

**North Jersey Resource Conservation & Development**

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# **Fish and Wildlife in the Upper Delaware Watershed**

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A Technical Report for the Upper Delaware  
Watershed Management Project  
December 2002





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The Fish and Wildlife Report is intended to provide an overview of the fish and wildlife resources of the Upper Delaware Watershed as well as some of the concerns about the resources expressed by stakeholders involved with the Upper Delaware Watershed Project.

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# Fish and Wildlife of the Upper Delaware Watershed

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## Introduction

Fish and wildlife resources play a critical role in the Upper Delaware Watershed. Interest in wild things is as old as human civilization itself. Today's attitudes towards fish and wildlife resources vary from intense interest by some individuals to complete indifference or even contempt for some wildlife species and wildlife populations. Fish and wildlife can affect the structure and function of ecosystems. Some species pollinate, help germinate and disperse many plants. Fish and wildlife play a role in nutrient flux and cycling and help break down organic wastes and some pollutants. They also provide spiritual and intellectual stimulation. Lastly fish and wildlife maintain biological diversity through their interactions with their habitat and among species.

Fish and wildlife have important economic value in today's world. In 1991, 25 million Americans spent over \$5.2 billion taking trips to observe, feed or photograph birds (US Fish & Wildlife Service, 1995). The US Fish & Wildlife Service reported in 1996 that 77 million people in the United States participated in wildlife related recreation creating \$101 billion in expenditures (Heard, 1999). In that same report it was noted that in 1995, 26% of New Jersey's population participated in "wildlife watching" which generated \$1.8 billion in expenditures in New Jersey. Studies of ecotourism in parts of New Jersey revealed that birding can result in as much as \$10 million to local communities adjacent to National Wildlife Refuges (Kerlinger 2002). Deer hunters spend more than \$100 million each year in New Jersey according to the New Jersey Division of Fish & Wildlife. Expenditures by anglers in Warren County, New Jersey are nearly \$20 million annually (McDowell 2000).

On the other hand, wildlife damage has become a significant topic in the Upper Delaware Watershed as well as the rest of New Jersey and the Northeastern United States. Species such as white-tailed deer, black bear, Canada geese and beavers have become more abundant in recent years causing conflicts with human populations such as crop damage, car accidents, water quality degradation and other problems. Drake and Grande (2001) report that in 2000, farmers on 111 farms covering 1400 acres in New Jersey claimed \$1.8 million dollars in crop losses to 10 different species of wildlife. The New Jersey Division of Fish & Wildlife (Holloway, Personal Communication) reported that in 2000, 1375 complaints were received by the Division about black bears. The incidents resulted in over \$200,000 worth of damage and included crop loss, livestock and pet kills and home entries.

The Upper Delaware Watershed provides some of the best quality fish and wildlife habitat in New Jersey for important game and nongame species and threatened or endangered species. The watershed includes over 100,000 acres of public land in National Recreation Areas, State Parks, State Forests, Wildlife Management Areas and other public holdings. This represents 22% of the land base in the watershed and this is one of the highest percentages of any New Jersey watershed. The public lands provide quality fish and wildlife habitat for the watershed. The stresses on fish and wildlife habitat from increased development and the resulting habitat loss will continue to occur without careful natural resource management. Habitat fragmentation will continue as housing, commercial development, roads, utility lines and communication towers spring up in forests and fields throughout the watershed. The wildlife damage issues will continue to grow as more people move into the area in close proximity to wildlife populations.

# Fisheries Resources

The Upper Delaware Watershed includes more than 300 miles of stream classified as trout production waters by NJ DEP. Over 40% of New Jersey's trout production and trout maintenance waters are found in the Upper Delaware Watershed. The classification as trout production and trout maintenance waters not only indicates suitability for the brook, rainbow and brown trout found in New Jersey, but also indicates the streams high level of water quality for other aquatic organisms and other human uses (swimming, drinking, etc.). Map 1 shows trout stream classifications in the Upper Delaware Watershed, as well as the location statewide of trout production streams.

In addition to the cold-water trout fishery, the Delaware River and some of the larger tributaries are home to other important cool and warm water recreational fishes such as, striped bass, smallmouth bass, walleye, muskellunge, channel catfish and American shad.

The return of the American Shad (*Alosa sapidissima*) to the Delaware River is a success story for both fisheries and water quality. Shad were nearly wiped out by pollution but have returned to become an important game fish in the river. Several towns along the Delaware River hold annual shad festivals that are important to the local economy and tourism industry. Below is a brief history of shad in the Delaware from the Delaware Shad Fisherman's Association:

When the Leni Lenape - the "Original People" - arrived at the valley of the Delaware River around A.D. 1396 after an epic migration that began in Asia 9,000 years earlier, they found a land of lush, green forests that were alive with animals and birds, and clear, sparkling rivers that teemed with fish. White settlers exploring the Delaware Valley two centuries later found the same scenario. An unnamed Englishman who visited the New World in 1588 was amazed by the variety of underwater life. In a letter to home he wrote:

*"For foure moenthes of the yeere, February, March, April and May, there are plentie of Sturgeons and also in the same moenthes of Herrings; some of the ordinary bignesse as ours in England, but the most part farre greater, of eighteene, twentie inches, and some two foot ein length and better. There are also Troutes, Porpoises, Rayes, Oldwines, Mulletts, Plaice, and very many other sortes of excellent good fish, which we have taken and eaten, whose names I know not but in the country language."*

The herring seen by the English traveler probably included the largest herring of all, the white shad, a relatively large, deep-bodied silver fish whose abundance was so great that it naturally became a source of food and income. What made shad even more important than other fish, though, was its taste. centuries later, well-known American ornithologist, Alexander Wilson, would dub the white shad *Alosa sapidissima*, or "most delicious shad". The Delaware River also harbored tremendous runs of migratory Atlantic and shortnose sturgeon, white perch, white catfish and river herring.

Shad rivers up and down the East Coast underwent drastic changes in the early 19th century as America began its change to an industrial society. Pollution came from unabated factory and sewage waste, from coal silt and sawdust, from tanneries and slaughter houses and a myriad of other businesses that treated the young nation's streams as nothing more than nature's gutters.

In late summer of 1955, twin hurricanes Connie and Diane lambasted portions of the East Coast with relentless fury. Particularly hard hit was the Delaware Valley, where the storms arrived on the heels of each other and dumped record amounts of rainfall in New York's Catskill Mountains and Pennsylvania's Poconos. Flooding was unprecedented and the loss of lives and property was staggering. Every dark cloud is said to have a silver lining, though, and if indeed there was one in the case of this natural disaster, it was that the Delaware River received a scouring that washed away decades of built-up pollutants and silt. Many people believe that this great flood of '55 was the beginning of the modern shad revival in the Delaware Valley.

With the passage of the Clean Stream Act [Clean Water Act] in 1970, cities such as Philadelphia and Camden were mandated to upgrade sewage treatment facilities. Around the same time, the Environmental Protection Agency toughened its pollution laws and cracked down on industries that were fouling rivers and smaller streams across the country.



**Figure 1: American Shad**

Slowly, the Delaware River became a cleaner environment for all fish species. By 1975, Fred Lewis's annual commercial catch in Lambertville had blossomed to 1,721 fish, and in 1979, he caught 2,052. By the late 1980s, the Delaware's shad population topped 700,000. And in 1992, there were almost one million fish entering the river according to estimates by the New Jersey Division of Fish, Game and Wildlife. Spawning grounds, which before 1970 were restricted to cleaner waters above the Delaware Water Gap, now extended south to Trenton and even into small tributaries entering Delaware Bay.

The striped bass (*Morone saxatilis*) in recent years has become more abundant in the Upper Delaware River. Historical data on Delaware River Basin striped bass stocks are scarce. There is insufficient data to determine abundance over an extended period of time. Early reports on the status of fish stocks in the Delaware River suggest that the basin once supported a thriving striped bass population prior to the Industrial Revolution. Commercial landings have been highly variable over time. Today, only the state of Delaware allows commercial fishing for striped bass.

Recreational freshwater striped bass fishing on the Delaware River in New Jersey takes place from the Philadelphia to the New York state border. Spawning takes place in the lower Delaware River up to the Route 1 Bridge in Trenton. Many striped bass continue to migrate farther up river while feeding on the spawning population of river herring and American shad that precede them. Large stripers have been caught in the Delaware River well up into New York State. Striped bass fishing usually commences around mid May.

The NJ DEP, Division of Fish & Wildlife manages fisheries resources in the Upper Delaware Watershed and throughout New Jersey. This responsibility includes protecting natural populations of fish, and maintaining a reasonable sustained annual harvest of fish. A trout-stocking program provides over 600,000 fish annually to New Jersey waters for recreational fishing purposes. The Pequest Hatchery, situated along the Pequest River in central Warren County, has been on line since 1983. The hatchery uses abundant ground water resources in the Pequest Valley to produce rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*) each year for the Division of Fish & Wildlife's stocking program.

Warm water species including channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), muskellunge (*Esox masquinongy*), northern pike (*Esox lucius*) and walleye (*Stizostedion vitreum*) have been stocked in the Upper Delaware Watershed rivers, streams, lakes and ponds by the Division of Fish & Wildlife in recent years. The Division's Hackettstown Hatchery, along the Musconetcong River opened in 1911, produces these warm water species. More than 25 public lakes provide recreational fishing for these warm water species in the Upper Delaware Watershed. Hundreds of private small lakes and farm ponds also furnish quality warm water angling opportunities.

## Wildlife Resources

New Jersey is home to over 500 species of vertebrate animals considered “wildlife”. If you consider invertebrate species such as recent additions to rare species lists like butterflies, beetles, dragonflies, damselflies and freshwater bivalves, the number of “wildlife” species is probably in the thousands. The Upper Delaware Watershed currently provides quality habitat for many of these species. The watershed’s wildlife habitat is changing and becoming more fragmented as land use patterns in the watershed change.

Important game species such as white-tailed deer, wild turkeys, cottontail rabbits and gray squirrels are abundant throughout the watershed. Other game species that occur naturally in the watershed include ring-necked pheasants and ruffed grouse. Waterfowl and wading birds are abundant in wetlands and along the major rivers especially the Delaware, Musconetcong, Pequest and Paulins Kill. Some species of waterfowl breed in these wetland complexes and other species use Upper Delaware Watershed wetlands as wintering habitat. The riparian areas are important migratory corridors for ducks, geese, and some shorebirds. Two large rookeries for the state threatened great blue heron are present in the Upper Delaware Watershed. One rookery is along the Pequest River in Independence Township, Warren County and one is located in the upper reaches of the Paulins Kill drainage in Lafayette Township, Sussex County. The *NJ Audubon Breeding Bird Atlas* (Walsh 1998) lists 166 species of birds that breed and rear young in the Upper Delaware Watershed. A full list of breeding birds from the Breeding Bird Atlas is provided in Appendix A.

