



Part V
**BIOLOGICAL
COMPONENTS**

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A. Watershed Biodiversity

There are three general kinds of biodiversity: habitat diversity, genetic diversity, and species diversity. The survival of each is linked to the health of the other two, and together they comprise the wealth of ecosystems.

Habitat diversity refers to the variety of places where life exists – forests, wetlands, etc. Each broad type of habitat is home for numerous species, most of which are utterly dependent on that habitat. The genetic diversity within a species is primarily the variety of populations that comprise it. Species reduced to a single population generally contain less genetic diversity than those consisting of many populations. Song sparrows, found over much of North America, occur in numerous populations and thus maintain considerable genetic diversity within that species. The survival of populations, as well as species, is important because of the unique genetic information contained within populations. Finally, species diversity describes the one and a half million named species on the earth and those that are currently unnamed.

Biodiversity is essential to the health of our natural environment and to sustaining the benefits that human beings derive from nature. The leading causes of biodiversity loss in Pennsylvania are loss and degradation/fragmentation of habitat, non-native invasive species, pollution, and the imbalance of native species such as the overabundance of white-tailed deer (DCNR, 2003).

Some useful definitions relating to species of concern in the watershed are listed below:

- **Endangered:** "Species in imminent danger of extinction or extirpation throughout their range in Pennsylvania."
- **Threatened:** "Species that may become endangered within the foreseeable future throughout their range in Pennsylvania."
- **Extirpated:** "Species that have disappeared from Pennsylvania but still exist elsewhere."
- **Extinction:** "Species that occurred in Pennsylvania, but no longer exist across their entire range."

1. FLORA

Pennsylvania has a diverse flora coupled with a long history of botanical work within the state dating from the 18th century. A variety of habitats and the occurrence of several physiographic provinces contribute to Pennsylvania's floristic diversity. Habitats range from freshwater tidal marshes to limestone barrens, and northern and southern forest types both occur within the state. Historically, the greatest threat to the native Pennsylvania flora have been land use practices that alter natural habitats, including deforestation, urban and suburban expansion, road-building through natural habitats, and draining of wetlands.

a. Forest Types

The vegetation of the watershed reflects the environmental conditions (geology, climate, and soils) associated with the different physiographic provinces and disturbance history, both natural and anthropogenic. The river crosses two major forest regions: the Hemlock-White Pine-Northern Hardwoods Forest Region and the Oak-Chestnut Forest Region. The Hemlock-White Pine-Northern Hardwoods Forest Region (or Northern Hardwoods) Allegheny Section, corresponds with the Pocono Plateau Section of the Appalachian Plateaus Physiographic Province.

The Mixed Oak Forest Region portion of the watershed encompasses the entire overland section from Wilkes-Barre to White Haven, the western portion from White Haven to Palmerton, and from Palmerton to Easton.

1. NORTHERN HARDWOOD FORESTS

The Northern Hardwoods Forest occurs in various forms from Minnesota to northern New England and eastern Canada and as far south as central Pennsylvania. The Allegheny Section of the Northern Hardwoods Forest covers the area from the source of the Lehigh River to White Haven and the highlands to the east of the Lehigh River Gap. Although most of the area is still forested, little of the current forest resembles the original forest cover. Sprout stands of sugar maple, beech, and red maple occupy much of the logged areas. Sugar Maple is probably more abundant now than in the original forest because of its ability to grow from stump sprouts and the quick growth of seedlings when exposed to open light after the canopy has been logged.

Topographic diversity has led to a variety of plant communities. Beech and sugar maple dominate the deciduous communities, while hemlock and white pine are dominant only on the steep ravine slopes now where they had once been common throughout. Because of the proximity of the Oak-Chestnut Forest Region and the Northern Hardwoods forest, species overlap and outliers can be found in either forest type due to aspect, moisture, and soils. Along valley floors, more southern species of the Oak-Chestnut Region have mixed with the species of the more northern forest. The dry ridges and south-facing slopes may have a large oak component.

2. MIXED OAK FOREST

Originally, the Oak-Chestnut Forest extended from southern New England to northern Georgia and was characterized by oaks and the American chestnut. Today, none of the original primary vegetation of this forest type remains because of the chestnut blight that eradicated a primary constituent of the forest community. The parasitic fungus *Endothia parasitica*, introduced to America in 1904, caused the demise of the chestnut. The Oak-Chestnut Forest region described by Braun in 1950 is now better classified Mixed Oak Forest (Oplinger and Halma, 1988).

As the name implies, oaks are the dominant forest trees. White, red, scarlet, and black oaks are the primary species of the forest. Sometimes these species occur together, but each prefers different moisture and nutrient conditions. White oaks do best on moist soils of the valleys, while red oaks prefer drier, better-drained soil conditions of lower slopes. Scarlet and black oaks thrive on exposed south-facing slopes. These driest sites typically have a shrub understory comprised almost entirely of lowbush blueberries and huckleberries. A mixed mesic (middle moisture) forest dominated by hemlock and white pine may occur where valley floors are narrow or on the lowest ravine slopes. Beech, maple, tulip poplar, and red oak may be common associates. These mixed mesic forests are transitional with the Northern Hardwoods Forest. The most mesic stands have great rhododendron as the dominant shrub species.

Where the watershed occurs within the Mixed Oak Forest region, three forest sections are recognized: the Glaciated, the Ridge and Valley, and the Piedmont. The Ridge and Valley Section extends from southern Tennessee to almost the southern glacial boundary near the Delaware River. The entire watershed from the Pocono Plateau to the Palmerton area is included. The valleys and steeply sloping ridges have a variety of distinctive plant communities. One of the most striking plant communities of the Ridge and Valley Section is the ridge top dwarf-tree forest. These communities occur only on the thin, dry soils of the ridges. Shallow, dry, nutrient-poor soils, fire, and wind have led to a stunted forest dominated by scrub oak and dwarf chestnut

oak. With pitch pine, sassafras, black gum and a variety of ericaceous shrubs, the forest is an almost impenetrable thicket that is often home to some of the rarest species in Pennsylvania.

The Glaciated Section of the Mixed Oak Forest reaches its southwestern edge in Pennsylvania just south of the glacial boundary. Most of Northampton County and eastern Lehigh County are in this section. This section is sometimes called “central hardwoods” or “sprout hardwoods” because of the preponderance of reproduction by sprouting from stumps after logging. Woodlands originating from seed are confined to abandoned farmland and pasture.

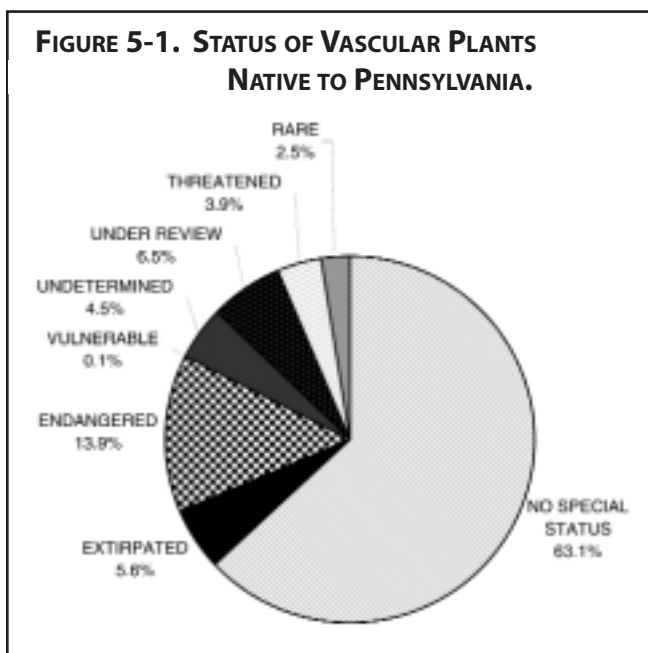
Black oak is common on the dry ridges, while red and white oaks tend to be on the moister sites, where tulip poplar is usually a common component. On these sites, there is usually a well-developed understory of dogwood, witch hazel, hop hornbeam and musclewood and a rich herbaceous layer. Pin oak, swamp white oak, and red maple occur on the poorly drained flood-plain soils.

Very little of the original Piedmont Section forest remains. Much of the southern watershed is either agricultural or suburban/urban. In those stands that remain, historical logging for lumber and fuel has produced even-aged stands that range in age from 40 to 80 years (Keever, 1972). Tulip poplar, a minor component of the original forest, is now co-dominant with the oaks in most remaining woodlands. It is a species whose seedlings do not germinate well in the shade (Tyron, 1980). Tulip poplars only developed in the original forest where the canopy opened when trees died and fell. Beech is found on the north-facing slopes and in ravines along streams leading to the Delaware River. Red maple, tulip poplar, and beech may also be components in hemlock communities.

b. Plants

1. Status of Plants

Native plants comprise slightly less than 63% of the vascular flora of Pennsylvania. Of these native taxa, approximately 30% are currently listed as plants of special concern (Figure 5-1).



More than 5% (116) of native plant species are believed to be extirpated in Pennsylvania, and an additional 20% are classified as endangered (288), threatened (80), rare (52), or vulnerable (3). Another 93 species are currently classified as undetermined, pending assignment to a specific status. The figure of 30% does not include the approximately 135 species that were under review as of July 1997 by the Pennsylvania Biological Survey (PABS) Vascular Plant Technical Committee for listing as species of special concern.

