticut River valley. At one time it was believed to have bred in the state (1874), but this record is not generally accepted.

Laterallus jamaicensis — Black Rail

Rare. A local breeder throughout its range, the East Coast. Populations of the Black Rail apparently reach their northern range limit in or near Connecticut. Although rare instances of breeding probably still take place in the Coastal region, no breeding sites are currently known in the state for this extremely secretive salt marsh bird.

CHARADRIIDAE (PLOVER FAMILY)

Charadrius melodus — Piping Plover

Declining. In the East, this shorebird breeds almost exclusively on undisturbed coastal sand beaches such as occur along the Connecticut shore of Long Island Sound, in both the Western and Eastern Coastal regions. These habitats are rapidly being lost through recreation and housing development. Market gunning had greatly reduced its numbers by the end of the 19th Century; it was finally saved by federal laws which removed it from the list of game birds. By the 1920's, the Piping Plover had begun to recover, only to be faced with the destruction of its breeding habitat.

SCOLOPACIDAE (SANDPIPER FAMILY)

Bartramia longicauda — Upland Sandpiper

Declining. A characteristic bird of midwestern prairies, it is primarily associated with agricultural lands in Connecticut, particularly hayfields, old pastures, and other grassland types. Once a fairly common breeding bird in the early 19th Century, its populations have progressively diminished in the state due to the decline in agricultural use of the land, urbanization, and regrowth of forests in formerly open areas. It is presently a very rare and local breeder in the Central Lowlands region.

Catoptrophorus semipalmatus — Willet

Rare. After an absence of many years, the northward expansion of the Willet's breeding range appears to be resulting in its recolonization of Connecticut, However, there are currently no definite breeding sites known for the state. In the East, Willets breed primarily in salt marshes along the coast.

LARIDAE (GULL AND TERN FAMILY)

Sterna albifrons — Least Tern

Declining. A widespread though local breeding bird throughout its range. In the East it nests mainly on relatively undisturbed coastal sand beaches, habitats which in Connecticut are scarce and threatened by development and recreational pressures. The extreme localization of colonies of nesting Least Terns in the Coastal region renders them highly vulnerable to disturbance. In some areas populations are threatened by Norway Rats (*Rattus norvegicus*).

Sterna dougallii — Roseate Tern

Declining. A species of very local distribution in the United States, its major breeding range is largely restricted to southern New England and eastern Long Island. The Roseate Tern breeds in colonies on relatively undisturbed coastal beaches and offshore islands and is thus severely habitat limited. Its population size is subject to large periodic fluctuations as a result of both human-caused and natural disturbances. However, in Connecticut its general population trend appears to be downward. In recent years Herring Gulls and Great Black-backed Gulls have been responsible for displacing both Roseate and Common Terns on many of their breeding grounds. In addition, colonies of Roseate Terns on Long Island have recently shown an increased incidence of developmental abnormalities, apparently the result of one or more environmental contaminants.

TYTONIDAE (BARN OWL FAMILY)

Tyto alba — Barn Owl

Declining. Rarely observed except at its nesting sites, which include abandoned buildings, barns, old wells, and church steeples, the Barn Owl is associated with agricultural land although it also inhabits cities, suburbs, or wherever rodents are abundant and nesting sites occur. Largely an uncommon and local breeder, the Barn Owl is believed to be declining in parts of its range, most especially so in Connecticut. No active breeding sites are presently known in the state although summering individuals have been recently sighted in the North-Central Lowlands region. Near the northern limit of its breeding range in Connecticut, the Barn Owl is nonmigratory and subject to considerable mortality during severe winters.

STRIGIDAE (OWL FAMILY)

Asio flammeus — Short-eared Owl

Indeterminate. Formerly breeding in Connecticut, the Short-eared Owl has declined greatly in the Northeast. Although reasons for its decline are not well understood, habitat destruction and urbanization are undoubtedly involved. At one time this owl bred in grassy meadows and marshes, including salt marshes in Connecticut, where it nested on the ground. Unlike most owls it is active during the daytime.

Asio otus — Long-eared Owl

Indeterminate. Formerly breeding in Connecticut, no recent breeding records are known for this owl. It inhabits deciduous or coniferous woods, usually near open agricultural lands. The Long-eared Owl is strictly nocturnal and uses tree cavities and old nests of squirrels and other birds for its nesting sites.

CAPRIMULGIDAE (GOATSUCKER FAMILY)

Caprimulgus carolinensis — Chuck-will's-widow

Indeterminate. Until recently this chiefly southeastern species was unknown in the state except as an accidental visitor. Now extending its range northward, it is believed to be breeding in the Western Coastal region. It inhabits oak and pine woodlands, clearings, and edges of fields, where it nests on the ground.