Deer hunting is an important contributor to the local economy in the Upper Delaware Watershed and much of the quality deer habitat in New Jersey is found in the watershed. Deer are managed in New Jersey by deer management zones. Deer management zones are areas with similar herd characteristics, hunting pressure and deer habitat, and are bounded by highways, rivers and other easily identifiable landmarks. In 1998, there were sixty-seven different deer management zones of varying sizes throughout the state. The Upper Delaware Watershed includes all of zones 1, 4, 5, and 7 and parts of zones 2, 6, 8, and 10. The number of deer harvested has increased dramatically in the watershed in the last 30 years. In 1980 only about 5000 deer were taken in the watershed. By 1990 the watershed deer harvest had increased to about 11,500 deer annually. And in the 2000-2001 seasons approximately 18,500 deer were harvested in the Upper Delaware Watershed, accounting for about one quarter of all the deer taken in New Jersey.

The return of the eastern wild turkey to New Jersey is an important achievement in modern wildlife management and it began in New Jersey in the Upper Delaware Watershed in the 1970’s. Today New Jersey supports a healthy population of turkeys throughout much of the state that came from an initial release of a few wild birds in Sussex County. The NJ Division of Fish & Wildlife estimates the statewide population at 23,000 birds. A season for wild turkeys was instituted in 1982. A native bird that did not occur in the watershed only 25 years ago is now a common sight with thousands harvested annually by turkey hunters.

Reptiles and amphibians (herptiles or “herps”) are abundant in the Upper Delaware Watershed. Amphibians include 14 species of salamanders and 14 species of frogs and toads. Twenty-six reptiles are represented by 15 species of snakes, 10 species of turtles and only 1 lizard species. The *New Jersey Herptile Atlas*, headed by the New Jersey Division of Fish & Wildlife’s Endangered & Nongame Species Program (ENSP), is a quantitative survey of all reptile and amphibian species throughout the State. The *Herp Atlas*, through the efforts of ENSP and its many volunteers, is collecting data on the specific location and abundance of all reptile and amphibian species in the state. This data will be used to map the critical habitat, abundance, and distribution of our state’s herp species. The *Herp Atlas* is an ongoing effort that should provide new information on species occurrence and abundance throughout New Jersey. A list of the reptile and amphibian species reported for the Upper Delaware Watershed by the *Herp Atlas* project is provided in Appendix B.

## Rare Species Habitat

The NJ DEP, Division of Fish & Wildlife's Endangered and Nongame Species Program (ENSP) is responsible for management of rare species of wildlife in New Jersey. The ENSP mission is "to actively conserve New Jersey's biological diversity by maintaining and enhancing endangered and nongame wildlife populations within healthy, functioning ecosystems". The program is responsible for the protection and management of nearly 500 wildlife species found in New Jersey. These include the 61 species currently listed as endangered or threatened.

In 1994 the ENSP adopted a large-scale (landscape level) approach to protect rare species and important habitats, which is entitled, the Landscape Project. The Landscape Project is a pro-active, ecosystem-level approach for the long-term protection of rare species and their habitat in New Jersey. One of the unique features of the Landscape Project is that it focuses on the big picture and not just on individual rare species locations as they become threatened. The Landscape Project identifies critical wildlife habitats within large landscapes that must be preserved now if we want to assure the conservation of New Jersey's rare wildlife for future generations. Since many animal populations require large expanses of natural habitat for their long-term survival, the Landscape Project focuses on large areas that are ecologically similar with regard to their plant and animal communities.

Using a Geographic Information System (GIS), the ENSP is developing maps that identify critical wildlife habitat based on rare species location information and land cover classifications. Areas of critical rare species habitat within each landscape region have been identified and mapped using an extensive database of rare species location information and land use classification data. Landscape Project maps provide an accurate, reliable and scientifically sound information base for habitat protection needs within each landscape. Critical wildlife habitat is delineated from 1 (lowest score) to 5 (highest score) based upon the conservation status of wildlife species present as follows:

- 5 = Federally Threatened or Endangered Species
- 4 = State Endangered Species
- 3 = State Threatened Species
- 2 = Non-listed State Priority Species
- 1 = Potential for Endangered or Threatened Species

Areas delineated as a 1 meet minimum size requirements, but have not been adequately surveyed to determine the presence or absence of rare species.

The Landscape Project has been designed to provide users with scientifically sound information that is easily accessible and can be integrated with planning and protection programs at every level of government. Landscape Project maps and overlays provide a basis for proactive planning such as the development of local habitat protection ordinances, zoning to protect critical habitat, management guidelines for rare species protection on public and private lands, and land acquisition projects. Maps 2-6 depict the Landscape Project's "Critical Areas" for the five major subwatershed groups in Upper Delaware Watershed.

The majority of the land base in the Upper Delaware Watershed provides critical forest, forested wetlands, emergent wetlands or grassland habitat as defined by the Landscape Project and shown in the five maps of the major subwatersheds. Fourteen percent of the entire state's critical forest wildlife habitat is found within the Upper Delaware Watershed and 13% of the state's critical grassland wildlife habitat is also found in the Upper Delaware Watershed. This is no doubt due in part to the large percentage of agricultural land and forestland found in the watershed. The relatively large, unbroken tracts of forestland and grassland present provide quality habitat for forest and grassland wildlife. Increasing development in the watershed is constantly fragmenting these areas. While not present in as large numbers, the Upper Delaware Watershed includes over 4% of the state's critical wetland forest and 4% of the state's critical emergent wetlands as defined by the Landscape Project. This is still very significant and illustrates the importance of wildlife habitat in the Upper Delaware Watershed. Along with the Pinelands and the Delaware Bay areas, the Upper Delaware Watershed has some of the most important wildlife habitat in New Jersey.

The Flat Brook Watershed group (Map 2) is dominated by critical forest wildlife habitat with over 69,000 acres. More than 75% of this watershed is wooded. This large percentage of forest can be attributed to the amount of land in state and federal ownership. The woodland provides habitat for a number of the area's threatened or endangered species such as timber rattlesnakes, long-tailed salamanders, Cooper's hawks and goshawks. The woodlands also provide valuable habitat for many neotropical migrant bird species such as warblers, vireos and thrushes. Wetland forest acres (almost 6000 acres) provide habitat for rare species such as red-shouldered hawks and wood turtles. The Flat Brook sub-watershed does include over 3300 acres of critical grassland habitat, mostly clustered around agricultural lands in the fertile stream valleys. These areas provide important habitat for the federally threatened bog turtle and several species of state threatened or endangered grassland birds.

The Paulins Kill Watershed group (Map 3) also includes significant acreage in critical forest wildlife habitat, almost 65,000 acres much of this in the northern half of that watershed. This area also includes federal and state owned forestland where rare species can find protection from development. The agricultural lands in the eastern reaches of the watershed and along the Paulins Kill provide over 18,000 acres of critical grassland habitat. Grassland birds and the federally threatened bog turtle are found in these important grassland habitats. Over 7000 acres of critical wetland forest in the watershed provides habitat for species such as red-shouldered hawks, barred owls and a rookery for great blue herons.

The Pequest Watershed group (Map 4) includes more than 45,000 acres of critical forest wildlife habitat, representing almost one half of the area of this sub-watershed. Much of this woodland is located on the steep ridges of Jenny Jump State Forest and Allamuchy State Park and forests along the Pequest River. These woodlands provide habitat for many of the rare birds, reptiles and amphibians found in the Upper Delaware Watershed. Additionally over 19,000 acres of critical grassland wildlife habitat is present in the agricultural areas spread throughout the watershed. The majority of this grassland is critical habitat for state threatened grassland birds such as the grasshopper sparrow, savannah sparrow and bobolink. This watershed also includes significant critical wetland habitat acreage with 6500 acres of forested wetland and about 5200 acres of emergent wetlands. These wetlands provide important habitat for many game species and nongame species. The wetlands are protected by the NJ Fresh Water Wetlands Act and should continue to provide valuable habitat for perpetuity.

The Pohatcong and Lopatcong Watershed group (Map 5) includes over 22,000 acres of critical forest wildlife habitat or about 32% of the forest found in this sub-watershed. Over 60% of this critical forest wildlife habitat is scored as a "5" (the highest score by the NJ Division of Fish & Wildlife). This is due to the presence of nesting bald eagles (federally threatened) at the Merrill Creek Reservoir in Harmony Township, Warren County. Almost 24,000 acres of critical grassland habitat is found in this watershed group. The grassland habitat is clustered in several intensively farmed areas in Harmony Township, Pohatcong Township and Franklin Township. Only about 2000 acres of critical wetland habitat occur on this watershed. The most critical wetland habitat is found in the upper reaches of Pohatcong Creek.

The Musconetcong Watershed (Map 6) includes over 48,000 acres of critical forest wildlife habitat and about 16,000 acres of critical grassland wildlife habitat. The forest habitat is found mainly on the steep ridges above the Musconetcong River and in Allamuchy State Park. The grassland habitat is centered in the agricultural areas from Bloomsbury to Port Murray in Warren County. Similar rare forest and grassland wildlife species are found in these critical habitats as the previous 4 sub-watersheds discussed. About 6400 acres of critical wetland habitat occur in this watershed. Most of this habitat is concentrated in the upper reaches of the watershed near the large lakes.

The Landscape Project data should be integrated with other local, county, regional and state land use planning data to provide a basis for wise land use decision-making that will protect the Upper Delaware Watersheds valuable wildlife resources. Landscape Project data can be used to acquire and protect critical habitat, develop local habitat protection ordinances and to develop management strategies for rare species on public and private land.

## Natural Heritage Priority Sites

Through its Natural Heritage Database, the Office of Natural Lands Management (ONLM) of the Department of Environmental Protection identifies critically important natural areas in order to conserve New Jersey's biological diversity. The database provides detailed, up-to-date information on rare species and natural communities to planners, developers, and conservation agencies for use in resource management, environmental impact assessment, and both public and private land protection efforts. Using the database, ONLM has developed this coverage of Natural Heritage Priority Sites that represent some of the best remaining habitat for rare species and exemplary natural communities in the state. These areas are considered to be top priorities for the preservation of biological diversity in New Jersey. If these sites become degraded or destroyed, we may lose some of the unique components of our state's natural heritage.

The Office of Natural Lands Management has identified 389 priority sites in New Jersey, about 75 of which are in the Upper Delaware Watershed. The Nature Conservancy and the DEP's Endangered and Nongame Species Program have provided key information or assisted with the delineation of a number of the sites. Natural Heritage Priority Site maps are used by individuals and agencies concerned with the protection and management of land. The maps have been used by municipalities preparing natural resource inventories, public and private conservation organizations preparing open space acquisition goals; land developers and consultants identifying environmentally sensitive lands; and public and private landowners developing land management plans. Maps 7-11 depict the Natural Heritage Priority Sites for the five watershed groups in the Upper Delaware Watershed.