Thirty-seven Pennsylvania plant species are listed as Globally Rare (G3 rank), Threatened (G2 rank), or Endangered (G1 rank) (Pennsylvania Natural Diversity Inventory (PNDI). Two species that occurred in Pennsylvania, Schweinitz's waterweed (*Elodea schweinitzii*) and Nuttall's mud-flower (*Micranthemum micranthemoides*), are considered to be extinct throughout their ranges (Rhoads and Klein 1993).

TABLE 5-1. PLANTS OF SPECIAL CONCERN IN THE LEHIGH RIVER WATERSHED
(The Pennsylvania Flora Database, Morris Arboretum of the University of Pennsylvania, 2003)

Scientific Name	Common Name	State Status	Proposed State Status
AGALINIS AURICULATA	EARED FALSE-FOXGLOVE	PE	PE
AMELANCHIER BARTRAMIANA	OBLONG-FRUITED SERVICEBERRY	PE	PE
ARCEUTHOBIUM PUSILLUM	DWARF MISTLETOE	PT	PT
BARTONIA PANICULATA	SCREW-STEM	N	TU
CAREX COLLINSII	COLLIN'S SEDGE	PE	PT
CAREX EBURNEA	EBONY SEDGE	PE	PE
CAREX OLIGOSPERMA	FEW-SEEDED SEDGE	PT	PT
CAREX PAUPERCULA	BOG SEDGE	PT	PR
CAREX POLYMORPHA	VARIABLE SEDGE	PE	PT
CAREX PRAIREA	PRAIRIE SEDGE	PT	PT
CAREX TETANICA	A SEDGE	PT	PT
CHENOPODIUM FOGGII	FOGG'S GOOSEFOOT	PE	PE
CLADIUM MARISCOIDES	TWIG RUSH	PE	PE
CYPERUS SCHWEINITZII	SCHWEINITZ'S FLATSEDE	PR	PR
ELATINE AMERICANA	LONG-STEMMED WATER-WORT	PX	PE
EPILOBIUM STRICTUM	DOWNY WILLOW-HERB	PE	PR
ERIOPHORUM TENELLUM	ROUGH COTTON-GRASS	PE	PE
GAULTHERIA HISPIDULA	CREEPING SNOWBERRY	PR	PR
GERANIUM BICKNELLII	CRANESBILL	PE	PE
GLYCERIA BOREALIS	SMALL-FLOATING MANNA-GRASS	PE	PT
GLYCERIA OBTUSA	BLUNT MANNA-GRASS	PE	PE
HUPERZIA POROPHILA	ROCK CLUBMOSS	PE	PE
HYPERICUM DENSIFLORUM	BUSHY ST. JOHN'S-WORT	PT	PR
JUNCUS FILIFORMIS	THREAD RUSH	PR	PR
JUNCUS TORREYI	TORREY'S RUSH	PT	PE
LYONIA MARIANA	STAGGER-BUSH	PE	PE
MUHLENBERGIA UNIFLORA	FALL DROPSEED MUHLY	PE	PT
MYRICA GALE	SWEET-GALE	PT	PT
MYRIOPHYLLUM FARWELLII	FARWELL'S WATER-MILFOIL	PE	PE
NAJAS GRACILLIMA	BUSHY NAIAD	PT	PT
NELUMBO LUTEA	AMERICAN LOTUS	PE	PE
ORYZOPSIS PUNGENS	SLENDER MOUNTAIN-RICEGRASS	PE	PE
PARNASSIA GLAUCA	CAROLINA GRASS-OF-PARNASSUS	PE	PE
PLATANThERA BLEPHARIGLOTTIS	WHITE FRINGED-ORCHID	N	TU
POA PALUDIGENA	BOG BLUEGRASS	PT	PR
POLYGONUM CAREYI	CAREY'S SMARTWEED	PE	PE
POTAMOGETON CONFEROIDES	TUCKERMAN'S PONDWEED	PT	PT
SALIX SERISSIMA	AUTUMN WILLOW	PT	PT
SCHOENOPECTUS TORREYI	TORREY'S BULLRUSH	PE	PE
SCIRPUS ANCISTROCHAETUS	NORTHEASTERN BULLRUSH	PE	PT
SPARGANIUM ANDROCLADUM	BRANCHING BUR-REED	PE	PE
STREPTOPUS AMPLEXIFOLIUS	WHITE TWISTED-STALK	PE	PE
UTRICULARIA INTERMEDIA	FLAT-LEAVED BLADDERWORT	PT	PT
UTRICULARIA MINOR	LESSER BLADDERWORT	PT	PT

Notes:
N-no special status
U-undetermined
PE-PA endangered
PT-PA threatened
PX-PA extirpated
PC-PA candidate
PR - PA reported
T-Threatened
U-Candidate-
 Undetermined

The number of Pennsylvania Endangered and Threatened plants may be attributable to the geographic position of Pennsylvania straddling a number of physiographic regions and the diversity of habitats found in the state. Seventy-seven percent of Endangered and Threatened plants in Pennsylvania are at the edge of their geographic range (Walck 1996). Although water-dependent habitats occupy only about 2% of the land surface in Pennsylvania, 57% of Endangered and Threatened plant species grow in these habitats (Walck 1996). Not surprisingly, families with the largest number of Pennsylvania Endangered and Threatened plants, the sedges (Cyperaceae), grasses (Poaceae), and composites (Asteraceae), are the families with the greatest number of species in Pennsylvania.

Plants found in the northern ridges and slopes of the Lehigh River watershed include some Canadian, northern species that are near their southern limit such as gold thread, mountain ash, showy lady slipper, striped maple, toothwort, buckthorn, and sheep laurel (Schaffer, 1949). Similarly, a number of Carolinian or southern plants reach their northern extent near South mountain. These species include Jersey pine, lady fern, common persimmon, Virginia snakeroot, shiny coneflower, and winter grape (Schaffer, 1949). Some plants are limited to the limestone formations and soils in the lower portion of the watershed such as bladdernut, false solomon's seal, grass-of-parnassus, purple cliff-brake fern, stiff gentian, and yellow oak (Schaeffer, 1949).

A list of the plants of special concern in the Lehigh River Watershed are listed in table 5-1.

2. *Exotic and Invasive Plants*

A native plant is defined as one that occurred within the state before settlement by Europeans. Native plants include ferns and club mosses; grasses, sedges, rushes, and their kin; flowering perennials; annuals; biennials and the woody trees, shrubs and vines. There are over 2,100 native plant species known in Pennsylvania (Pennsylvania DCNR, 1998). An introduced or "exotic" plant is one that has been brought in and becomes established. In 1998, there were 1,300 species of exotic plants in Pennsylvania (Pennsylvania DCNR, 1998), and more introduced plants are identified every year. An "invasive" plant not only becomes established, but spreads aggressively into new areas and environments. Some native plants are aggressive in disturbed areas, but most invasive plants are introduced from other continents, leaving behind pests, diseases, predators, and natural controls.

Species that have flourished and spread on their own only after people transported them across barriers they could not otherwise surmount (such as oceans, mountain ranges and deserts) are considered non-natives or exotics. Non-native species populations are sometimes established on land that has been altered, such as by clearcutting. These changes disrupt the natural plant community and foster conditions for non-native plant propagation. In many areas, these plants have overwhelmed the native plants and animals. These species are considered invasive. Exotic species are responsible for most damaging invasions, but a far smaller number of natives also have invaded and degraded new habitats (Marinelli, 1996). Invasives reproduce rapidly and can form stands that exclude nearly all other plants. In the process, they damage natural areas, altering ecosystem processes, displacing native species, hybridizing with natives and changing their genetic makeup, and supporting other non-native plants, animals and pathogens (Marinelli, 1996).

More than any other group of organisms in Pennsylvania, the state's native flora has been impacted by the establishment of alien species (DCNR PABS). Over 37% of the vascular plant species now growing within the borders of Pennsylvania are not native. This figure is much higher in some groups, such as the mustard family (Brassicaceae), for which almost 80% of the species in Pennsylvania are introduced.

Humans have relocated hundreds of plant species from their native ranges to new areas. Many of the exotic plants that have been introduced, either by accident or by intention, have been beneficial and ecologically benign. However, a small percentage have run rampant. Gaining a foothold first in areas disturbed by human activities, these species then move into natural areas where they have not only driven out indigenous species but also in the worst cases radically altered the ecosystems they have invaded.

As shown in Table 5-2, a number of invasive and exotic species have been identified within the watershed. These species present a threat to the abundance and diversity of native vegetation within the watershed. Invasive species usually establish themselves first in disturbed areas and then quickly spread across the surrounding landscape. Some species that have been identified in abundance within the watershed include Multiflora rose, Russian and autumn olive, Tartarian honeysuckle, and purple loosestrife.

Some invasive species in the region, such as Norway maples, release toxins to the soil that inhibit growth and reproduction of native species. Invasive trees are often overlooked because they do not have the dense vine or shrub form typical of exotics. The threat of the Norway maple in many regions is unnoticed because most trees are still saplings. However, by the time these saplings mature, the forested land will be composed almost exclusively of Norway maple. These trees prevent the establishment of an herbaceous or shrub layer, leaving much of the soil bare and subject to erosion. The Norway maple is no longer recommended for planting, but a large demand still exists and it continues to be used on a widespread basis (Andropogon Associates, 1991).

In forested areas, trees such as Norway maple (*Acer platanoides*) grow into the canopy, as do vines like Japanese honeysuckle (*Lonicera japonica*), where they shade out or topple trees. In wetlands in the northern third of the United States and southern Canada, purple loosestrife (*Lythrum salicaria*) forms large, dense strands, eliminating the open water areas that waterfowl require and elsewhere displacing native plants that feed and shelter wildlife.