PICIDAE (WOODPECKER FAMILY)

Centurus carolinus — Red-bellied Woodpecker

Rare. A southern species which has been expanding its breeding range northward in recent years. Formerly only an accidental species, it is presently a rare breeder, primarily in southwestern Connecticut. It nests in dead trees in mixed deciduous forests and swamps, especially near watercourses, and also in roadside trees and birdhouses. Its recent range expansion and increase in numbers may be due in part to the increasing numbers of dead American Elm trees along rivers, which provide an abundant source of insect prey.

Melanerpes erythrocephalus — Red-headed Woodpecker

Rare. Common in Connecticut during the early and middle 19th Century, the Red-headed Woodpecker has been an extremely rare breeder in the state since then. Decline of this species, which has occurred throughout most of its northeastern range, has been attributed to a number of factors, the foremost being a decline in agricultural land use in the Northeast. Destruction by automobiles as a result of the bird's habit of swooping low over roads to catch flying insects has affected it in recent years. Nesting competition from Starlings has also adversely affected it. Primarily a bird of open country, in the East it inhabits open woodlands, farmland with wooded borders, and very open swamps with dead trees. It nests in tree, pole, and fencepost cavities. Recent Connecticut breeding records are mostly from the western part of the state.

Sphyrapicus varius — Yellow-bellied Sapsucker

Rare. Although occurring locally farther south in the Appalachian Mountains, the Yellow-bellied Sapsucker reaches the southern limit of its major breeding range in Connecticut. It nests in cavities of dead trees in coniferous and deciduous forests or woodlands. Apparently it has always been a rare, sporadic breeder in the Northwest Highlands and Uplands regions.

TYRANNIDAE (FLYCATCHER FAMILY)

Empidonax virescens — Acadian Flycatcher

Rare. At the northern limit of its breeding range in Connecticut, the Acadian Flycatcher is typically a bird of moist deciduous forests, although on occasion it nests in much drier habitats. Formerly a more common breeder in the Northeast, it declined in the early 1900's in much of New Jersey, New York, and Connecticut for reasons which are not well understood. It is presently a rare and very local breeding bird in the state.

ALAUDIDAE (LARK FAMILY)

Eremophila alpestris — Horned Lark

Rare. This species breeds primarily along the coast in Connecticut in sandy, open areas and locally inland in waste places with patches of bare ground and sparse vegetation. Golf courses, airports, and other large, short-grass fields are also used for nesting. Originally a prairie species, it expanded its range eastward to include Connecticut in the 19th Century, where it still remains quite rare as a breeding bird.

HIRUNDINIDAE (SWALLOW FAMILY)

Petrochelidon pyrrhonota — Cliff Swallow

Declining. A formerly common and widespread breeder in Connecticut, the numbers of Cliff Swallows began declining throughout most of the Northeast around the end of the 19th Century. Because they attach their mud nests under the eaves of buildings, especially barns, their decline has been attributed to a growing scarcity of favorable nesting sites--namely, unpainted surfaces to which their nests can adhere. Nesting competition and harrassment from House Sparrows have also been implicated as possible factors in their decline.

Progne subis — Purple Martin

Declining. Although breeding in tree cavities prior to the arrival of European man in the New World, the Purple Martin now nests almost exclusively in multi-chambered "Martin houses." At one time widely distributed and common in Connecticut and the rest of the Northeast, it has been declining since the 1880's partly as a result of nesting competition from House Sparrows and Starlings. Breeding localities in the state are few and local in their occurrence.

TROGLODYTIDAE (WREN FAMILY)

Cistothorus platensis — Short-billed Marsh Wren

State Endangered. A species of wet, grassy or sedge meadows, bogs, and drier portions of salt marshes, the Short-billed Marsh Wren is a rare and erratic breeder throughout much of its range. Its rather specific habitat requirements, especially with respect to moisture conditions, probably accounts for its scarcity. It is presently known from the Northern Marble Valley and the Eastern Coastal region.

TURDIDAE (THRUSH FAMILY)

Catharus ustulatus — Swainson's Thrush

Rare. In Connecticut it is at the southern limit of its breeding range. Most of the current breeding records are from the northwestern part of the state. It nests primarily in northern coniferous forests.