The Flat Brook Watershed group (Map 7) includes only one area with "Outstanding Significance" and one area with "Very High Significance". The Arctic Meadows area in Walpack Township is an inland acid seep that includes a grass/sedge meadow, surrounded by a hemlock-deciduous forest. The plant communities here contain the only known example of a globally imperiled, state endangered plant species. This outstanding significance site spills over into the Paulins Kill Watershed. The Montague Rivershore area in Montague Township, near the Route 206 bridge, is the only very high significance site. This site includes unique rock ledges and seepage areas along the Delaware River that harbor an assemblage of endangered plant species. This watershed group also includes about 1700 acres of areas with "High significance", 2000 acres with "Moderate Significance" and 4500 acres of "General Biodiversity Interest". These areas include a diverse array of rare plant and animal species and unique natural communities.

The Paulins Kill Watershed group (Map 8) includes only one area with outstanding significance, the previously mentioned Arctic Meadows site that is partially within the Flat Brook Watershed. There are eight sites, totaling about 1500 acres that have very high significance in the Paulins Kill Watershed. These areas are mostly wetlands with rare plant and animal species and include the Monroe Big Springs near Lafayette, the Swartwood Sinkhole Ponds in Stillwater Township, Woodruffs Gap Fen in Sparta Township and White Lake in Blirstown Township. Over 4000 acres of Natural Heritage sites with moderate significance and almost 9000 acres of areas with general biodiversity interest area present in the watershed. The largest individual area is the 6600 acre Kittatinny Mountain Macrosite that is almost 10 miles of extensive hardwood forest, talus slopes, cliffs, hemlock ravines and hardwood and coniferous swamps.

Generally the farther south you move in the Upper Delaware Watershed, more human disturbance occurs and fewer rare plants, animals and natural communities can be found. The Pequest Watershed group (Map 9), south of the Paulins Kill and Flat Brook Watersheds, includes fewer Natural Heritage priority sites than sub watersheds farther north. No outstanding significance sites are found. A large area (2400 acres+) of very high significance is found where Green, Andover and Fredon Townships all meet near Springdale, Sussex County in the uppermost reach of the Pequest Watershed. In this area a large limestone wetland complex includes numerous alkaline seeps, streams and a concentration of rare plants and animals. Most of this site is within the state's Whittingham Wildlife Management Area, managed by the NJ Division of Fish and Wildlife. Most of the other Natural Heritage priority sites of high significance (6 sites), moderate significance (6 sites) and of general biodiversity interest (5 sites) are found in wetlands and forests in the upper reaches of this watershed.

The Pohatcong and Lopatcong Watershed group (Map 10) contains only four Natural Heritage sites of moderate significance and three sites of general Biodiversity interest. Two large areas of farmland, the Garrison Road site in Harmony Township (almost 2500 acres) and the Alpha Grasslands in Pohatcong Township (almost 2000 acres), provide habitat to a number of state threatened or endangered grassland bird species.

The Musconetcong Watershed group (Map 11) contains only one Natural Heritage site of high significance (Budd Lake Bog) and five sites of moderate significance. The Budd Lake Bog site in Mt. Olive Township contains an imperiled natural community – a black spruce swamp and a number of state rare plant species. The moderate significant sites include wooded swamps, alluvial woodlands and hemlock ravines that have state rare plant and animal species present.

The Natural Heritage Priority Sites displayed contain some of the best and most viable occurrences of endangered and threatened species and natural communities, but they do not cover all known habitat for endangered and threatened species in the Upper Delaware Watershed. Additional information on each priority site can be obtained from the DEP publication *An Atlas of Natural Heritage Priority Sites for the Preservation of Biological Diversity* (ONLM 1999) or from the DEP's GIS web site at <http://www.state.nj.us/dep/gis/>.

## Threatened or Endangered Species

The unique wetlands, grasslands and forestlands of the Upper Delaware Watershed provide habitat for many rare wildlife species. Twenty-five species, listed as threatened or endangered by the NJ Division of Fish & Wildlife occur in the Upper Delaware Watershed. An additional 10 wildlife species are on the NJ Natural Heritage's rare species list, designated as either declining or their status is undetermined. A list of the Upper Delaware Watershed's rare wildlife species from the Natural Heritage Database can be found in Appendix C. Lists of rare, threatened or endangered species and natural communities for the Upper Delaware Watershed and all of New Jersey can be obtained from the Office of Natural Lands Management web site at [www.natureserve.org/nhp/us/nj/](http://www.natureserve.org/nhp/us/nj/). Several noteworthy rare species are found in the Upper Delaware Watershed including the bog turtle, bald eagle, timber rattlesnake, bobcat and several species of grassland birds. These are discussed below.

### *Bog Turtle*

The bog turtle (*Clemmys muhlenbergii*) is listed as an endangered species on New Jersey's threatened and endangered species list, and as a federally threatened species by the US Fish & Wildlife Service. Over 50% of New Jersey's bog turtle habitat has been lost in the last 30 years (Niles). Much of New Jersey's remaining bog turtle habitat occurs in fens, bogs and wetland meadows in the Upper Delaware Watershed. Bog turtle habitat is characterized by mucky, organic soils that are saturated by perennial groundwater discharge. Plant communities in bog turtle habitat are almost always dominated by low growing hydrophytic grasses, sedges, rushes, mosses and ferns. Shrub and tree cover in bog turtle habitat is usually very sparse. Other features in good bog turtle habitat include spring fed rivulets, shallow mucky pools and abundant hummocks.



**Figure 2: Bog Turtle**

Intensive land use such as development, agriculture and transportation corridors can destroy bog turtle habitat through wetland alteration or through secondary impacts such as water table alteration, stormwater discharge and nutrient enrichment. Interestingly agricultural areas such as pastures can provide quality bog turtle habitat. Grazing livestock can control woody vegetation and maintain the proper wetland hydrology and herbaceous plant community. Pasture must not be overgrazed and water quality issues must be monitored closely in order for bog turtles to coexist with grazing livestock.

The NJ Division of Fish & Wildlife's Endangered and Nongame Species Program (ENSP) has created and is implementing a comprehensive bog turtle management initiative to provide long term conservation of important bog turtle populations in New Jersey, many of which occur in the Upper Delaware Watershed. This effort should help to foster relationships with private landowners, facilitate acquisition of sites threatened by development, perform habitat management on public and private sites and advance bog turtle habitat protection. The USDA Natural Resources Conservation Service (NRCS) has provided federal funding for habitat management since 1998 for known bog turtle populations through the Wildlife Habitat Incentives Program (WHIP). Up to 75% of the costs of implementing best management practices such as, woody vegetation management, livestock fencing, invasive plant control and water quality protection, can be funded by WHIP. Private landowners or other partners need to provide the remaining funding either through in-kind or cash contributions. Local contributions can be through in-kind contributions of labor or materials needed to implement or maintain the practice. To date, 29 bog turtle habitat enhancement projects have been funded by WHIP in New Jersey.

### *Bald Eagle*

The bald eagle (*Haliaeetus leucocephalus*) is listed as an endangered species on New Jersey's threatened and endangered species list, and as a federally threatened species by the US Fish & Wildlife Service. New Jersey was once home to more than 20 pairs of nesting bald eagles. By 1970 only one pair of eagles nested in New Jersey due to extensive pesticide use (DDT and others) that bioaccumulate and cause egg shell failures. Through laws that banned the use of harmful chemicals as well as the efforts of ENSP and others, nest success has increased to almost the historic levels. Winter bald eagle census data has shown increases from less than 10 eagles sighted in New Jersey in 1978 to over 100 eagles observed in the late 1990's. The Upper Delaware Watershed is an important wintering area for bald eagles, with eagles feeding mainly along the Delaware River from Belvidere in Warren County to the New York State line.

There was only one verified active bald eagle nest in the Upper Delaware Watershed in 2001, located at Merrill Creek Reservoir in Harmony Township, Warren County (Valent, personal communication). Breeding season eagle activity along the Delaware River in Warren and Sussex counties is increasing and undiscovered nests may be present. One of the greatest threats to the active nests is human disturbance during the breeding season from February to June. Education, establishing safe viewing locations and habitat acquisition are all undertaken to reduce disturbance of active eagle nests. The threat of contaminants from pollution continues to be a concern.

### *Timber Rattlesnake*

The timber rattlesnake (*Crotalus horridus*) may be the state's most endangered species. They occur in relatively small numbers in the few remaining remote and rugged areas of the state. The Upper Delaware Watershed contains some of the best remaining habitat for timber rattlesnakes in New Jersey. Zappalorti, *et al.* (1995) report that of northern New Jersey's 29 extant timber rattlesnake den colonies, 7 are located in Sussex and Warren counties, within the Upper Delaware Watershed.

Den sites are generally on rocky ledges, talus slides or boulder fields at the base of a cliff with open fissures leading to hibernation chambers below frost level. Basking areas that receive direct sunlight with few trees and shrubs are often found near the den site. Mature deciduous or mixed deciduous-coniferous forests, usually with relatively open forest canopy, are preferred habitat after the denning season. Habitat destruction and alteration and human encroachment into timber rattlesnake habitat are currently considered the greatest threats to their survival in New Jersey. Timber rattlers are also often illegally collected by amateur snake hunters, causing threats to local populations. Others will wantonly kill timber rattlesnakes on sight due to past human conditioning.

During the spring of 1999 the NJ Division of Fish & Wildlife's Endangered and Nongame Species Program began a project to study the seasonal movements and habitat use of a timber rattlesnake population at the Delaware Water Gap National Recreation Area. Biologists surgically implanted small radio transmitters into the bodies of eleven adult timber rattlesnakes that enabled them to follow each snake throughout the entire active season. Using radio telemetry equipment, researchers located each snake every other day from the time the transmitters were implanted until they went into hibernation in the fall. Using satellites and a global positioning system, biologists can precisely map each snake's location. Snake locations are then downloaded into a computer mapping or Geographic Information System (GIS) to provide a precise picture of each snakes' movement during the entire season. Biologists have located additional winter dens for timber rattlesnakes that were previously unknown. The information will help National Park Service managers make sound decisions regarding recreational uses of public lands while protecting a unique wildlife population.

### *Bobcats*

The bobcat (*Felis reflexus*) virtually disappeared from New Jersey at the turn of the 19th century when most of the state's woodland was cleared. In the 1950's and 1960's there were reports of bobcat sightings but by the early 1970's they were believed to be extirpated from the state (NJ Div. Fish, Game & Wildlife). In 1977 the Division of Fish, Game & Wildlife initiated a project to restore bobcats in New Jersey. By 1982, 24 bobcats that were captured in Maine were released in northern New Jersey. Since that time bobcat sightings have become more common and bobcats have become established in Sussex, Warren, Morris and Passaic counties. In 1991 the bobcat was listed as an endangered species under the NJ Endangered and Nongame Species Act.