Invasive and exotic species are a major environmental threat to many naturally vegetated regions. Many natural lands, which are becoming more frequently disturbed and fragmented, are increasingly susceptible to invasive and exotic species. When introduced to a new region, invasive vegetation spreads rapidly, overtaking the native species. The introduction of just a few invasive species is sufficient to severely limit the diversity of a natural system, especially if that system is also stressed by other environmental factors. Limiting vegetative diversity ultimately limits wildlife diversity, as birds and animals require different vegetative species for cover and food (Andropogon Associates, 1991).

TABLE 5-2. SOME INVASIVE EXOTIC SPECIES FOUND IN THE LEHIGH RIVER WATERSHED

Common Name	Scientific Name
TREES	
Norway Maple	<i>Acer platanoides</i>
Norway Spruce	<i>Picea glauca</i>
Russian Olive	<i>Eleagnus angustifolia</i>
Autumn Olive	<i>Eleagnus umbellatus</i>
SHRUBS AND SMALL TREES	
Tartarian Honeysuckle	<i>Lonicera tatarica</i>
Multiflora Rose	<i>Rosa multiflora</i>
VINES	
Japanese Honeysuckle	<i>Lonicera japonica</i>
HERBACEOUS PLANTS	
Purple Loosestrife	<i>Lythrum salicaria</i>
Japanese Knotweed	<i>Polygonum cuspidatum</i>
Canada Thistle	<i>Cirsium altissimum</i>
Timothy grass	<i>Phleum pratense</i>
Crabgrasses	<i>Digitaria sanguinalis</i>
Quackgrass	<i>Elytrigia repens</i>
Garlic Mustard	<i>Alliaria petiolata</i>

Invasive species have been and are abundantly and widely distributed as quick solutions to erosion problems. These invasive exotics have shallow root systems that spread quickly to provide ground cover for bare slopes. However, these roots do not effectively stabilize soil, streambanks or road cuts that, instead, continue to erode (Andropogon Associates, 1991).

Exotic species threaten the ecology of naturally vegetated areas, as they do not provide proper food and habitat for native wildlife. For example, if an aquatic macro-invertebrate did not evolve feeding on Norway maple, it will not be edible to that species now. Therefore, that macro-invertebrate species may relocate or be wiped out of the stream entirely, if it cannot find the feeding material on which it evolved eating. Since macro-invertebrates, diatoms and other microorganisms are basic building blocks in the food chain, a loss of them could disrupt the ecology within the riparian habitat.

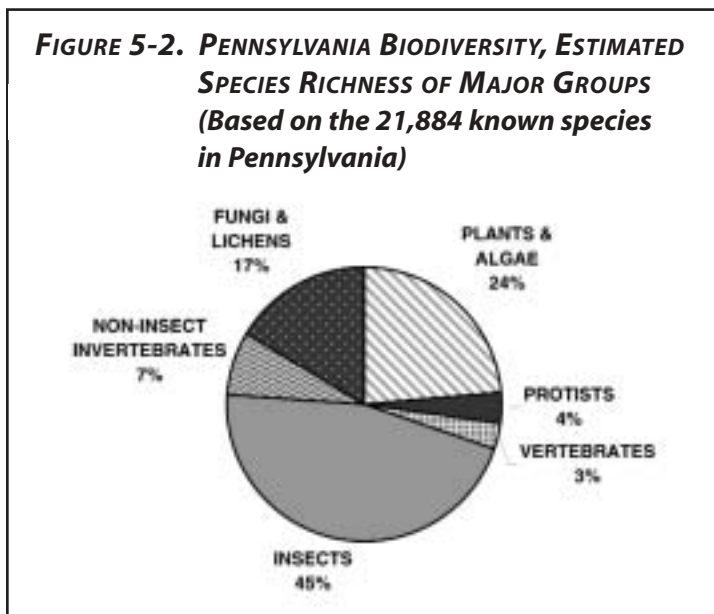
Invasive species are a severe problem because there are no means of effectively controlling their spread. Many invasive species are spread very rapidly over great distances by animal and bird dispersal. The only means of control is to eliminate as many existing plants as possible and restrict planting of new species (Andropogon Associates, 1991). No species that is proven to be or even suspected of being a successful invader should be planted.

2. FAUNA

The fauna in the watershed is diverse and includes invertebrates, fish, amphibians, reptiles, birds, and mammals. Threats to watershed fauna include land use changes, deforestation, water pollution, introduction of nonnative species, fragmentation and or loss of habitat, and changes in vegetation due to overpopulation of species, such as the white-tailed deer.

a. Invertebrates

Invertebrates are present in every conceivable biotic habitat, and in most ecosystems, they constitute the groups with greatest species richness. Invertebrates are ecologically involved with virtually every biotic process occurring in natural communities, from pollination, herbivory, and predation to soil formation, disease transmission, nutrient cycling and decomposition to name only a few.



Invertebrates comprise the large majority of Pennsylvania's animals. It's been estimated that when all the sponges, planaria, snails, spiders, millipedes, moths, beetles and other insects are added, the total would be a staggering 15,000+ species-- or roughly 70 % of all Pennsylvania's flora and fauna. Unfortunately, little is known about this large group.

The great diversity of invertebrates, especially insects, in natural systems makes their abundance or absence a powerful indicator of more than just the composition of biological communities, but also provides information on structural aspects of those systems (especially trophic relationships) and on the viability of processes influencing their

integrity and stability over time (Kim 1993, New 1993). Invertebrates as a group are the dominant element of biodiversity in natural systems, second only to plants in biomass and unsurpassed in terms of the nature and number of their ecological associations and interactions (Wilson 1987).

1. Status of Invertebrates

As shown in Figure 5-2, the total number of species of organisms in Pennsylvania is estimated to be 21,884, of which 11,702 (53.2%) are invertebrates, 5,143 (23.5%) are plants (including algae), 3,619 (16.5%) are fungi and lichens, and 710 (3.2%) are vertebrates. Insects constitute 46% of total biodiversity in the state, and at least 80% of those are terrestrial.

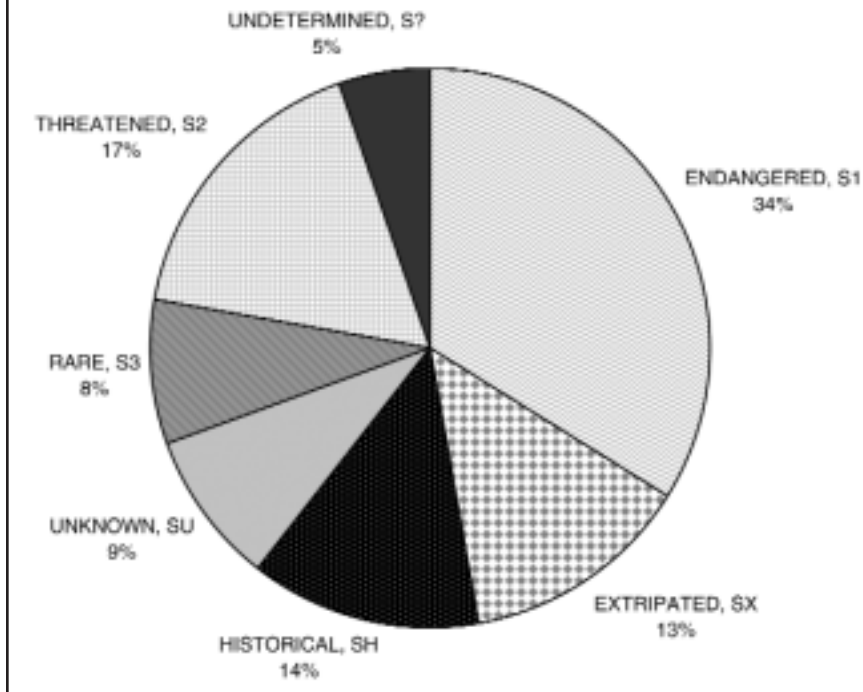
Aside from their sheer numbers, these invertebrates are a key foundation block upon which all ecological systems depend. Hundreds of different birds and mammals, for example, depend upon invertebrate populations as food sources, and many of the higher plants rely on invertebrate pollinators and seed dispersers. Yet with all of this tremendous--in fact, critical--importance, there is one animal in particular that has yet to fully appreciate invertebrates--people.

Current information regarding the conservation status of only a few invertebrate species is known, and those are limited almost entirely to aquatic groups of insects and mollusks. Modern surveys have been conducted in all drainage basins by the Academy of Natural Sciences in Philadelphia (ANSP) and the Western Pennsylvania Conservancy (WPC) in collaboration with the Carnegie Museum of Natural History (CMNH) and in conjunction with the Pennsylvania Fish and Boat Commission and the U.S. Fish and Wildlife Service (Bier 1994).