Sialia sialis — Eastern Bluebird

Declining. Although still locally common in some parts of Connecticut, the Bluebird has been declining throughout much of its range. Reasons for the decline of this once common breeding bird have been attributed to nesting competition with Starlings and House Sparrows and loss of nesting habitat--farmlands and weedy fields with tree cavities for nest sites. In areas where nest boxes have been provided and Starlings and House Sparrows have been kept out, the Bluebird has exhibited a marked and favorable breeding response.

SYLVIIDAE (GNATCATCHER AND KINGLET FAMILY)

Regulus satrapa — Golden-crowned Kinglet

Rare. Although a common winter resident, the Golden-crowned Kinglet is rare as a breeder, reaching the southern limit of its breeding range in Connecticut. Typically a bird of northern coniferous forests, its breeding distribution is restricted to the higher elevations of the northeastern and northwestern parts of the state (Northwest Highlands and Northern Uplands regions).

PARULIDAE (WOOD WARBLER FAMILY)

Dendroica cerulea — Cerulean Warbler

Rare. A midwestern and southeastern warbler which has expanded its breeding range northeastward in recent years, it is currently at the eastern limit of its breeding range in Connecticut. While still quite rare as a breeder, summer sightings are becoming increasingly more frequent. The Cerulean Warbler is characteristically a species of river and stream bottomlands where there is an abundance of tall deciduous trees.

Dendroica coronata Yellow-rumped or Myrtle Warbler

Rare. A common spring and fall migrant, the Yellow-rumped Warbler is at the southern limit of its breeding range in the state, having recently extended its range southward. It nests in northwestern and probably northeastern Connecticut in coniferous and mixed forests. Possibly more common than supposed.

Dendroica magnolia Magnolia Warbler

Rare. In spite of its name, the Magnolia Warbler is typically a bird of cool coniferous and mixed forests of the North. In Connecticut, the southern limit of its breeding range, breeding is essentially restricted to the Northwest Highlands and Uplands regions.

Dendroica pinus Pine Warbler

Rare. As its name implies, the Pine Warbler breeds almost exclusively in pine forests. In the East, sandy pine "barrens" dominated by Pitch Pine (*Pinus rigida*) are preferred habitats, although other pines may be utilized on rare occasions. It appears to have always been a rather rare breeder in Connecticut, probably because of scarcity of adequate habitat.

Oporornis formosus Kentucky Warbler

Indeterminate. Although always a rare breeder in Connecticut, where it reaches the northern limit of its breeding range, the Kentucky Warbler withdrew from most of the Northeast around the turn of the century for reasons which are not presently known. It is apparently now extinct in the state. It nests in dense understory vegetation of moist deciduous woodlands, thickets, and shady ravines near streams.

Parula americana Northern Parula

Rare. In the Northeast this species is principally a bird of deciduous and coniferous forests along the coast. In the 19th Century the Parula was a regular and common breeder in Connecticut, but nesting records for it are extremely rare today. Its decline during the early 1900's coincided with the decline of *Usnea* lichens, or "Beard Moss," which the Parula used as its major nesting material. The cause of the disappearance of Beard Moss, both in Connecticut and Long Island, is not definitely known, although the extreme sensitivity of lichens to air pollution is probably involved.

FRINGILLIDAE (FINCH FAMILY)

Ammodramus henslowii — Henslow's Sparrow

State Endangered. Formerly a common breeding bird in northwestern Connecticut, the Henslow's Sparrow is declining seriously throughout the eastern portions of its range. Local and unpredictable in its occurrence, it is characteristically a bird of wet grassy meadows, habitats which are now being lost through urbanization, decline in agricultural land use, and destruction of wetlands.

Ammodramus savannarum — Grasshopper Sparrow

Declining. Formerly a common breeding bird of dry, tall grasslands, especially in cultivated fields, pastures, hayfields, and abandoned weedy fields in much of the Northeast. It has declined in parts of its range, including Connecticut, primarily as a result of loss of habitat, associated with a decline in agriculture and subsequent industrial and suburban development. Currently it is an extremely rare and local breeder in the state.

Hesperiphona vespertina — Evening Grosbeak

Rare. Characteristically a bird of boreal coniferous forests, the Evening Grosbeak is currently near the southern limit of its breeding range in Connecticut. Virtually unknown in the state before 1890, it was still regarded as an extremely rare accidental winter visitor in 1910. It has since expanded its breeding range dramatically; the first recorded breeding in Connecticut occurred in 1962. It is now a rare though possibly only sporadic breeder in northern Connecticut.