Bobcats have a large home range that, depending upon prey availability and mating opportunities, may be up to 80 square miles (Koehler 1987). Bobcats are wide-ranging species that need large contiguous patches of suitable habitat to survive. Forest fragmentation and habitat destruction and alteration from urban sprawl are the greatest threats to bobcats in New Jersey. Fragmentation of bobcat habitat can isolate individuals and result in population declines. Bobcats are also very susceptible to feline distemper, a deadly viral disease transmitted to bobcats by domestic and feral house cats.

### *Grassland Birds*

Grassland birds are a group of species that rely on open landscapes and grass or grass-like vegetation for their habitat needs. The US Geologic Survey's Biological Resources Division has conducted Breeding Bird Surveys (BBS) for more than 25 years and reports that grassland birds, as a group, have declined more than other groups such as forest and wetland birds (USDA NRCS 1999). In New Jersey several species of grassland birds are either threatened or endangered, mainly due to loss of large tracts of grassland. The Upper Delaware Watershed provides some of the best grassland bird habitat in New Jersey due to the presence of large unbroken tracts of farmland. Even in this region habitat fragmentation, habitat loss, farmland conversion and other threats are causing grassland species to decline.

Most of the grassland species that are declining require large (> 50 acres) unbroken grassland tracts for nesting and other habitat functions. Each individual species has unique habitat requirements such as short grass and abundant insects for grasshopper sparrows, or tall grasses and abundant rodents for northern harriers. Most of the grassland birds will avoid small fields of grassland that are broken up by small woodlots or even hedgerows.

Many large grassland tracts that are hayed by modern farming equipment are sinks for grassland birds. Grassland birds may be attracted to the sites by abundant suitable vegetation during the early nesting season only to have the nests destroyed by haying operations in May and June.

Habitat protection efforts include protection of large unbroken grassland tracts by acquisition by government agencies or non-governmental environmental groups and implementing management practices conducive to grassland bird nesting. The USDA NRCS's Wildlife Habitat Incentives Program (WHIP) has been used to provide incentive payments for delaying grass mowing until after bird nesting

season. In addition WHIP funds have been used to establish diverse grassland habitats such as native grasses and grass/forb mixtures that provide various vegetation densities and heights.

## **Habitat Loss**

Habitats for all of these rare species (and many more species) are in danger due to land use changes occurring in the Upper Delaware Watershed. Habitat fragmentation due to residential and commercial development, transportation corridor construction, utility construction, and invasion of invasive exotic plants all pose serious threats to rare species and many other wildlife species present in the watershed. The potential consequences of fragmentation for wildlife include direct loss of habitat, increased predation and nest parasitism, interference with dispersal and migratory patterns and introduction of non-native species.

Residential and commercial development projects impact fish and wildlife populations in many ways. Runoff from impervious surfaces can create drastic changes to water quality and water quantity into streams severely impacting aquatic ecosystems. Temperature sensitive cold water fisheries are especially vulnerable to the thermal impacts (warming) of runoff from stormwater management systems. The existing habitat (forest, grassland, scrub/shrub land) is drastically changed into buildings, asphalt and concrete surrounded by lawns, usually made up of exotic plant species. Most, if not all, habitat is lost. No food, cover or living space remains for indigenous wildlife species. Stream ecosystem impairment can begin with as little as 10% impervious cover in a watershed (Schueler 1994). New Jersey's Freshwater Wetlands Act allows development activities around wetland areas which effectively creates isolated pockets of wetland habitat. The surrounding hydrology and habitat is altered thus ultimately affecting the "protected" wetland area. A few species (like deer, some rodents, some songbirds) may benefit from the drastic landscape change, however most species are negatively impacted.

Transportation corridors and utility lines effectively fragment habitats. Some amphibians can not cross roads, railroads and utility right-of-ways that alter the natural landscapes. Historical migratory corridors or seasonal movement patterns for reptiles, amphibians, small mammals and birds can be disrupted and populations become isolated. Immigration rates between isolated patches decrease. Isolated populations lose genetic variability and become less healthy. Factors like inbreeding, catastrophic disturbance and disease outbreaks can cause populations to decline over time and eventually become locally extinct. Road crossing mortality can be significant for many species of reptiles and amphibians, especially during breeding season.

In recent years construction of communication towers (mainly cell phone towers) on forested ridges in the Upper Delaware Watershed has contributed significantly to forest fragmentation. Towers constructed in forested areas (and the new road construction to these facilities) open these areas to a host of new species. Interior forest nesting birds such as some warblers, vireos, thrushes and flycatchers require large unbroken forest habitats. This forest size can range from 500 to 5000 acres depending on the individual species needs. These "area sensitive" species do not survive near edges in forests. Nest predation and parasitism are serious threats to these species. Nest predators such as foxes, raccoons, skunks, opossums, feral cats and crows are attracted to roadways and wooded edges. Nest parasites such as brown-headed cowbirds lay their eggs in the nest of other species and the larger more aggressive cowbird hatchlings survive. Female cowbirds prefer wooded edges for finding host nests and can lay up to 77 eggs in one season (Herkert, *et al.* 1993). Nest predators and nest parasites may extend up to 100 meters into interior forests from a disturbed edge. This creates a band about 600 feet wide along any road through a forest that is unsuitable habitat for interior forest nesting birds. Some ecologists feel that habitat fragmentation is the most serious threat to biological diversity worldwide today. Some wildlife species may be attracted to newly created edges, but there is no shortage of edge habitat in the Upper Delaware Watershed landscape that is crisscrossed by roads and power lines and dotted with cell phone towers, rural residential areas, farms and commercial development.

Wildlife corridors are important for seasonal migrations, species dispersal, and for providing food and cover for many wildlife species. Exactly how corridors are arranged and connected in the landscape determines their wildlife habitat value. The habitat fragmentation occurring in the Upper Delaware Watershed has resulted in loss of these important corridors.

## **Invasive Exotic Vegetation**

An "invasive species" is defined as a species that is non-native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary means of invasive species introductions. Invasive species are a serious concern of land managers because of the threat they pose to biological diversity worldwide, our nation's lands and waters, and to the natural heritage of local communities.

On federal lands alone, it is estimated that weeds are claiming 4600 acres every day and dominate over 17 million acres in the western United States, with similar expansions occurring in Canada and Mexico. Control of exotic plants is expensive and control expenses continue to escalate as the problem grows. The federal and state departments of agriculture, national and state park systems, and The Nature Conservancy devote large and increasing resources to efforts to control exotic plant species. Nationally hundreds of grassroots groups selectively address the problem in specific areas, but their work is dwarfed by the magnitude of the overall problem. Taxpayers have spent billions of dollars purchasing and protecting wildlands, which are now being lost due to invasion by weeds. In many cases these invasions-- which will result in permanent, effectively irreversible damage if they are allowed to proceed unopposed due to short-term budget considerations. Economic return is reduced in areas dominated by weeds.

In the Upper Delaware Watershed disturbed woodlands are frequently invaded by non-native plants such as Japanese barberry, multiflora rose, autumn olive, garlic mustard, eulalia, and others plants, which prevent establishment of seedling trees. Upper Delaware Watershed wetlands are being overrun by phragmites and purple loosestrife, sometimes causing declines in species such as the federally threatened bog turtle. Biological control is expensive and time-consuming but is often the most cost-effective remedy for controlling some of the most widespread invaders. The NJ Department of Agriculture's Beneficial Insect Lab has had some success with purple loosestrife control with the introduction of leaf eating beetles.

Non-native plants modify wildlife habitat, altering the species composition, sometimes drastically. Exotic plants may trap nearly all the energy flowing through the natural systems of the many areas where they have completely displaced indigenous plants, resulting in conversion from one vegetation type to another. This energy, instead of entering the food chain, is channeled into further proliferation by the invading plant, thus energizing the cycle. Land dominated by invasive exotic weeds has low biological value and is of little or no use to human societies. The land's ability to function in a biologically stable way is impaired.

In February 1999 President Clinton issued Executive Order 13112 establishing the National Invasive Species Council. The Executive Order requires that Council of Departments dealing with invasive species be created. Currently there are 10 Departments and Agencies on the Council.

A group called the Delaware River Invasive Plant Partnership (DRIPP) recently formed to increase public awareness and understanding of the impacts of non-native invasive plant species and facilitate the exchange of information regarding these weeds in the Delaware River watershed. The major goals of DRIPP are:

To unite private citizens, organizations, and academic institutions with local, state, and federal agencies

To develop an overview of what is known and what is being done in the watershed regarding invasive plants

To create a comprehensive invasive plant management plan that includes thorough inventories to assess the impacts of invasive plant species, and identification and prioritization of the most problematic invasive plants

- To coordinate watershed-wide invasive plant control efforts

For more information on DRIPP online visit <http://groups.yahoo.com/groups/DRIPP/>.

## Wildlife Damage

Wildlife impacts to agricultural crops, livestock, landscape plantings, and natural vegetation is a major concern among farmers, homeowners and foresters in the Upper Delaware Watershed. Most of these impacts are related to damage from white-tailed deer. Many agricultural operations are limited as to what crops can be grown because of the local deer populations. Most homeowner landscaping projects are limited to using plants that are not favored by deer and that list of plants is becoming smaller each year! Foresters report that reforestation efforts are severely limited in some areas due to heavy browsing by deer on any natural regeneration or newly planted tree seedlings in the watershed.

The New Jersey Division of Fish & Wildlife's Wildlife Control Unit provides technical assistance to the general public as well as the agricultural community in controlling wildlife-related damage to crops and property. The unit reports that the primary focus of their work statewide is the solution of problems involving white-tailed deer, black bears, beavers and coyotes. In 1998 the unit responded to 3,495 wildlife complaints, the majority of which were due to damage from deer.

### White-tailed Deer

In 2001 the NJ Division of Fish & Wildlife, with input from the NJ Department of Agriculture, prepared the Governors Report on Deer Management in New Jersey. The report includes a comprehensive analysis of New Jersey's deer population, identifies problem areas in the state, evaluates factors contributing to deer over-abundance and provides recommendations to help alleviate deer conflicts. The current goals of New Jersey's deer management program are:

- 1) To maintain a healthy deer population on suitable habitat throughout the state;
- 2) To keep the deer population at a density compatible with land use; and
- 3) To maximize the recreational and economic benefits derived from this renewable natural resource.

This results in three deer management strategies the state will employ: to increase deer populations; to stabilize deer populations; or to decrease deer populations in various deer management zones. Each winter the Division reviews deer zone management strategies based upon deer harvest data and requests from hunters, farmers and other interested parties. Deer-human conflicts and loss of habitat are major factors that require deer populations to be reduced in New Jersey. These conflicts include damage to crops and residential landscaping, deer-vehicle accidents and concerns regarding Lyme disease. Information on deer damage is obtained annually by the Division from State and County Boards of Agriculture, farmer representatives on the NJ Fish and Game Council, farm damage surveys and direct contact with the farm community. Statistics on deer-vehicle accidents are obtained from the NJ Department of Transportation. The result is that in most areas of New Jersey's deer range, management is based upon the "cultural carrying capacity" of a zone rather than the biologic carrying capacity.