The only serious baseline inventories of insects to date for the entire state concentrate on aquatic lineages. Dragonflies and damselflies (Odonata) are relatively well known (170 species). Baseline inventories have been completed for other orders of aquatic insects, supported by the Pennsylvania Wild Resource Conservation Fund and Pennsylvania Fish and Boat Commission. These include 312 species of Trichoptera (caddisflies) and 136 species of Plecoptera (stoneflies) and a thorough treatment of Simuliidae (black flies). No terrestrial lineage of invertebrates in Pennsylvania has been adequately inventoried, including conspicuous lineages such as butterflies, tiger beetles, large moths, land snails, and spiders. Knowledge for some large groups is especially weak, and novices soon learn that even species-level identification is a major undertaking. Butterflies (*Lepidoptera: Papilionoidea*) and skippers (*Lepidoptera: Hesperioidea*) have never been thoroughly surveyed across the state. The Nature Conservancy (TNC) has been monitoring and protecting the critically imperiled regal fritillary butterfly (*Speyeria idalia*), and both TNC and WPC have investigated populations of other butterflies of special concern. Land snails (Mollusca: Gastropoda) remain unstudied except for county records recorded in Hubricht (1985). Spiders (Arachnida: Araneae) are virtually unknown outside collections and systematic revisions.

The nocturnal Macrolepidoptera ("larger moths") have been studied extensively in recent years by workers at CMNH, WPC, and TNC (Rawlins et al. 1997), but no general publication is available. Not a single family in the largest order of living invertebrates, the beetles (Coleoptera), has been thoroughly reviewed for Pennsylvania in recent decades. Coleopterists at CMNH have been studying several large families of ecological importance in Pennsylvania (e.g., ground beetles [Carabidae], carrion beetles [Silphidae], long horned beetles [Cerambycidae] and others), but no formal survey or inventory has been initiated. As for smaller orders of insects and minor lineages of arachnids (daddy longlegs, ticks and mites) and myriapods (centipedes and millipedes), the level of knowledge is quite low.

FIGURE 5-3. CONSERVATION STATUS OF PENNSYLVANIA INVERTEBRATES OF SPECIAL CONCERN (Adapted from PNDI, based on 282 species of special concern as of July 1998.)



The Pennsylvania Natural Diversity Inventory (PNDI) currently recognizes 282 species of invertebrates of real or potential special concern for conservation, only 2.4% of the estimated number of invertebrate species. PNDI recognition of these taxa is unofficial, and only two freshwater mussels are formally listed as Endangered for Pennsylvania. Of species on the PNDI list, 13.1% are thought to be extirpated from the state and an additional 13.5% are known from historical records only (see Figure 5-3). The Pennsylvania Biological Survey (PABS) Invertebrate Technical Committee concludes that: (1) little is known about Pennsylvania invertebrates and (2) invertebrates are poorly protected with respect to informed awareness of their conservation status. No Pennsylvania invertebrate is thought to be extinct globally, but so little is known about factors necessary to

interpret occurrence data that few conclusions can be made with confidence (PABS). These factors include information on species ranges; data on habitat requirements and restrictions, especially those involving unusual or limiting habitats such as barrens, wetlands, viable watercourses, and caves; and information on obligatory ecological associations (food plants, pollinators, hosts for parasitoids, and fungal associates to name just a few). The invertebrates of special concern in the watershed are shown in Table 5-3.

2. Exotic Invertebrates

An increasing number of non-native invertebrates have been recorded in Pennsylvania, formally registered in the recently established North American Non-Indigenous Arthropod Database (NANIAD) developed at The Pennsylvania State University and soon to appear on the World Wide Web through the United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA/APHIS/PPQ). In August 1998, NANIAD listed 2,419 species of non-indigenous arthropods as having been reported from the United States, of which 152 species were cited specifically for Pennsylvania, and a few others listed only from the general region including Pennsylvania. Many European insects have long been known to have populations in Pennsylvania, but others are just being documented (i.e., *Idaea dimidiata*, Geometridae, was just noted in Rawlins et al., 1998). With more than a third of the vascular plants in Pennsylvania being alien, it is not surprising that many exotic insects in the state are herbivores or graminivores feeding on an introduced plant, e.g., *Calophasia lunula* (Noctuidae) feeding on *Linaria biennis* (Scrophulariaceae), and *Harpalus (Ophonus) puncticeps* (Carabidae) on seeds of *Daucus carota* (Apiaceae).

TABLE 5-3. INVERTEBRATES OF SPECIAL CONCERN IN THE LEHIGH RIVER WATERSHED

Source: (PNDI, 1998; William Gleason, County Natural Heritage Inventory Ecologist PA Science Office, The Nature Conservancy, 2003)

Scientific Name	Common Name	State Rank	Global Rank	Date Last Observed
<i>Aeshna clepsydra</i>	Spotted Blue Darner	S2S3	G4	1985
<i>Amblyscirtes vialis</i>	Roadside Skipper	S?	G5	1970 (H)
<i>Apamea cristata</i>	A Noctuid Moth	SU	G4	1985
<i>Apharetra purpurea</i>	A Noctuid Moth	S2	G4	1987
<i>Aplectoides condita</i>	A Noctuid Moth	S2S3	G4	1985
<i>Atrytonopsis hianna</i>	Dusted Skipper	S3	G4G5	1965 (H)
<i>Chaetagnela cerata</i>	A Sallow Moth	S1	G3G4	1985
<i>Chlosyne harrisii</i>	Harris' Checherspot	S3	G4	1971(H)
<i>Cuscuta cephalanthi</i>	Button-Bush Dodder	SU	G5	
<i>Dorocordulia lepida</i>	Elegant Skimmer	S2	G5	1989
<i>Enallagma boreale</i>	Boreal Bluet	S2	G5	1979 (H)
<i>Epiglaea apiata</i>	Pointed Sallow	S3S4	G5	1991
<i>Epirrita autumnata henschawi</i>	November Moth	SU	G5T5	1985
<i>Erynnis martialis</i>	Mottled Duskywing	S1S2	G3G4	1971 (H)
<i>Erynnis persius persius</i>	Persius Duskywing	S1S2	G5T2T3	1971 (H)
<i>Euphyes conspicuus</i>	Black Dash	S3	G4	2001
<i>Glena cognataria</i>	Blueberry Gray	S1	G4	1985
<i>Hemileuca maia</i>	Barrens Buckmoth	S1S2	G5	1991
<i>Hemipachnobia monochromatea</i>	Sundew Cutworm Moth	S2S3	G4	
<i>Hesperia metea</i>	Cobweb Skipper	S2S3	G4G5	1965 (H)
<i>Incisalia henrici</i>	Henry's Elfin	S2S3	G5	1970 (H)
<i>Incisalia henrici</i>	Hoary Elfin	S1	G5	1970 (H)
<i>Itame sp. 1</i>	Barrens Itame	S1	G3	1987
<i>Lasius minutis</i>	An Ant	S?	G?	1997
<i>Lithomoia solidaginis germana</i>	A Moth	S3S4	G5T5	1991
<i>Lycaena epixanthe</i>	Bog Copper	S2	G4G5	2000
<i>Lycia rachelae</i>	Twilight Moth	S1	G4	1986
<i>Metaxaglaea semitaria</i>	Footpath Sallow Moth	S2	G5	1991
<i>Papaipema sp. 1</i>	Flypoison Borer Moth	S2	G2G3	2000
<i>Polygonia progne</i>	Gray Comma	SU	G5	1970 (H)
<i>Psectraglaea carnosia</i>	Pink Sallow	S1	G3	1999
<i>Speyeria idalia</i>	Regal Fritillary	S1	G3	1973 (H)
<i>Zale curema</i>	A Zale Moth	S1	G3G4	1985
<i>Zale sp. 1</i>	Pine Barrens Zale	S1	G3Q	1988
<i>Zale submediana</i>	A Zale Moth	S2	G4	1985
<i>Zanclognatha martha</i>	Pine Barrens Zanclognatha	S1S2	G4	1987

H = HISTORIC

Some additional exotic species are expected in Pennsylvania as they are known to be established elsewhere in North America (e.g., European *Noctua pronuba* [Noctuidae] gradually expanded its range southward from Canada [Passoa and Hollingsworth 1996], and was just recently established across Pennsylvania).

Several exotic species have become serious pests. Forests in the watershed have been baraged with a host of non-native insect outbreaks that constantly threaten the structure and health of our forests. The Hemlock woolly adelgid has caused severe dieback in many of the infested trees and the full impact is still unknown. Pennsylvania Bureau of forestry biologists are experimenting with releasing a non-native ladybug that feeds on the adelgid. Gypsy moths, found in the watershed, prefer oaks but feed on a wide array of trees and shrubs. Gypsy moth outbreaks can have short-term impacts on forest wildlife. For forest canopy nesting birds, the loss of cover can allow an increase in predation and nest parasitism. Small mammals have been known to feed on gypsy moth caterpillars, and other species may also take advantage of the food source. However, the defoliation can be severe and cause tree mortality. Suppression programs using an introduced fungus have helped limit tree mortality.

Some exotic species are considered beneficial (e.g., honey bees) and several were intentionally introduced for biocontrol of weeds and pest insects. As baseline inventories increase in rigor and taxonomic breadth, it is expected that viable populations of many additional alien species of invertebrates will be discovered in Pennsylvania.

b. Fish

Pennsylvania supports a diverse assemblage of fishes. Denoncourt (1975) and Cooper (1983) identified 27 and 24 families of fish, respectively, which represented nearly 160 species. More recent collections (e.g., by Jay Stauffer and by the Pennsylvania Fish and Boat Commission) indicate that there may be as many as 194 species representing approximately 40 families. This

large increase is due primarily to the addition of many estuarine fishes that are known to occur in the Delaware River, an increased sampling effort among research scientists and fishery biologists and improvements in sampling equipment.

The physiography and geology of six major drainages contribute to Pennsylvania's relatively high fish diversity. These drainages are the Delaware, Potomac, and Susquehanna (Atlantic Slope), Ohio (Mississippi Valley), and Erie and Genesee (Great Lakes). Historically, advancing glaciers influenced the dispersion and range of many species. Today, each drainage supports a distinctive species assemblage that is separated or influenced by the Appalachian Mountains.