Passerculus sandwichensis — Savannah Sparrow

Declining. Generally a colonial nester, the preferred breeding habitats of the Savannah Sparrow include moist or dry dense grassy fields--especially agricultural fields and pastures, salt marshes, and, rarely, sand dunes. It is successful in some parts of its range on dry sand-fill or spoil areas. Formerly a common breeder in Connecticut, its present decrease has been attributed to loss of habitat as a consequence of decline in agricultural land-use.

Passerculus sandwichensis princeps — Ipswich Sparrow

U. S. Threatened. Declining primarily as a result of the physical erosion of its major breeding locality: Cape Sable Island, Nova Scotia. The Ipswich Sparrow occurs in Connecticut during migration and winter on grass-covered coastal beaches along the shores of Long Island Sound--habitats which are currently threatened by development.

Pooecetes gramineus Vesper Sparrow

Declining. A species of dry short-grass fields, pastures, and cultivated land, it is suffering from a loss of breeding habitat associated with a decline in agricultural land use in the East. Chiefly a mid-western and western bird, the Vesper Sparrow was formerly more widespread and common in Connecticut; it is presently only a very rare and local breeder.

RARE AND ENDANGERED MAMMALS OF CONNECTICUT

Scientific names, common names, and arrangement of families are presented according to Jones, Carter, and Genoways (1975). Genera and species are arranged alphabetically within each family.

Habitat information on each species is primarily for Connecticut. Species' distributions in Connecticut are indicated by ecoregions (fig. 1) rather than by towns or actual locality, unless the species is widely distributed over the state or shows no particular affinity to one region or another. Information on the past and present status of rare Connecticut mammals was obtained from a number of published and unpublished reports, museum specimens and personal interviews with acknowledged experts at the University of Connecticut, Yale University, and Southern Connecticut State College. The following selected major published sources of information were used extensively in this report.

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SORICIDAE (SHREW FAMILY)

Cryptotis parva — Least Shrew

Indeterminate. The Least Shrew has not been recorded in the state for a number of years. An extremely small and secretive mammal, little is known of its habits. Occurs primarily in salt meadows and other grassy areas in the Western Coastal region of Connecticut, the northern limit of its geographical range.

VESPERTILIONIDAE (BAT FAMILY)

Myotis keenii — Keen's Bat

Rare. Keen's Bats are found only rarely in large groups throughout their range. Caves and mines provide winter shelter, while in summer a variety of shelters, including buildings, cliff crevices, and hollow trees, as well as caves are used. It feeds along forest edges and over ponds and clearings. The habits of the Keen's Bat are not well known. Few individuals have ever been found in Connecticut.

Myotis leibii leibii — Small-footed Myotis

Indeterminate. Common and widespread in the western United States, the eastern race of this bat is one of the rarest and smallest of the eastern U. S. bats. Hibernating only in caves and mines, in summer it may also use buildings and trees. Although not definitely recorded in Connecticut, its occurrence is considered probable in view of its native occurrence in New York State near the western border of Connecticut.

Myotis sodalis — Indiana Bat

U. S. Endangered. In Connecticut the Indiana Bat has been reported from only a single locality, the habitat of which has since been destroyed. Although no individuals have been found in many years, it may still occur in natural caves in the Western Marble Valley region or in abandoned mines in other parts of Connecticut. Caves with high humidities and moderate temperatures are used for hibernating and mating. Its summer habits are poorly known, although it probably seeks out cool places for roosting. It has declined greatly throughout its range in recent years, in many instances probably as the result of human disturbances, including cave exploring, habitat destruction, and possibly insecticides.

SCIURIDAE (SQUIRREL FAMILY)

Glaucomys sabrinus — Northern Flying Squirrel

Indeterminate. Although occurring locally farther south along the Appalachian Mountains, the Northern Flying Squirrel is at the southern limit of its major geographical range in the Northern Uplands and Highlands regions of Connecticut. Essentially an inhabitant of northern coniferous and mixed hardwood forests, it nests in natural tree cavities and woodpecker holes. Its close resemblance to the more common Southern Flying Squirrel *(Glaucomys volans)* as well as its nocturnal habits have contributed to the difficulty in determining the status of this species in Connecticut. At present only two authentic specimens have been taken in the state, both in winter, and these may simply represent wandering individuals.

CRICETIDAE (RAT AND MOUSE FAMILY)

Neotoma floridana — Eastern Woodrat

Indeterminate. Sensitive to human disturbance, the Woodrat typically inhabits rocky ledges, caves, and rock piles on mountain slopes, usually in wild, secluded areas. It is extremely rare or perhaps unnoticed in the state and is probably to be expected at higher elevations in the Northwest Uplands and Highlands regions. Although there have been no recent sightings of individuals, characteristic nests of this species have been observed in northwestern Connecticut.