In 1999 there were no deer population increases proposed for any deer management zones in New Jersey. Population reductions were called for in 46 of the states 63 deer management zones (76% of New Jersey's deer range) and population stabilization was sought for 17 zones.

The table below shows the deer management zones that occur wholly or partially in the Upper Delaware Watershed. Deer range, 1999 deer population estimate, management strategy and the deer harvest data for these areas as contained in the *Governors Report on Deer Management in New Jersey* and updated information for the 2001-2002 deer season is presented. The deer management zones in the Upper Delaware Watershed are presented on Map 12.

**Table 1: Deer Management Statistics for Deer Management Zones Wholly or Partially in the Upper Delaware Watershed.**

Source NJ Division of Fish and Wildlife

Deer Management Zone	Deer Range (square miles)	1999 Pre-hunting season Population	Avg. deer density (deer per square mile)	1999 Population Management Strategy	Harvest Total 1995-1996 Season	Harvest Total 2000-2001 Season	Harvest Total 2001-2002 Season
1	64	2,793	43	Stabilize	924	964	648
2	170	7,761	46	Decrease	2,266	3,316	2,914
4	64	3,096	48	Stabilize	1,452	1,282	953
5	239	13,524	57	Decrease	5,397	7,022	5,661
6	165	6,346	38	Decrease	1,521	1,539	928
7	110	6,895	63	Decrease	2,327	3,199	2,719
8	221	14,662	66	Decrease	5,318	7,216	5,999
10	120	9,146	76	Decrease	3,019	4,579	4,028
					22,224	29,117	23,850

Zones 1,4 and 5 fall wholly within the Upper Delaware Watershed. Parts of zones 2, 6, 7, 8 and 10 are within the watershed. In the Upper Delaware Watershed the 1999 plan for zones 2, 5, 6, 7, 8, and 10 was to decrease the population of deer. The management strategy for zones 1 and 4 was to stabilize the deer population. Much of zones 1 and 4 are within state and federal land dominated by the Delaware Water Gap National Recreation Area, Stokes State Forest and High Point State Park. The areas are heavily wooded, with relatively little agricultural land and the area receives heavy hunting pressure.

As previously mentioned in the “Wildlife Resources” section deer harvest has increased dramatically in the last 30 years in the Upper Delaware Watershed. The increase in deer harvest is no doubt related to the huge increase in deer population in the watershed over that 30-year period, as well as the tremendous increase in the number of days of deer hunting allowed by the more liberal deer hunting regulations in effect over the last 6 to 8 years. With this increase in population is an increase in human-deer interactions. Car-deer collisions, damage to agricultural crops, browsing of landscape plants and alteration of natural plant communities have all increased dramatically in the Upper Delaware Watershed in the last 30 years. The data from table 1 shows that in the 2001-2002 season deer harvest was down almost 20% in the Upper Delaware Watershed even though liberal bag limits and long seasons continued. This indicates that hunters are encountering fewer deer in the field and populations are down from the previous year.

The Division’s Wildlife Control Unit’s works directly with farmers, foresters and other landowners to minimize deer damage. The Unit provides repellents, fencing and issues permits to shoot deer that are damaging crops. In 1998 350 rolls of mesh wire and 100 rolls of barbed wire were distributed to farmers statewide. Farmers and residential property owners received 627 gallons of deer repellent to discourage deer from feeding on crops and landscape plants. Each year the Unit issues more than 500 permits to shoot deer to farmers experiencing losses of crops to deer. In recent years between 2,500 and 3,200 deer have been removed on these permits annually (NJ Division of Fish & Wildlife).

In 1999 and 2000 the Sussex County Board of Agriculture hired “Hot/Shot Infrared Inspections, Inc.” to perform aerial infrared deer censuses on parts of Sussex County to help determine deer population levels. An infrared video camera is mounted externally on a helicopter and remotely controlled from inside the helicopter. A flight at an altitude of 400-500 feet was flown at about 50 knots in March 2001 to obtain deer population estimates for about 6000 acres. The 2000 census showed deer populations in some areas at over 250 deer per square mile. A similar flight in Warren County, in March of 2001 on about 4500 acres showed deer populations of about 20 deer per square mile (Brodhecker, Personal Communication). These data reveal that very local populations of deer can vary drastically probably due to local deer habitat available as well as local hunting access and hunting pressure.

Drake and Grande (2002), of Rutgers Cooperative Extension, surveyed farmers and reported crop damages from 30 farms in Warren and Sussex Counties in the 2000 crop year. Crop losses due to wildlife damage totaled almost \$300,000. Twenty-seven of the thirty farms reported the damages were from deer. The individual crop loss figures varied dramatically, ranging from an individual farm loss of \$10 to \$91,667. Acreage losses varied from .83 cents per acre to \$35,640 per acre. The results do reveal a crop damage problem is evident in the Upper Delaware Watershed. The great discrepancy among the per acre figures may result from individual landowners attitudes rather than actual crop loss.

Siemer and Decker (1991) summarized more than one dozen studies, over a period of 20 years, on human attitudes about wildlife damage by stating that thresholds of wildlife damage tolerance are very specific to the individual situation. Although different stakeholders may experience similar levels of damage, they often express dissimilar levels of damage tolerance. Damage tolerance is influenced by many factors such as specific stakeholders expectations, behaviors, and concerns. For instance a full time farmer who derives all of his/her income from fruit crops severely damaged by deer will have little damage tolerance. A part-time farmer, who receives off farm income, will tolerate more deer damage. That same part-time farmer may tolerate a lot more damage if he/she is a deer hunter or wildlife photographer and enjoys seeing high populations of deer. Specifically in New York, Siemer and Decker found that individuals with high ecological, educational and appreciative values of wildlife are usually more tolerant of damage. Also their findings reveal that as damage levels increase, tolerance decreases. The ability to withstand the economic consequences of damage also creates more tolerance to damage.

Rutgers Cooperative Extension has developed a web site called Deer and People in NJ that summarizes ecological, economical and social issues surrounding deer and discusses management options to deal with excess deer. The web site can be accessed at [www.aesop.rutgers.edu/~deer/](http://www.aesop.rutgers.edu/~deer/).

## Canada Geese

Although Canada goose (*Branta canadensis*) populations are migratory, wintering in the southern United States and migrating north to summer breeding grounds in the Canadian Arctic, increasing urban and suburban development in the U.S. has resulted in the creation of ideal goose habitat conditions. These conditions, park-like open areas with short grass adjacent to small bodies of water, have in turn enticed rapidly-growing numbers of locally-breeding geese to live in New Jersey year round. Conflicts with human activities in many parts of New Jersey have resulted. For years, the US Fish & Wildlife Service (FWS) attempted to address the problem by adjusting hunting season frameworks and issuing control permits on a case-by-case basis. However, hunting restrictions in most urban and suburban communities have limited efforts to increase the harvest of resident geese.

The resident Canada goose population in New Jersey doubled between 1989 and 1996 (Roscoe, 1999). These non-migratory geese pose nuisance problems at swimming ponds, golf courses, parks and business park lawns throughout New Jersey. It is frequently alleged that the goose feces, which are part of the nuisance issue, also pose a health hazard. No human disease outbreaks have been directly linked to exposure to goose feces and there is limited information on the frequency of human pathogens in goose feces. *Cryptosporidia* and *Giardia* were relatively common, occurring in 10% and 15% of resident Canada geese sampled by Roscoe (1999) in New Jersey.

Since the Canada goose is listed as a migratory species, the US Fish & Wildlife Service has responsibility for issuing permits for goose population control. The USDA APHIS Wildlife Services section also works with the state and federal agencies to help resolve goose damage problems in New Jersey.

## Black Bears

Historically black bears (*Ursus americanus*) occurred statewide in New Jersey. By the mid 1900's less than 100 bears existed and only in northern New Jersey, mostly in the Upper Delaware Watershed. Limited hunting seasons occurred from 1958 to 1970 and 46 bears were legally harvested by hunters (Carr 2002). Hunting was closed in 1971 and that protection along with bear population increases in Pennsylvania and New York has resulted in an expanding and increasing bear population in New Jersey since the 1980's. Today's New Jersey black bear population is estimated at over 1100 bears with the majority of the bears in Sussex, Warren, Passaic and Morris Counties (Carr 2001). Bears are dispersing

from these counties and populations are now thought to be established in Hunterdon, Bergen and Somerset counties. In fact bear sightings were reported from 16 New Jersey counties in 2000.



**Figure 3: Black bears in this region display some of the highest reproductive rates in the US**

The black bear population in the Upper Delaware Watershed is increasing at a time when human population is increasing in these same areas. The large bear home range and food needs of a mature black bear often come in conflict with humans in the Upper Delaware Watershed. During 1995, the NJ Division of Fish & Wildlife's Wildlife Control Unit (WCU) received 285 black bear complaints. In 2000, the unit received 1375 bear complaint calls. Damage estimates in 2000 are estimated at over \$200,000, and the damage complaints included home entries, garbage cans disturbed, beehives destroyed, livestock kills, pet attacks and more. Also in 2000, 62 bears were reported killed by vehicle collisions. The NJ Division of Fish & Wildlife will destroy bears that constitute a threat to life and property. In 2001, 24 bears were destroyed that constituted a threat to life and property in New Jersey: 11 of these were in the Upper Delaware Watershed area.

## Beavers

The beaver (*Castor canadensis*) is North America's largest rodent and can reach 4 feet in length and weigh over 60 pounds. In the early 1800's beavers ranged over most of North America including all of New Jersey and the Upper Delaware Watershed. Excessive commercial trapping for pelts and human encroachment into beaver habitat resulted in beavers being nearly eliminated from most of New Jersey. With protection instituted by fish and game agencies, wetland protection efforts and relatively low fur prices in recent years beavers are again populating many wetland habitats in the Upper Delaware Watershed.

Probably no other animal (except humans) has the capacity to modify its environment as much as the beaver. Beavers dam up flows to create ponds where they feed and reproduce. Unfortunately this activity is often in conflict with human activities. Beavers flood agricultural lands, forests, homes, septic systems and roads and can cause economic hardship for landowners. Beaver impoundments in close proximity to residential areas can create mosquito problems. The Warren County Mosquito Commission in 2002 treated nine sites, flooded by beavers, for mosquito larvae (Duckworth 2002). In 1997, the NJ Division of Fish & Wildlife's Wildlife Control Unit (WCU) received 160 beaver damage complaints. In situations where beavers can be live trapped and relocated to areas with long range potential for beaver occupation, this is done. In some cases beavers must be destroyed. When complaint colonies do not threaten human health or safety, licensed trappers are given the opportunity to harvest beaver during the regular trapping season in January and February. In some cases beaver friendly water control leveling devices can be installed that prevent beavers from increasing water levels while maintaining wetlands above the beaver dam. Beavers are diligent dam builders that continually repair breaches and dams removed by humans. Several devices are on the market, which if carefully installed and maintained, can prevent beaver problems.