Indications are that there may be as many as 194 species representing approximately 40 families of fish in Pennsylvania. These trout are not among the 30% of the state's fishes which are of special concern.

1. Status of Fish

Approximately 30% of Pennsylvania's fishes are of special concern (Figure 5-4). Among the 194 species found in the state, the following 11 species are listed as State Endangered: brook lamprey, shortnose sturgeon, lake sturgeon, gravel chub, ironcolor shiner, longnose sucker, spotted darter, eastern sand darter, tippecanoe darter, longhead darter, and checkered sculpin. The tippecanoe darter and ironcolor shiner are the most recent additions to this list. Another nine are listed as State Threatened: Ohio lamprey, mountain brook lamprey, Atlantic sturgeon, mountain madtom, northern madtom, burbot, bluebreast darter, channel darter, and gilt darter. The shovel-nose sturgeon, blacknose shiner, northern redbelly dace, bullhead minnow, river carpsucker, highfin carpsucker, lake chubsucker, longjaw cisco, lake herring, deepwater sculpin, mud sunfish, blackbanded sunfish, swamp darter, sharpnose darter, and blue pike are thought to be extirpated, bringing the potential species richness of the state to 209. Only the shortnose sturgeon is listed as Endangered under the Federal Endangered Species Act.

Table 5-4 lists the fish species in the Lehigh River watershed. In the Lehigh River, smallmouth and largemouth bass are well established in the lower stretches of the river. Other species in the river, as recorded by the Pa. Fish and Boat

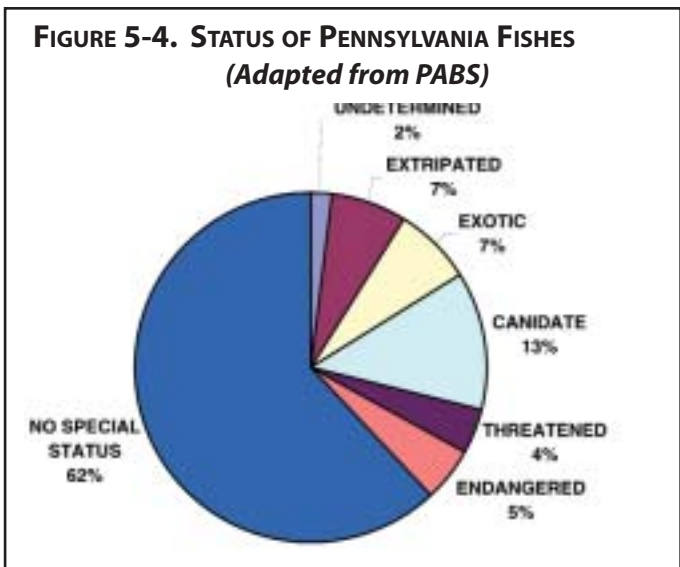


TABLE 5-4 FISH OF THE LEHIGH RIVER WATERSHED

(Data Source: Pennsylvania DCNR, www.dcnr.state.pa.us/pabs/fish; David Arnold, Pennsylvania Fish and Boat Commission, personal correspondence, 2003)

Family	Common Name	Scientific Name	Status
lampreys: Family Petromyzontidae	American brook lamprey	<i>Lampetra appendix</i>	N
	sea lamprey	<i>Petromyzon marinus</i>	N
eel: Family Anguillidae	American eel	<i>Anguilla rostrata</i>	N
herrings: Family Clupeidae	blueback herring	<i>Alosa aestivalis</i>	N
	alewife	<i>Alosa pseudoharengus</i>	N
	American shad	<i>Alosa sapidissima</i>	N
gizzard shad		<i>Dorosoma cepedianum</i>	N
	bay anchovy	<i>Anchoa mitchilli</i>	N
minnows: Family Cyprinidae	goldfish	<i>Carassius auratus</i>	I
	satinfin shiner	<i>Cyprinella analostanus</i>	N
	spotfin shiner	<i>Cyprinella spiloptera</i>	N
	common carp	<i>Cyprinus carpio</i>	I
	cutlips minnow	<i>Exoglossum maxillingua</i>	N
	common shiner	<i>Luxilus cornutus</i>	N
	pearl dace	<i>Margariscus margarita</i>	N
	hornyhead chub	<i>Nocomis biguttatus</i>	PC
	golden shiner	<i>Notemigonus crysoleucas</i>	N,I
	spottail shiner	<i>Notropis hudsonius</i>	N
	swallowtail shiner	<i>Notropis procne</i>	N
	bluntnose minnow	<i>Pimephales notatus</i>	N
blacknose dace	<i>Rhinichthys atratulus</i>	N	
longnose dace	<i>Rhinichthys cataractae</i>	N	
creek chub	<i>Semotilus atromaculatus</i>	N	
fallfish	<i>Semotilus corporalis</i>	N	

Notes: Fish Status

N-no special status U-undetermined RE-Recently extinct in PA PE-PA endangered
 PT-PA threatened PC-Pennsylvania candidate LE-Federally endangered I-Introduced to non-native drainage

continued on next page

TABLE 5-4 FISH OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status
suckers: Family Catostomidae	quillback	<i>Carpiodes cyprinus</i>	N
	white sucker	<i>Catostomus commersoni</i>	N
	creek chubsucker	<i>Erimyzon oblongus</i>	N
catfishes: Family Ictaluridae	white catfish	<i>Ameirus catus</i>	N
	yellow bullhead	<i>Ameirus natalis</i>	N
	brown bullhead	<i>Ameirus nebulosus</i>	N
	channel catfish	<i>Ictalurus punctatus</i>	N
	stonecat	<i>Noturus flavus</i>	N
pikes: Family Esocidae	margined madtom	<i>Noturus insignis</i>	N
	redfin pickerel	<i>Esox americanus americanus</i>	N
	muskellunge	<i>Esox masquinongy</i>	N,I
	tiger muskellunge	<i>Esox masquinongy X Esox lucius</i>	I
	chain pickerel	<i>Esox niger</i>	N
smelt: Family Asmeridae	rainbow smelt	<i>Osmerus mordax</i>	N,I
trout: Family Salmonidae	kokanee, sockeye salmon	<i>Oncorhynchus nerka</i>	I
	rainbow trout	<i>Oncorhynchus mykiss</i>	I
	brown trout	<i>Salmo trutta</i>	I
	brook trout	<i>Salvelinus fontinalis</i>	N,I
	tiger trout	<i>Salmo trutta X Salvelinus fontinalis</i>	I
	lake trout	<i>Salvelinus namaycush</i>	I
killifishes: Family Cyprinodontidae	banded killifish	<i>Fundulus diaphanus</i>	N
sticklebacks: Family Gasterosteidae	fourspine stickleback	<i>Apeltes quadracus</i>	N
	threespine stickleback	<i>Gasterosteus aculeatus</i>	N
sculpins: Family Cottidae	slimy sculpin	<i>Cottus cognatus</i>	N
	mottled sculpin	<i>Cottus bairdi</i>	N
temperate basses: Family Percichthyidae	striped bass	<i>Morone saxatilis</i>	N,I
	striped bass hybrid		I
sunfishes: Family Centrarchidae	rock bass	<i>Ambloplites rupestris</i>	N
	bluespotted sunfish	<i>Enneacanthus gloriosus</i>	N
	redbreast sunfish	<i>Lepomis auritus</i>	N
	green sunfish	<i>Lepomis cyanellus</i>	N
	pumpkinseed	<i>Lepomis gibbosus</i>	N
	bluegill	<i>Lepomis macrochirus</i>	N
	smallmouth bass	<i>Micropterus dolomieu</i>	N
	largemouth bass	<i>Micropterus salmoides</i>	N
perches: Family Percidae	black crappie	<i>Pomoxis nigromaculatus</i>	N,I
	greenside darter	<i>Etheostoma blenniodes</i>	N
	tessellated darter	<i>Etheostoma olmstedi</i>	N
	yellow perch	<i>Perca flavescens</i>	N
	shield darter	<i>Percina peltata</i>	N
	walleye	<i>Stizostedion vitreum vitreum</i>	N

Notes: Fish Status

N-no special status **U**-undetermined **RE**-Recently extinct in PA **PE**-PA endangered
PT-PA threatened **PC**-Pennsylvania candidate **LE**-Federally endangered **I**-Introduced to non-native drainage

Commission, include brown and brook trout, chain pickerel, rock bass, bluegills, crappie, fallfish, darters, suckers, eels, bullheads, and some types of shiners and dace. In addition, muskellunge, which are stocked in the river below Bethlehem, are doing well. Attempts to bring shad back to the river are discussed below.

2. Exotic Fish

When discussing the number of exotic fish species in Pennsylvania, it is useful to analyze the state by drainage basin. For example, a species of fish native to the Susquehanna River basin that is moved to the Allegheny River basin is considered an exotic in the Allegheny River basin. Some exotic species of fish were purposely introduced, including Pacific salmon, rainbow trout, brown trout, Amur pike, goldfish, redear sunfish, and common carp. Other exotics were introduced accidentally or illegally. According to the Pennsylvania Biological Survey's Fish Technical Committee,

there are 102 species of fish in the Delaware River basin, of which 18 are introduced species. Of the six Pennsylvania drainage basins, the Delaware is second only to the Susquehanna (with 22 species) in the number of introduced fishes.