Peromyscus maniculatus — Deer Mouse

Rare. Widespread and common throughout much of the United States, the Deer Mouse occurs only very locally in Connecticut. This species is very difficult to distinguish from the much more abundant White-footed Mouse, a factor which makes it difficult to determine its distribution and abundance in the state. It inhabits relatively dry forests and grassy meadows.

Synaptomys cooperi — Southern Bog Lemming

Rare. The extremely secretive habits of the Bog Lemming and its occurrence in densely vegetated habitats make it difficult to determine its distribution and abundance in the state. Inhabits marshes, wooded bogs, and swamps, especially Atlantic White Cedar swamps in eastern Connecticut.

URSIDAE (BEAR FAMILY)

Ursus americanus

Black Bear

Rare. The Black Bear was a common forest and swamp dweller in the state until the mid-1800's, when habitat destruction and excessive hunting brought about its complete extirpation from Connecticut. While still rare today, bears, including cubs, are on occasion reported in more remote areas of the state. The decline in agricultural land use and charcoaling has restored former habitats through the regrowth of forest resulting in the apparent repopulation of the Black Bear's former territory. They winter in caves and hollow trees.

MUSTELIDAE (WEASEL FAMILY)

Martes pennanti

Fisher

Indeterminate. This former resident was extirpated in Connecticut by the early 1900's, probably as a result of excessive trapping and loss of woodland habitat at that time. The Fisher is believed to be currently extending its range southward from northern New England, where it is still fairly common, and may now occur again in wilder portions of northwestern Connecticut. This range extension has been attributed, at least in part, to the recent increase and range extension of the Porcupine, a major prey species of the Fisher. A northern forest and swamp dweller, the Fisher's secretive and nocturnal habits may be partially responsible for the lack of any recent definitive records or sightings in the state.

FELIDAE (CAT FAMILY)

Felis concolor cougar

Eastern Cougar or Mountain Lion

U. S. Endangered. An inhabitant of wild, generally mountainous and heavily forested areas. Formerly not uncommon in the northern part of Connecticut, the Cougar, or Eastern Mountain Lion, was extensively hunted for bounty during the Colonial period and finally extirpated in the state by the early 1800's. Although its present status is poorly known, the Cougar is apparently reestablishing itself in the East. A wide-ranging hunter, it may now on occasion wander through and perhaps even breed in wilder, more remote areas of the state. Caves and overhanging ledges are preferred den sites, although thickets may also be used.

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APPENDIX

Definitions of Categories

U. S. Endangered Taxon: (U. S. Endangered)
In immediate danger of extinction throughout all or most of its range; normally occurring in Connecticut during at least a portion of the year. Listed as "endangered" in Report on Endangered and Threatened Plant Species of the United States (Smithsonian Institution, 1975), United States Fish and Wildlife Service reports (U. S. Department of the Interior, 1975b, 1976a,b), or United States List of Endangered Fauna (U. S. Department of the Interior, 1974).

U. S. Threatened Taxon: (U. S. Threatened)
Likely to become endangered in the near future throughout all or most of its range; normally occurring in Connecticut during at least a portion of the year. Listed as "threatened" in Report on Endangered and Threatened Plant Species of the United States (Smithsonian Institution, 1975), United States Fish and Wildlife Service reports (U. S. Department of the Interior, 1975b, 1976a), or Threatened Wildlife of the United States (U. S. Department of the Interior, 1973).

State Endangered Taxon: (State Endangered)
In danger of extinction in Connecticut as a reproducing taxon; rare or very local throughout all or much of its range, or having a relatively restricted geographic range.

State Declining Taxon: (Declining)
A threatened taxon, whose populations are currently undergoing a prolonged, noncyclic decline in Connecticut and in many other parts of its range, and is either approaching rarity or is already very rare in the state. These taxa are likely to become endangered within the near future in the state.

State Rare Taxon: (Rare)
Populations and/or individuals occurring in very low numbers relative to other similar taxa in the state, although common or regularly occurring throughout much of their ranges. They may be found in a restricted geographic region or occur sparsely over a wider area. Although rare, populations are apparently stable. Also included in this category are migrant or wintering birds that regularly occur in Connecticut, although are rare throughout all or much of their range.

Taxon of Indeterminate Status: (Indeterminate)
One whose population status within the state is unclear or unknown at this time; further investigation and additional information is necessary. This category includes those taxa that have not been collected or observed in a great many years and which may now be extinct in the state.