There is some concern that an overabundance of beavers in local watersheds in the Upper Delaware Watershed can cause water quality concerns. Beaver impoundments will slow surface water and warm the water before it is discharged to cold water trout production streams. Several impoundments on one small trout stream may have a significant impact. While this may be a concern, there is little data to support this contention. Beaver impoundments also create wildlife habitat diversity and benefit species such as waterfowl, wading birds, reptiles and amphibians. Beaver impoundments may remove sediment

and nutrients from runoff and help protect water quality downstream. Additional study of this situation is warranted.

## Habitat Protection Strategies

The Upper Delaware Watershed includes some of the most important fish and wildlife habitat in New Jersey. The watershed includes over 125,000 acres of protected open space in federal, state, county, municipal and private easement-protected lands (Kelly and McGinnis 2001) that help protect these important habitats. This accounts for about 25% of the entire watershed and this is one of the highest percentages of protected land of any New Jersey watershed. Important fish and wildlife habitats already protected in the watershed include the Delaware Water Gap National Recreation Area (with 32,000 acres in New Jersey), twenty-five state wildlife management areas and nine state parks or forests.

The **New Jersey Green Acres Program** has several focus areas in the Upper Delaware Watershed and has purchased many tracts in the area since 1998. This state funded program is actively pursuing new lands that provide important fish and wildlife habitat, wildlife corridors, greenways, and recreational opportunities in the Upper Delaware Watershed.

The Green Acres Program serves as the real estate agent for the Department of Environmental Protection (DEP), acquiring land - much of which has been offered for sale by property owners - that becomes part of the system of state parks, forests, natural areas, and wildlife management areas. Green Acres works with the DEP's Divisions of Parks and Forestry, Fish and Wildlife, and the New Jersey Natural Lands Trust to determine which lands should be preserved. Green Acres does not own the land it acquires; instead land is assigned to the divisions for management.

The Program's Appraisal Review Section guides applicants through the real estate appraisal process, reviews appraisals, and certifies the market value of property included in local government, nonprofit and state acquisition projects, and in requests for diversions of land from recreation or conservation use.

Several of Green Acres' program focus areas cover parts of the Upper Delaware Watershed including the Delaware River Greenway, the Highlands Greenway, Jenny Jump State Forest, the Musconetcong River/Pohatcong Creek Greenway, the Paulins Kill Greenway and Pequest River Greenway projects.

There are also many non-governmental groups working in the Upper Delaware Watershed on habitat acquisition. Groups such as The Nature Conservancy, the NJ Conservation Foundation, New Jersey Audubon and the Ridge and Valley Conservancy are acquiring important fish and wildlife habitat areas for protection of these resources. Fish and wildlife conservation organizations are active in the watershed including Trout Unlimited, The National Wild Turkey Federation and Ducks Unlimited. These national groups have state or local chapters that work on land protection and acquisition and habitat enhancement projects on private and governmental lands.

The USDA Natural Resources Conservation Service (NRCS) uses several programs that provide direct technical assistance to landowners as well as financial incentives for fish and wildlife habitat management. The **Conservation Reserve Program** (CRP) provides up to 90% federal cost sharing for installation of high priority conservation practices on croplands adjacent to streams, wetlands and ponds. In addition annual rental payments are paid for retiring these lands from crop production for a period of 10-15 years. In order for lands to be eligible for enrollment in CRP they must be devoted to active agriculture and planted to annual crops in recent years. The NRCS's **Wildlife Habitat Incentives Program** (WHIP) provides cost sharing for several habitat types and unique wildlife species that are present in the Upper Delaware Watershed. WHIP does not require that lands have had been in active agricultural production. The **Wetlands Reserve Program** (WRP) can provide cost sharing assistance and easement purchase for wetland restoration projects on active or formerly farmed lands. More information on the specifics of each of these programs is available on the USDA NRCS web site at [www.nrcs.usda.gov/](http://www.nrcs.usda.gov/).

The **Partners for Fish & Wildlife Program** (Partners), administered by the US Fish & Wildlife Service, can provide technical and financial assistance to landowners to restore fish and wildlife habitats. Native grassland establishment, riparian tree plantings, streambank stabilization and wetland restoration projects have been popular Partners projects in the Upper Delaware Watershed in recent years. A habitat restoration agreement must be entered into on all Partners projects for a minimum of 10 years.

## **Summary**

Fish and wildlife resources are critical to the Upper Delaware Watershed. Fish and wildlife help provide important ecological functions, economic values and aesthetic importance to the watershed. Much of what attracts people to visit, vacation or live in this area of New Jersey is related to the healthy fish and wildlife populations that are present.

The streams of the watershed are important recreational fisheries for trout, shad, bass and other species. Recreational fishing brings in millions of dollars annually to businesses in the watershed. The healthy fish resources are due in large part to the good water quality present in most of the regions streams. Strategies should be employed to protect water quality of these streams to maintain or improve fisheries resources.

Wildlife also provides recreational opportunities such as birding and hunting. These activities also have important impacts to the regional economy. The Upper Delaware Watershed also provides tens of thousands of acres of critical habitat for many of New Jersey's rare species. The watershed represents the last stronghold in New Jersey for some of these rare species. Protection of wildlife habitat in the Upper Delaware Watershed should be a priority of local, regional and state planners due to the important role wildlife plays in today's society. Several wildlife species are over abundant and can create negative economic impacts to the local economy, especially to the agricultural community.

About 25% of the land in the Upper Delaware Watershed is currently protected open space and managed by federal, state, county and local governmental agencies or non-governmental conservation organizations. Management of these governmental lands is important so that habitat is protected and invasive exotic plant problems are controlled. Governmental groups will need to develop adequate land management staff and equipment as the acreages increase. Local, regional and state planners and land managers have tools such as the NJ Division of Fish & Wildlife's Landscape Project data to help protect fish and wildlife resources for the future.

## References

- Anonymous . New Jersey Bog Turtle Project. NJ Division of Fish & Wildlife, Endangered and Nongame Species Program. Trenton, NJ. 2000
- Brodhecker, Tom. Sussex County Board of Agriculture. Newton, NJ. Personal Communication. 2002.
- Carr, Patrick. NJ Division of Fish and Wildlife, Wildlife Control Unit. Clinton, NJ. Personal Communication. 2002.
- Drake, David and Grande, John. Assessment of Wildlife Depredation to Agricultural Crops in New Jersey. Journal of Extension. Volume 40, number 1. 2002.
- Duckworth, Teresa. Warren County Mosquito Commission. Oxford, NJ. Personal Communication. 2002.
- Heard, Pete. USDA Natural Resources Conservation Service - Wildlife Habitat Management Institute. Jackson, Mississippi. Personal Communication. 1999.
- Herkert, J.R., Szafoni, R.E., Kleen, V.M. and Schwegman, J.E. Habitat Establishment, Enhancement and Management for Forest and Grassland Birds in Illinois. Illinois Department of Conservation. Natural Heritage Technical Publication #1. Springfield, Illinois.1993.
- Holloway, Brad. NJ Division of Fish & Wildlife, Wildlife Control Section. Clinton, NJ. Personal Communication. 2001.
- Kelly, F. and McGinnis, S. Setting of the Upper Delaware Watershed – A Technical Report for the Upper Delaware Watershed Management Project. North Jersey RC&D Council, Annandale, NJ. 2001.
- Kerlinger, Paul. Curry & Kerlinger, LLC. Cape May Point, NJ . Personal Communication. 2002.
- Koehler, G. The Bobcat. Audubon Wildlife Report, pp. 399-409. National Audubon Society. 1987.
- McDowell, Robert. Director, NJ Division of Fish & Wildlife. Trenton, NJ. Personal Communication. 2000.
- NJ Division of Fish & Wildlife. Wildlife Control Unit Annual Report. Trenton, NJ. 1998.
- NJ Division of Fish & Wildlife. Governor's Report on Deer Management in New Jersey. Trenton, NJ 2001.
- NJ Division of Fish & Wildlife. The Landscape Project – A Model for Rare Species Protection. Trenton, NJ 2002.
- Niles, Lawrence J., Myers, J. and Valent, M. The Landscape Project. NJ DEP, Division of Fish & Wildlife, Endangered and Nongame Species Program. Trenton, NJ.
- Paturzo, Stephen, E. Stiles, K. Clark and L. Niles. New Jersey Bald Eagle Management Project. NJ Division of Fish & Wildlife, Endangered and Nongame Species Program. Trenton, NJ. 1998.
- Roscoe, Douglas E. A Survey to Determine the Prevalence of *Salmonella* sp., *Shigella* sp., *Yersinia* sp. Bacteria and *Cryptosporidium* sp., *Giardia* sp. Protozoa in Resident Canada Geese (*Branta canadensis*) in New Jersey. NJ Division of Fish & Wildlife Federal Aid Project. 1999.
- Schueler, T. The Importance of Imperviousness: Watershed Protection Techniques, v.1, no. 3, p.100-111. 1994.

Siemer, William F. and D.J. Decker. Human Tolerance of Wildlife Damage: Synthesis of Research and Management Implications. HDRU Series No. 91-7. Human Dimensions Research Unit, Department of Natural Resources, NY State College of Agriculture and Life Sciences. Cornell University, Ithica, NY 1991.

US Fish & Wildlife Service. The Economic Contributions of Bird and Waterfowl Recreation in the US During 1991. International Assoc. of Fish and Wildlife Agencies. 1995.

USDA - NRCS. Grassland Birds. Fish and Wildlife Habitat Management Leaflet Number 8. USDA NRCS Wildlife Habitat Management Institute. Madison, MS. 1999.

Valent, Mike. NJ Division of Fish & Wildlife, Endangered and Nongame Species Program. Clinton, NJ. Personal Communication. 2002.

Walsh, Joan. Breeding Bird Atlas Data. New Jersey Audubon, Cape May, NJ. 1998.