3. Shad in the Lehigh River

White Shad, or *Alosa sapidissima* meaning most delicious shad, have traditionally been an important resource to the inhabitants of the Lehigh River watershed. Shad and their roe have been considered a delicacy for all of the Lehigh Valley's historical inhabitants. The shad's life cycle is the primary reason the fish have become a valuable asset to the Lehigh Valley. As anadromous fish, shad live in oceans but migrate into freshwater to spawn. During spring, shad fry hatch from eggs in rivers. In the fall, young fish migrate down rivers to join oceanic populations that head south for the winter. The following spring the schools of fish migrate back north and the sexually mature individuals return to their rivers of origin to spawn. Most shad die following the spawn but some do survive to spawn again. The migrations of shad into rivers present an opportunity for humans and wildlife to harvest massive some of these fish.



*The American shad, or *Alosa sapidissima* (which means "most delicious shad") have been an important resource for the inhabitants of the watershed. These shad ladders now make it possible for the anadromous shad to reach their breeding grounds upriver.*

The Lehigh Valley's first residents, the Lenni-Lenape, were dependent on the Lehigh's seemingly limitless supply of shad. The Lenni-Lenape perfected shad harvest with the use of large v-shaped rock dams that acted as a funnel. The dams were constructed with an opening in the middle covered by a net into which the Lenni-Lenape herded schools potentially containing thousands of shad. Learning fishing techniques from the Lenni-Lenape, shad also became a primary food source for the Lehigh Valley's European settlers. The dangerous job of Lehigh River shad fishing and distribution for the community became the duty of a group of adventurous young men called "The Single Brethren's Choir." Their records are important today for use in studying the historical fish populations.

The pinnacle of the Lehigh River's use as a shad fishery was the 1770s when a record 5,300 shad were caught in a day by the Single Brethren's Choir. Not long afterwards, industrialization at the beginning of the nineteenth century began to decimate the once seemingly innumerable shad. The shad population that appeared impervious to heavy commercial fishing for years could not withstand the sewage, factory, tannery, and slaughterhouse wastes; coal silt, sawdust, acid mine drainage, sedimentation, and a variety of other by-products of industrialization. Vital stream habitat was removed when the Lehigh was channelized to accommodate barges transporting coal. As a result, shad populations declined steadily until 1829 when shad were completely isolated from the Lehigh River. Construction of a dam at the river's confluence with the Delaware River controlled water levels for the Lehigh Canal, but it also completely blocked shad migrations. Eventually the Delaware River became so polluted that, by 1953, no shad were caught by commercial fishing corporations out of Lambertville, New Jersey. So much sewage and organic waste entered the Delaware River that nearly sixty miles of water around Philadelphia, Camden, and Wilmington had depleted levels of dissolved oxygen to the point that shad could not pass through without suffocating. The tragic loss of shad and other wildlife was not unique to the Lehigh River; the Schuylkill, Susquehanna, Hudson, and Connecticut Rivers experienced the same fate.

The beginning of shad restoration in the Delaware and Lehigh Rivers came from an unexpected source. In 1955, Hurricanes Connie and Diane caused massive flooding in the Delaware Valley. While the hurricanes caused tragic fatalities and property loss, it washed away years of accumulated pollutants from the Delaware River and its tributaries. In the early 1960s, reports of fisherman catching shad from the Delaware River sparked a great deal of interest from sportsmen, biologists, and commercial fisherman. Although shad made a strong comeback in the early sixties, shad runs varied greatly from year to year. When pollution levels drove dissolved oxygen below 4 mg/l, the river yielded practically no shad. One shad run however was estimated to contain up to 500,000 individuals. Finally, the Clean Water Act in 1970 required most cities within the Delaware River watershed to upgrade their sewage treatment facilities. The EPA increased policing of factory discharge. The result was a stable population of shad returning to the Delaware River yearly. Since then the shad population has increased steadily. By the 1990's, the Delaware River's shad population was estimated at nearly one million individuals. The final major victory for Delaware River Shad was when the United States Congress officially blocked an Army Corps of Engineers plan to construct a dam on the Delaware near Shawnee Pennsylvania in 1992. While the dam would have provided flood control, recreation, and drinking water, it would have had detrimental environmental effects including excluding shad from nearly 100 miles of historic spawning grounds.

Despite the Delaware's tremendous rejuvenation in the 1970s, its second largest tributary, the Lehigh River, was still without its historic shad run. The success realized in reestablishing shad into the Delaware prompted the Pennsylvania Fish Commission to begin a study in 1973 to see if the Lehigh River was capable of supporting shad reproduction. Shad eggs planted in the upper Lehigh showed high survival rates. It was concluded however that even if shad hatched from the river, they would not return into the Lehigh because water quality at its confluence with the Delaware was poor. The collapse of the steel and zinc industries along the Lehigh in the 1980s brought a dramatic improvement to the Lehigh River's water quality. Consequently, there was renewed interest in shad restoration. Local sportsmen and conservation organizations began an effort to restock shad within the Lehigh. After several failed efforts, juvenile shad attempting to return to the ocean were caught for the first time in decades from the Lehigh River near Bethlehem. Although the Lehigh River was now "clean enough," shad restoration was still impossible because there was no way for shad to enter the Lehigh River. Their passage was still blocked by the now obsolete canal dam. In 1984, a bill was introduced to the Pennsylvania Legislature to assign 3.3 million dollars for construction of fish passageways at the dams blocking the Lehigh's mouth and several miles upstream. Unfortunately, the bill that easily passed through Pennsylvania's Legislature died at the desk of the governor. In 1985 an economic study was released that theorized a shad fishery on the Lehigh similar to the Delaware's would bring about 2.1 million dollars annually to local business. In addition, a petition of nearly 40,000 signatures from across the state in support of the fish passages was delivered to Governor Casey. The following year Casey announced approval for the project. The completion of the fish passage in 1993 finally allowed shad and other fishes access to waters unused for decades.

Shad have not only regained access to their native waters in the Lehigh Valley (see Table 5-5), but have also been reassimilated into

TABLE 5-5. SHAD PASSAGE MONITORED AT EASTON AND ALLENTOWN DAMS

<i>Year</i>	<i>Allentown Dam</i>	<i>Easton Dam</i>
2002	1479	3314
2001	2057	4740
2000	508	2060
1999	479	2346
1998	694	3293
1997	126	1428
1996	496	1141
1995	873	N/A
1994	87	N/A

the culture of its residents. With a meager passage of 87 shad in its first year of use, the Lehigh's shad population has grown tremendously. Shad that make their yearly run into the Delaware and Lehigh Rivers are important to fisherman both as sport and commercially. They are also an important part of the river ecosystem. Many people actually go to the fish passage at Easton in the spring to view their yearly migration.

c. Reptiles and Amphibians

Amphibians and reptiles, (collectively called *herpetofauna*, or *herps*) are excellent indicators of stream and watershed health. Because many of these animals live part of their lives in water and part on land, their survival depends not only on water quality but also on the physical make-up of both environments.

1. Status of Reptiles and Amphibians

Pennsylvania possesses a diverse assemblage of amphibians and reptiles, including 4 orders, 17 families, 44 genera, and 74 species. Thirty-six species of amphibians are native, including 14 frogs and toads, and 22 salamanders. Pennsylvania is home to 38 species of reptiles: 13 turtles, 4 lizards, and 21 snakes. The varied physiography and presence of three major drainage systems contribute greatly to the diversity of Pennsylvania's herpetofauna.

Twenty-two percent of the species of amphibians and reptiles native to Pennsylvania are of special concern or have been extirpated from the state. The recently completed initial phase study by Ruhe et al (2004), found that based on observations and collections, almost half of all amphibian and reptile species in the Lower Lehigh River watershed are at critical levels of population occurrence and distribution. Of the Pennsylvania threatened and endangered species, the bog turtle (*Glyptemys muhlenbergi*), listed as "Endangered", is the only one that is known to have been observed in the watershed area; the bog turtle is also listed as "Threatened" under the Federal Endangered Species Act. In addition, the timber rattlesnake (*Crotalus horridus*) has candidate status for state listing as a "species of Concern." Amphibians and reptiles observed in the Lehigh River watershed are included in Table 5-6.

2. Exotic Reptiles and Amphibians

Primarily due to its temperate climate, Pennsylvania is home to few exotic species of amphibians and reptiles. Most species that would likely be introduced into the state either accidentally or intentionally would come from the pet trade. The vast majority of species in this trade are tropical or semi-tropical and cannot survive the harsh winter climate of Pennsylvania. For example, there have been numerous reports of alligators within Pennsylvania waters. Although some individuals might be able to survive for more than a year, the climate precludes the possibility of successful reproduction.

The red-eared slider (*Pseudemys scripta elegans*) has recently been reported in Lehigh County where numerous individuals of different sizes have been observed. At this time, it is not known if it is a breeding population or simply a group of individuals released over a period of several years. The red-eared slider has established successful introduced populations throughout most



Herps are excellent indicators of stream and watershed health.