## Appendix A

Breeding Birds of the Upper Delaware Watershed

Source: New Jersey Audubon's Breeding Bird Atlas



# Breeding Birds of the Upper Delaware Watershed

Source: New Jersey Audubon's Breeding Bird Atlas

<b>Common Name</b>	<b>Scientific Name</b>	<b>Status</b>
<b><u>Loons &amp; Grebes:</u></b>		
Pied-billed Grebe	<i>Podilymbus podiceps</i>	E
<b><u>Cormarant:</u></b>		
Double -crested Cormorant	<i>Phalacrocorax auritus</i>	INC
<b><u>Bitterns &amp; Herons:</u></b>		
American Bittern	<i>Botaurus lentiginosus</i>	E
Least Bittern	<i>Ixobrychus exilis</i>	D
Great Blue Heron	<i>Ardea herodias</i>	S
Green-backed Heron	<i>Butorides striatus</i>	S
<b><u>Vultures:</u></b>		
Black Vulture	<i>Coragyps atratus</i>	S
Turkey Vulture	<i>Cathartes aure</i>	S
<b><u>Swans, Geese &amp; Ducks:</u></b>		
Mute Swan	<i>Cygnus olor</i>	I
Canada Goose	<i>Branta canadensis</i>	INC
Wood Duck	<i>Aix sponsa</i>	S
Green-winged Teal	<i>Anas crecca</i>	S
American Black Duck	<i>Anas rubripes</i>	S
Mallard	<i>Ansa platyrhynchos</i>	INC
Gadwall	<i>Anas strepera</i>	S
Hooded Merganser	<i>Lophodytes cucullatus</i>	S
Common Merganser	<i>Mergus merganser</i>	S
<b><u>Osprey, Kites, Hawks &amp; Eagles:</u></b>		
Osprey	<i>Pandion haliaetus</i>	T
Bald Eagle	<i>Haliaeetus leucocephalus</i>	E
Northern Harrier	<i>Circus cyaneus</i>	E
Sharp-shinned Hawk	<i>Accipiter stiatu</i>	U
Cooper's Hawk	<i>Accipiter cooperii</i>	T
Northern Goshawk	<i>Accipiter gentilis</i>	E
Red-shouldered Hawk	<i>Buteo lineatus</i>	E
Broad-winged Hawk	<i>Buteo platypterus</i>	S
Red-tailed Hawk	<i>Buteo jamaicensis</i>	INC
<b><u>Falcons:</u></b>		
American Kestrel	<i>Falco sparverius</i>	S
Peregrine Falcon	<i>Falco peregrinus</i>	E
<b><u>Gallinaceous Birds:</u></b>		
Ring-necked Pheasant	<i>Phasianus colchicus</i>	D
Ruffed Grouse	<i>Bonasa umbellus</i>	S
Eastern Wild Turkey	<i>Melaegris gallopavo</i>	INC
Northern Bobwhite	<i>Colinus virginianus</i>	S
<b><u>Rails:</u></b>		
King Rail	<i>Rallus elegans</i>	P
Virginia Rail	<i>Rallus limocola</i>	S
Sora	<i>Porzana carolina</i>	S

Common Moorhen	<i>Gallinula chloropus</i>	S
American Coot	<i>Fulica americana</i>	D
Killdeer	<i>Charadrius vociferus</i>	S
<b><u>Sandpipers:</u></b>	<b><u>Scolopacidae</u></b>	
Spotted Sandpiper	<i>Acitis macularia</i>	S
Common Snipe	<i>Gallinago gallinago</i>	S
American Woodcock	<i>Philohela minor</i>	S
<b><u>Doves:</u></b>	<b><u>Columbidae</u></b>	
Rock Dove	<i>Columba livia</i>	I
Mourning Dove	<i>Zenaida macroura</i>	S
<b><u>Cuckoos:</u></b>	<b><u>Cuculidae</u></b>	
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	S
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	S
<b><u>Barn Owls:</u></b>	<b><u>Tytonidae</u></b>	
Common Barn Owl	<i>Tyto alba</i>	S
<b><u>Typical Owls:</u></b>	<b><u>Strigidae</u></b>	
Eastern Screech Owl	<i>Otus asio</i>	S
Great Horned Owl	<i>Bubo virginianus</i>	S
Barred Owl	<i>Strix varia</i>	T
Long-eared Owl	<i>Asio otus</i>	S
Northern Saw-whet Owl	<i>Aegolius acadicus</i>	S
<b><u>Nightjars:</u></b>	<b><u>Caprimulgidae</u></b>	
Common Nighthawk	<i>Chordeilus minor</i>	S
Whip-poor-will	<i>Caprimulgus vociferus</i>	D
<b><u>Swifts:</u></b>	<b><u>Apodidae</u></b>	
Chimney Swift	<i>Chaetura pelagica</i>	S
<b><u>Hummingbirds:</u></b>	<b><u>Trochilidae</u></b>	
Ruby-throated Hummingbird	<i>Archilochus colubris</i>	D
<b><u>Kingfishers:</u></b>	<b><u>Alcedinidae</u></b>	
Belted Kingfisher	<i>Ceryle alcyon</i>	S
<b><u>Woodpeckers:</u></b>	<b><u>Picidae</u></b>	
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	T
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>	S
Downy Woodpecker	<i>Picoides pubescens</i>	S
Hairy Woodpecker	<i>Picoides villosus</i>	S
Northern Common Flicker	<i>Colaptes auratus</i>	S
Pileated Woodpecker	<i>Dryocopus pileatus</i>	S
<b><u>Tapaculos:</u></b>	<b><u>Tyrannidae</u></b>	
Eastern Wood Pewee	<i>Contopus virens</i>	S
Acadian Flycatcher	<i>Empidonax virescens</i>	S
Alder Flycatcher	<i>Empidonax alorum</i>	S
Willow Flycatcher	<i>Empidonax traillii</i>	S
Least Flycatcher	<i>Empidonax minimus</i>	S
Eastern Phoebe	<i>Sayornis phoebe</i>	S
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	S
Eastern Kingbird	<i>Tyrannus tyrannus</i>	D

**Vireos:**

White-eyed Vireo  
 Solitary Vireo  
 Yellow-throated Vireo  
 Red-eyed Vireo

**Crows & Jays:**

Blue Jay  
 American Crow  
 Fish Crow  
 Common Raven

**Larks:**

Horned Lark

**Swallows:**

Purple Martin  
 Tree Swallow  
 Northern Rough-winged Swallow  
 Bank Swallow  
 Cliff Swallow  
 Barn Swallow

**Chickadees & Titmice:**

Black-capped Chickadee  
 Carolina Chickadee  
 Tufted Titmouse

**Nuthatches:**

Red-breasted Nuthatch  
 White-breasted Nuthatch

**Creepers:**

Brown Creeper

**Wrens:**

Carolina Wren  
 House Wren  
 Winter Wren  
 Marsh Wren

**Kinglets:**

Golden-crowned Kinglet

**Old World Warblers:**

Blue-gray Gnatcatcher

**Thrushes:**

Eastern Bluebird  
 Veery  
 Hermit Thrush  
 Wood Thrush  
 American Robin

**Mimic Thrushes:**

Catbird  
 Northern Mockingbird  
 Brown Thrasher

**Vireonidae**

*Vireo griseus* D  
*Vireo solitarius* S  
*Vireo flavifrons* S  
*Vireo olivaceus* INC

**Corvidae**

*Cyanocitta cristata* S  
*Corvus brachyrhynchos* S  
*Corvus ossifragus* S  
*Corvus corax* P

**Alaudidae**

*Eremophila alpestris* D

**Hirundinidae**

*Progne subis* D  
*Tachycineta bicolor* S  
*Stelgidopteryx serripennis* S  
*Riparia riparia* S  
*Hirundo pyrrhonota* S  
*Hirundo rustica* S

**Paridae**

*Parus atricapillus* S  
*Parus carolinensis* S  
*Parus bicolor* S

**Sittidae**

*Sitta pusilla* S  
*Sitta carolinensis* S

**Certhiidae**

*Certhia americana* S

**Troglodytidae**

*Thryothorus ludovicianus* S  
*Troglodytes aedon* S  
*Troglodytes troglodytes* S  
*Cistothorus palustris* D

**Regulidae**

*Regulus satrapa* S

**Sylviidae**

*Poliaptila carulea* S

**Turdidae**

*Sialia sialis* S  
*Catharus fuscescens* S  
*Catharus guttatus* S  
*Hylocichla mustelina* S  
*Turdus migratorius* S

**Mimidae**

*Dumetella carolinensis* S  
*Mimus polyglottos* S  
*Toxostoma rufum* D

**Starlings:**

European Starling

**Waxwings:**

Cedar Waxwing

**Wood Warblers:**

Blue-winged Warbler  
 Golden-winged Warbler  
 Nashville Warbler  
 Northern Parula  
 Yellow Warbler  
 Chestnut-sided Warbler  
 Magnolia Warbler  
 Black-throated Blue Warbler  
 Yellow-rumped Warbler  
 Black-throated Green Warbler  
 Blackburnian Warbler  
 Yellow-throated Warbler  
 Pine Warbler  
 Prairie Warbler  
 Cerulean Warbler  
 Black and White Warbler  
 American Redstart  
 Prothonotary Warbler  
 Worm-eating Warbler  
 Ovenbird  
 Northern Waterthrush  
 Louisiana Waterthrush  
 Kentucky Warbler  
 Common Yellowthroat  
 Hooded Warbler  
 Canada Warbler  
 Yellow-breasted Chat

**Tanagers:**

Summer Tanager  
 Scarlet Tanager

**Cardinals, Grosbeaks, & Allies:**

Northern Cardinal  
 Rose-breasted Grosbeak  
 Blue Grosbeak  
 Indigo Bunting  
 Dickcissel

**Towhees & Sparrows:**

Rufous-sided Towhee  
 Chipping Sparrow  
 Field Sparrow  
 Vesper Sparrow  
 Savannah Sparrow  
 Grasshopper Sparrow  
 Song Sparrow  
 Swamp Sparrow  
 White-throated Sparrow  
 Dark-eyed Junco

**Sturnidae***Sturnus vulgaris***Bombycillidae***Bombycilla cedrorum***Parulidae**

*Vermivora pinus*  
*Vermivora chrysoptera*  
*Vermivora reficapilla*  
*Parula americana*  
*Dendroica petechia*  
*Dendroica pensylvanica*  
*Dendroica magnolia*  
*Dendroica caerulescens*  
*Dendroica coronata*  
*Dendroica virens*  
*Dendroica fusca*  
*Dendroica dominica*  
*Dendroica pinus*  
*Dendroica discolor*  
*Dendroica cerulea*  
*Miniotilta varia*  
*Setophaga ruticilla*  
*Protonotaria citrea*  
*Helmitheros vermivorus*  
*Seiurus aurocapillus*  
*Seiurus noveboracensis*  
*Seiurus motacilla*  
*Oporornis formosus*  
*Geothlysis trichas*  
*Wilsonia citrina*  
*Wilsonia canadensis*  
*Icteria virens*

**Thraupidae**

*Piranga rubra*  
*Piranga olivacea*

**Cardinalidae**

*Cardinalis cardinalis*  
*Pheucticus ludovicianus*  
*Guiraca caerulea*  
*Passerina cyanea*  
*Spiza americana*

**Emberizidae**

*Pipilo erythrophthalmus*  
*Spizella passerina*  
*Spizella pusilla*  
*Poocetes gramineus*  
*Passerculus sandwichensis*  
*Ammodramus savannarum*  
*Melospiza melodia*  
*Melospiza georgiana*  
*Zonotrichia albicollis*  
*Junco hyemalis*

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**Blackbirds & Orioles:**

Bobolink  
Red-winged Blackbird  
Eastern Meadowlark  
Common Grackle  
Brown-headed Cowbird  
Orchard Oriole  
Northern Oriole

**Finches:**

Purple Finch  
House Finch  
Pine Siskin  
American Goldfinch  
Evening Grosbeak

**\*Key**

E-Endangered  
T-Threatened  
D-Decreasing  
INC-Increasing  
S-Stable  
U-Undetermined  
I-Introduced  
P-Peripheral

***Icteridae***

*Dolichonyx oryzivorus* T  
*Agelaius phoeniceus* S  
*Sturnella magna* D  
*Quiscalus quiscula* S  
*Molothrus ater* S  
*Icterus spurius* S  
*Icterus galbula* S

***Fringillidae***

*Carpodacus purpureus* S  
*Carpodacus mexicanus* S  
*Carduelis pinus* S  
*Carduelis tristis* S  
*Hesperiphona vespertinus* INC



## Appendix B

Reptiles and Amphibians of the Upper Delaware Watershed  
Source: New Jersey Division of Fish & Wildlife's Herp Atlas (unpublished data)



# Reptiles and Amphibians of the Upper Delaware Watershed

Source: New Jersey Division of Fish & Wildlife's Herp Atlas (unpublished data)

<b>Common Name</b>	<b>Scientific Name</b>	<b>Status</b>
<b><u>Salamanders:</u></b>		
Marbled Salamander	<i>Ambystoma opacum</i>	D
Jefferson Salamander	<i>Ambystoma jeffersonianum</i>	D
Blue-spotted Salamander	<i>Ambystoma laterale</i>	E
Spotted Salamander	<i>Ambystoma maculatum</i>	D
Red-spotted Newt	<i>Notophthalmus v. viridescens</i>	S
Northern Dusky Salamander	<i>Desmognathus f. fuscus</i>	S
Mountain Dusky Salamander	<i>Desmognathus ochrophaeus</i>	U
Red-backed Salamander	<i>Plethodon c. cinereus</i>	S
Northern Slimy Salamander	<i>Plethodon g. glutinosus</i>	S
Four-toed Salamander	<i>Hemidactylium scutatum</i>	D
Northern Spring Salamander	<i>Gyrinophilus p. porphyriticus</i>	D
Northern Red Salamander	<i>Pseudotriton r. ruber</i>	D
Northern Two-lined Salamander	<i>Eurycea b. bislineata</i>	S
Long-tailed Salamander	<i>Eurycea longicauda</i>	T
<b><u>Frogs &amp; Toads:</u></b>		
Eastern Spadefoot Toad	<i>Scaphiopus h. holbrookii</i>	D
American Toad	<i>Bufo americanus</i>	S
Fowler's Toad	<i>Bufo woodhousii fowleri</i>	S
Northern Cricket Frog	<i>Acris c. crepitans</i>	U
Northern Spring Peeper	<i>Hyla c. crucifer</i>	S
Northern Gray Treefrog	<i>Hyla versicolor</i>	S
New Jersey Chorus Frog	<i>Pseudoacris triseriata kalmi</i>	S
Upland Chorus Frog	<i>Pseudoacris triseriata feriarum</i>	U
Bullfrog	<i>Rana catesbeiana</i>	S
Carpenter Frog	<i>Rana virgatipes</i>	U
Green Frog	<i>Rana clamitans melanota</i>	S
Wood Frog	<i>Rana sylvatica</i>	S
Southern Leopard Frog	<i>Rana spenocephala</i>	S
Pickerel Frog	<i>Rana palustris</i>	S
<b><u>Turtles:</u></b>		
Common Snapping Turtle	<i>Chelydra s. serpentina</i>	S
Common Musk Turtle (Stinkpot)	<i>Sternotherus odoratus</i>	S
Eastern Mud Turtle	<i>Kinosternon s. subrubrum</i>	U
Spotted Turtle	<i>Clemmys guttata</i>	U
Bog Turtle	<i>Clemmys muhlenbergi</i>	E
Wood Turtle	<i>Clemmys insculpta</i>	T
Eastern Box Turtle	<i>Terrapene c. carolina</i>	S
Common Map Turtle	<i>Graptemys geographica</i>	U
Red-eared Turtle	<i>Pseudoemys scripta elegans</i>	I
Eastern Painted Turtle	<i>Chrysemys p. picta</i>	S

**Lizards:**

Five-lined Skink	<i>Eumeces fasciatus</i>	U
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**Snakes:**

Northern Water Snake	<i>Nerodia s. sipedon</i>	S
Northern Brown Snake	<i>Storeria d. dekayi</i>	S
Northern Red-bellied Snake	<i>Storeria o. occipitomaculata</i>	S
Eastern Garter Snake	<i>Thamnophis s. sirtalis</i>	S
Eastern Ribbon Snake	<i>Thamnophis s. sauritus</i>	S
Eastern Hognose Snake	<i>Heterodon platyrhinos</i>	D
Northern Ringneck Snake	<i>Diadophis punctatus edwardsi</i>	S
Southern Ringneck Snake	<i>Diadophis p. punctatus</i>	S
Eastern Worm Snake	<i>Carphophis a. amoenus</i>	U
Northern Black Racer	<i>Coluber c. constrictor</i>	U
Eastern Smooth Green Snake	<i>Opheodrys v. vernalis</i>	U
Black Rat Snake	<i>Elaphe o. obsoleta</i>	U
Eastern Milk Snake	<i>Lampropeltis t. triangulum</i>	S
Northern Copperhead	<i>Agkistrodon contortrix mokasen</i>	U
Timber Rattlesnake	<i>Crotalus n. horridus</i>	E

**\*Key**

E-Endangered

T-Threatened

D-Decreasing

INC-Increasing

S-Stable

U-Undetermined

I-Introduced

P-Peripheral

## Appendix C

Upper Delaware Watershed Rare Wildlife Species  
Source: New Jersey Natural Heritage Database



## Appendix C

### Upper Delaware Watershed Rare Wildlife Species

Source: New Jersey Natural Heritage Database

NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS
*** Vertebrates			
ACCIPITER COOPERII	COOPER'S HAWK		E
ACCIPITER GENTILIS	NORTHERN GOSHAWK		T/T
ACRIS CREPITANS CREPITANS	NORTHERN CRICKET FROG		U
AMBYSTOMA JEFFERSONIANUM	JEFFERSON SALAMANDER		D
AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER		E
AMBYSTOMA MACULATUM	SPOTTED SALAMANDER		D
AMBYSTOMA OPACUM	MARBLED SALAMANDER		D
AMMODRAMUS HENSLOWII	HENSLOW'S SPARROW		E
AMMODRAMUS SAVANNARUM	GRASSHOPPER SPARROW		T/T
ARDEA HERODIAS	GREAT BLUE HERON		T/S
ASIO OTUS	LONG-EARED OWL		T/T
BARTRAMIA LONGICAUDA	UPLAND SANDPIPER		E
BOTAURUS LENTIGINOSUS	AMERICAN BITTERN		T/S
BUTEO LINEATUS	RED-SHOULDERED HAWK		E/T
CISTOTHORUS PLATENSIS	SEDGE WREN		E
CLEMMYS INSCULPTA	WOOD TURTLE		T
CLEMMYS MUHLENBERGII	BOG TURTLE	LT	E
CROTALUS HORRIDUS HORRIDUS	TIMBER RATTLESNAKE		E
DOLICHONYX ORYZIVORUS	BOBOLINK		T/T
EMPIDONAX ALNORUM	ALDER FLYCATCHER		S/S
EURYCEA L. LONGICAUDA	LONGTAIL SALAMANDER		T
HALIAEETUS LEVCOCEPHALUS	BALD EAGLE	LT	E
HEMIDACTYLIUM SCUTATUM	FOUR-TOED SALAMANDER		D
LYNX RUFUS	BOBCAT		E
MELANERPES ERYTHROCEPHALUS	RED-HEADED WOODPECKER		T/T
MYOTIS LEIBII	EASTERN SMALL-FOOTED MYOTIS		U
NEOTOMA MAGISTER	ALLEGHENY WOODRAT		E
PASSERCULUS SANDWICHENSIS	SAVANNAH SPARROW		T/T
PETROCHELIDON PYRRHONOTA	CLIFF SWALLOW		T/S
PODILYMBUS PODICEPS	PIED-BILLED GREBE		E/S
POOECETES GRAMINEUS	VESPER SPARROW		E
SOREX DISPAR	LONG-TAILED OR ROCK SHREW		U
STRIX VARIA	BARRED OWL		T/T
VERMIVORA CHRYSOPTERA	GOLDEN-WINGED WARBLER		D/S
VIREO SOLITARIUS	SOLITARY VIREO		S/S

## FEDERAL STATUS CODES

The following U.S. Fish and Wildlife Service categories and their definitions of endangered and threatened plants and animals have been modified from the U.S. Fish and Wildlife Service (F.R. Vol. 50 No. 188; Vol. 61, No. 40; F.R. 50 CFR Part 17). Federal Status codes reported for species follow the most recent listing.

LE -- Taxa formally listed as endangered.

LT -- Taxa formally listed as threatened.

PE -- Taxa already proposed to be formally listed as endangered.

PT -- Taxa already proposed to be formally listed as threatened.

C -- Taxa for which the Service currently has on file sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species.

S/A -- Similarity of appearance species.

## STATE STATUS CODES

The state status codes and definitions provided reflect the most recent lists that were revised in the New Jersey Register, Monday, June 3, 1991.

EX -- Extirpated species-a species that formerly occurred in New Jersey, but is not now known to exist within the state.

E -- Endangered species-an endangered species is one whose prospects for survival within the state are in immediate danger due to one or many factors - a loss of habitat, over exploitation, predation, competition, disease. An endangered species requires immediate assistance or extinction will probably follow.

T -- Threatened species-a species that may become endangered if conditions surrounding the species begin to or continue to deteriorate.

D -- Declining species-a species which has exhibited a continued decline in population numbers over the years.

S -- Stable species-a species whose population is not undergoing any long-term increase/decrease within its natural cycle.

INC -- Increasing species-a species whose population has exhibited a significant increase, beyond the normal range of its life cycle, over a long term period.

P -- Peripheral species-a species whose occurrence in New Jersey is at the extreme edge of its present natural range.

U -- Undetermined species-a species about which there is not enough information available to determine the status.

I -- Introduced species-a species not native to New Jersey that could not have established itself here without the assistance of man.

Status for animals separated by a slash(/) indicate a dual status. First status refers to the state breeding population, and the second status refers to the migratory or winter population.