TABLE 5-6. HERPETOFAUNA OF THE LEHIGH RIVER WATERSHED**Source: PNDI; Brandon Ruhe, personal communication, 2003)**

CLASS AMPHIBIA	Common Name	Scientific Name
Order Caudata: Salamanders		
Family Ambystomatidae: Mole Salamanders	Jefferson Salamander Spotted Salamander Marbled Salamander	<i>Ambystoma jeffersonianum</i> <i>Ambystoma maculatum</i> <i>Ambystoma opacum</i>
Family Plethodontidae: Lungless Salamanders	Northern Dusky Salamander Allegheny Dusky Salamander Northern Two-lined Salamander Longtail Salamander Northern Spring Salamander Northern Redback Salamander Northern Slimy Salamander Northern Red Salamander	<i>Desmognathus fuscus</i> <i>Desmognathus ochrophaeus</i> <i>Eurycea bislineata</i> <i>Eurycea l. longicauda</i> <i>Gyrinophilus p. porphyriticus</i> <i>Plethodon cinereus</i> <i>Plethodon glutinosus</i> <i>Pseudotriton r. ruber</i>
Family Salamandridae: Newts	Red-Spotted Newt	<i>Notophthalmus v. viridescens</i>
Order Anura: Frogs and Toads		
Family Bufonidae: True Toads	Eastern American Toad Fowler's Toad	<i>Bufo a. americanus</i> <i>Bufo fowleri</i>
Family Ranidae: True Frogs	Wood Frog Pickerel Frog Northern Leopard Frog Bullfrog Green Frog	<i>Rana sylvatica</i> <i>Rana palustris</i> <i>Rana pipiens</i> <i>Rana catesbeiana</i> <i>Rana clamitans melanota</i>
Family Hylidae: Treefrogs, Chorus Frogs and Cricket Frogs	Northern Spring Peeper Gray Treefrog Northern Cricket Frog	<i>Pseudacris c. crucifer</i> <i>Hyla versicolor</i> <i>Acris c. crepitans</i>
CLASS REPTILIA		
Order Lacertilia: Lizards		
Family Scincidae: Skinks	Five-lined Skink	<i>Eumeces fasciatus</i>
Order Serpentes: Snakes		
Family Colubridae: Harmless Snakes	Northern Black Racer Northern Ringneck Snake Eastern Rat Snake Eastern Milk Snake Northern Water Snake Northern Brown Snake Northern Redbelly Snake Eastern Garter Snake	<i>Coluber c. constrictor</i> <i>Diadophis punctatus edwardsii</i> <i>Pantherophis alleghaniensis</i> <i>Lampropeltis t. triangulum</i> <i>Nerodia s. sipedon</i> <i>Storeria d. dekayi</i> <i>Storeria o. occipitamaculata</i> <i>Thamnophis s. sirtalis</i>
Family Viperidae: Pit Vipers	Northern Copperhead Timber Rattlesnake	<i>Agkistrodon contortrix mokasen</i> <i>Crotalus horridus</i>
CLASS CHELONIA		
Order Cryptodeira: Turtles		
Family Chelydridae: Snapping Turtles	Common Snapping Turtle	<i>Chelydra s. serpentina</i>
Family Emydidae: Water and Box Turtles	Midland Painted Turtle Eastern Painted Turtle Spotted Turtle Wood Turtle Bog Turtle Eastern Box Turtle	<i>Chrysemys picta marginata</i> <i>Chrysemys picta picta</i> <i>Clemmys guttata</i> <i>Glyptemys insculpta</i> <i>Glyptemys mühlenbergii</i> <i>Terrapene c. carolina</i>

of Maryland west of the Chesapeake Bay and east of the Allegheny Mountains (Conant and Collins 1991). Climatic conditions are not greatly different in southeastern Pennsylvania, so it is likely that the Lehigh County population is reproductive. In 1997, several volunteers for the Pennsylvania Herpetological Atlas Project reported observing red-eared sliders from several locations (i.e., Northampton, Crawford, and Philadelphia Counties).

Several species that are native to Pennsylvania have been moved to areas of the state where they did not naturally occur. These species that have been introduced to regions outside of their natural range can be considered exotic, but only in the regions where they have been introduced.

d. Birds

Since the advent of the *Peterson Field Guide to the Birds* in 1932, birdwatching has grown as a popular avocation across a broad spectrum of American society. As a result, public participation in the study of birds is enthusiastic and considerable. Volunteers are critical to the success of bird inventory and monitoring efforts.

Many bird observers who engage in friendly competition to find rare birds have increased our understanding of Pennsylvania's bird diversity. The great dispersal ability of birds provides many opportunities to observe species that are peripheral to the state or visit it only occasionally. The taxonomy also has changed, adding species formerly considered subspecies. The American Ornithological Union (AOU) has split several species in recent years, adding to the potential state list (AOU, 1997). The Official List of Pennsylvania Birds is maintained by the Pennsylvania Ornithological Records Committee (PORC), a subcommittee of the Pennsylvania Biological Survey's Ornithological Technical Committee (OTC).



The common presence of the great blue heron in the Lehigh River watershed indicates a relatively healthy habitat.

1. Status of Birds

Observers have identified 394 wild bird species in Pennsylvania (AOU 1997). This includes 186 species that regularly nest in the state and others that are winter residents, transients, or occasional visitors. At least 20 species have a history of nesting occasionally in the state, but have not been documented nesting in recent years with regularity. The high mobility and resourcefulness of birds make it difficult to make concrete classifications of species.

The PABS's Ornithology Technical Committee (OTC) proposes the list of Endangered and Threatened birds to the Pennsylvania Game Commission (PGC), and the OTC and PGC list only species that breed regularly in the state. As of December 1997, the OTC has proposed 11 species as Endangered in the state: American bittern, least bittern, great egret, yellow-crowned night heron, bald eagle, peregrine falcon, king rail, common tern, black tern, short-eared owl, and loggerhead shrike. Of these, the American bittern, least bittern, yellow-crowned night heron, peregrine falcon, and the bald eagle have been documented in the Lehigh River watershed area. Another five species are proposed as Threatened in Pennsylvania: osprey, upland sandpiper, yellow-bellied flycatcher, sedge wren, and dickcissel. Of these, the osprey and sedge wren have

**TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED
(Saenger, Malt, and Crilley, 2002)**

Family	Common Name	Scientific Name	Status	Special Concern Code
LOONS: FAMILY GAVIIDAE				
	red-throated loon	<i>Gavia stellata</i>	N	
	common loon	<i>Gavia immer</i>	N	
GREBES: FAMILY PODICIPEDIDAE				
	pied-billed grebe	<i>Podilymbus podiceps</i>	B	R
	horned grebe	<i>Podiceps auritus</i>	N	
	red-necked grebe	<i>Podiceps grisegena</i>	N	
	eared grebe	<i>Podiceps nigricollis</i>	N	
CORMORANTS: FAMILY PHALACROCORACIDAE				
	great cormorant	<i>Phalacrocorax carbo</i>	A	
	double-crested cormorant	<i>Phalacrocorax auritus</i>	I	
HERONS AND BITTERNS: FAMILY ARDEIDAE				
	American bittern	<i>Botaurus lentiginosus</i>	B	E
	least bittern	<i>Ixobrychus exilis</i>	B	E
	great blue heron	<i>Ardea herodias</i>	B	
	great egret	<i>Ardea alba</i>	B	E
	snowy egret	<i>Egretta thula</i>	B	A
	little blue heron	<i>Egretta caerulea</i>	N	
	tricolored heron	<i>Egretta tricolor</i>	N	
	cattle egret	<i>Bubulcus ibis</i>		I
	green heron	<i>Butorides virescens</i>	B	
	black-crowned night-heron	<i>Nycticorax nycticorax</i>	B	A
	yellow-crowned night-heron	<i>Nyctanassa violacea</i>	B	E
IBISES: FAMILY THRESKIORNITHIDAE				
	glossy ibis	<i>Plegadis falcinellus</i>	N	
VULTURES: FAMILY CATHARTIDAE				
	black vulture	<i>Coragyps atratus</i>	B	
	turkey vulture	<i>Cathartes aura</i>	B	
SWANS: FAMILY CYGNINAE				
	tundra swan	<i>Cygnus columbianus</i>	N	
	mute swan	<i>Cygnus olor</i>	B	O
GEESE: FAMILY ANSERINAE				
	greater white-fronted goose	<i>Anser albifrons</i>	N	
	snow goose	<i>Chen caerulescens</i>	N	
	Ross' goose	<i>Chen rossii</i>	N	
	brant	<i>Branta bernicla</i>	N	
	Canada goose	<i>Branta canadensis</i>	B	
MARSH DUCKS: FAMILY ANATINAE				
	wood duck	<i>Aix sponsa</i>	B	
	green-winged teal	<i>Anas crecca</i>	B	R
	American black duck	<i>Anas rubripes</i>	B	
	mallard	<i>Anas platyrhynchos</i>	B	
	northern pintail	<i>Anas acuta</i>	B	
	blue-winged teal	<i>Anas discors</i>	B	
	northern shoveler	<i>Anas clepeata</i>	N	
	gadwall	<i>Anas strepera</i>	N	
	Eurasian wigeon	<i>Anas penelope</i>	N	
	American widgeon	<i>Anas americana</i>	N	

TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
DIVING DUCKS: FAMILY AYTHYINAE				
	canvasback	<i>Aythya visinaria</i>	N	
	redhead	<i>Aythya americana</i>	B	
	ring-necked duck	<i>Aythya collaris</i>	N	
	greater scaup	<i>Aythya marila</i>	N	
	lesser scaup	<i>Aythya affinis</i>	N	
	black scoter	<i>Melanitta nigra</i>	N	
	surf scoter	<i>Melanitta perspicillata</i>	N	
	white-winged scoter	<i>Melanitta fusca</i>	N	
	common goldeneye	<i>Bucephala clangula</i>	N	
	bufflehead	<i>Bucephala albeola</i>	N	
MERGANSERS: FAMILY MERGINAE				
	hooded merganser	<i>Lophodytes cucullatus</i>	B	
	common merganser	<i>Mergus merganser</i>	B	
	red-breasted merganser	<i>Mergus serrator</i>	N	
STIFFTAILS: FAMILY OXYURINAE				
	ruddy duck	<i>Oxyura jamaicensis</i>	B	
OSPREYS: FAMILY PANDIONIDAE				
	osprey	<i>Pandion haliaetus</i>	B	T
KITES: FAMILY ELANINAE				
	Mississippi kite	<i>Ictinia mississippiensis</i>	A	
HARRIERS: FAMILY CIRCINAE				
	northern harrier	<i>Circus cyaneus</i>	B	A
BUTEOS AND EAGLES: FAMILY BUTEONINAE				
	bald eagle	<i>Haliaeetus leucocephalus</i>	B	E
	sharp-shinned hawk	<i>Accipiter striatus</i>	B	
	Cooper's hawk	<i>Accipiter cooperii</i>	B	
	northern goshawk	<i>Accipiter gentilis</i>	B	R
	red-shouldered hawk	<i>Buteo lineatus</i>	B	
	broad-winged hawk	<i>Buteo platypterus</i>	B	
	Swainson's hawk	<i>Buteo swainsoni</i>	N	
	red-tailed hawk	<i>Buteo jamaicensis</i>	B	
	rough-legged hawk	<i>Buteo lagopus</i>	N	
	golden eagle	<i>Aquila chrysaetos</i>	N	
FALCONS: FAMILY FALCONINAE				
	American kestrel	<i>Falco sparverius</i>	B	
	merlin	<i>Falco columbarius</i>	N	
	peregrine falcon	<i>Falco peregrinus</i>	B	
	gyrfalcon	<i>Falco rusticolus</i>	N	

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TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
QUAIL: FAMILY PHASIANIDAE				
	ring-necked pheasant	<i>Phasianus colchicus</i>	B	O
	northern bobwhite	<i>Colinus virginianus</i>	B	R
GROUSE: FAMILY TETRAONIDAE				
	ruffed grouse	<i>Bonasa umbellus</i>	B	
TURKEYS: FAMILY MELEAGRIDAE				
	wild turkey	<i>Meleagris gallapavo</i>	B	
RAILS: FAMILY RALLIDAE				
	yellow rail	<i>Coturnicops noveboracensis</i>	A	
	black rail	<i>Laterallus jamaicensis</i>	A	
	king rail	<i>Rallus elegans</i>	B	E
	Virginia rail	<i>Rallus limicola</i>	B	
	sora	<i>Porzana carolina</i>	B	
	spotted rail	<i>Pardirallus maculatus</i>	A	
	purple gallinule	<i>Porphyryla martinica</i>	A	
	American coot	<i>Fulica americana</i>	B	R
CRANES: FAMILY GRUIDAE				
	sandhill crane	<i>Grus canadensis</i>	B	
PLOVERS: FAMILY CHARADRIIDAE				
	black-bellied plover	<i>Pluvialis squatarola</i>	N	
	American golden-plover	<i>Pluvialis dominica</i>	N	
	Wilson's plover	<i>Charadrius wilsonia</i>	A	
	semipalmated plover	<i>Charadrius semipalmatus</i>	N	
	killdeer	<i>Charadrius vociferus</i>	B	
SANDPIPERS: FAMILY SCOLOPACIDAE				
	greater yellowlegs	<i>Tringa melanoleuca</i>	N	
	lesser yellowlegs	<i>Tringa flavipes</i>	N	
	solitary sandpiper	<i>Tringa solitaria</i>	N	
	willet	<i>Catoptrophorus semipalmatus</i>	N	
	spotted sandpiper	<i>Actitis macularia</i>	B	
	upland sandpiper	<i>Bartramia longicauda</i>	B	T
	Eskimo curlew	<i>Numenius borealis</i>	X	
	whimbrel	<i>Numenius phaeopus</i>	N	
	ruddy turnstone	<i>Arenaria interpres</i>	N	
	sanderling	<i>Calidris alba</i>	N	
	semipalmated sandpiper	<i>Calidris pusilla</i>	N	
	western sandpiper	<i>Calidris mauri</i>	N	
	least sandpiper	<i>Calidris minutilla</i>	R	
	white-rumped sandpiper	<i>Calidris fuscicollis</i>	N	
	pectoral sandpiper	<i>Calidris malanotos</i>	N	
	dunlin	<i>Calidris alpina</i>	N	
	short-billed dowitcher	<i>Limnodromus griseus</i>	N	
	long-billed dowitcher	<i>Limnodromus scolopaceus</i>	N	
	common snipe	<i>Gallinago gallinago</i>	B	T
	American woodcock	<i>Scolopax minor</i>	B	
	Wilson's phalarope	<i>Phalaropus tricolor</i>	N	
	red-necked phalarope	<i>Phalaropus lobatus</i>	N	
	red phalarope	<i>Phalaropus fulicaria</i>	N	
GULLS AND TERNS: FAMILY LARIDAE				
	laughing gull	<i>Larus atricilla</i>	N	
	little gull	<i>Larus minutus</i>	A	
	ring-billed gull	<i>Larus delawarensis</i>	B	
	herring gull	<i>Larus argentatus</i>	B	
	Iceland gull	<i>Larus glaucoides</i>	A	
	lesser black-backed	<i>Larus fuscus</i>	N	

TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
GULLS AND TERNS: FAMILY LARIDAE (continued)				
	glaucous gull	<i>Larus hyperboreus</i>	N	
	great black-backed gull	<i>Larus marinus</i>	N	
	Sabine's gull	<i>Xema sabini</i>	A	
TERNs: FAMILY STERNINAE				
	Arctic tern	<i>Sterna paradisaea</i>	A	
	Forster's tern	<i>Sterna forsteri</i>	N	
	least tern	<i>Sterna antillarum</i>	A	
	black tern	<i>Sterna niger</i>	B	E
SKIMMERS: FAMILY RYNCHOPIDAE				
	black skimmer	<i>Rynchops niger</i>	A	
PIGEONS AND DOVES: FAMILY COLUMBIDAE				
	rock dove	<i>Columba livia</i>	B	O
	mourning dove	<i>Zenaida macroura</i>	B	
CUCKOOS: FAMILY CUCULIDAE				
	black-billed cuckoo	<i>Coccyzus erythrophthalmus</i>	B	
	yellow-billed cuckoo	<i>Coccyzus americanus</i>	B	
BARN OWLS: FAMILY TYTONIDAE				
	barn owl	<i>Tyto alba</i>	B	A
	eastern screech-owl	<i>Otus asio</i>	B	
TYPICAL OWLS: FAMILY STRIGIDAE				
	great horned owl	<i>Bubo virginianus</i>	B	
	snowy owl	<i>Nyctea scandiaca</i>	N	
	barred owl	<i>Strix varia</i>	B	C
	long-eared owl	<i>Asio otus</i>	B	U
	short-eared owl	<i>Asio flammeus</i>	B	E
	northern saw-whet owl	<i>Aegolius acadicus</i>	B	U
GOATSUCKERS: FAMILY CAPRIMULGIDAE				
	common nighthawk	<i>Chordeiles minor</i>	B	
	whip-poor-will	<i>Caprimulgus vociferus</i>	B	
SWIFTS: FAMILY APODIDAE				
	chimney swift	<i>Chaetura pelagica</i>	B	
HUMMINGBIRDS: FAMILY TROCHILIDAE				
	ruby-throated hummingbird	<i>Archilochus colubris</i>	B	
KINGFISHERS: FAMILY ALCEDINIDAE				
	belted kingfisher	<i>Ceryle alcyon</i>	B	
WOODPECKERS: FAMILY PICIDAE				
	red-headed woodpecker	<i>Melanerpes erythrocephalus</i>	B	
	red-bellied woodpecker	<i>Melanerpes carolinus</i>	B	
	yellow-bellied sapsucker	<i>Sphyrapicus varius</i>	B	
	downy woodpecker	<i>Picoides pubescens</i>	B	
	hairy woodpecker	<i>Picoides villosus</i>	B	
	northern flicker	<i>Colaptes auratus</i>	B	
	pileated woodpecker	<i>Dryocopus pileatus</i>	B	

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TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
FLYCATCHERS: FAMILY TYRANNIDAE				
	olive-sided flycatcher	<i>Contopus cooperi</i>	B	X
	eastern wood-pewee	<i>Contopus virens</i>	B	
	yellow-bellied flycatcher	<i>Empidonax flaviventris</i>	B	E
	acadian flycatcher	<i>Empidonax virescens</i>	B	
	alder flycatcher	<i>Empidonax alnorum</i>	B	
	willow flycatcher	<i>Empidonax traillii</i>	B	
	least flycatcher	<i>Empidonax minimus</i>	B	
	eastern phoebe	<i>Sayornis phoebe</i>	B	
	great crested flycatcher	<i>Myiarchus crinitus</i>	B	
	eastern kingbird	<i>Tyrannus tyrannus</i>	B	
SHRIKES: FAMILY LANIIDAE				
	northern shrike	<i>Lanius excubitor</i>	N	
	loggerhead shrike	<i>Lanius ludovicianus</i>	B	E
VIREOS: FAMILY VIREONIDAE				
	white-eyed vireo	<i>Vireo griseus</i>	B	
	blue-headed vireo	<i>Vireo solitarius</i>	B	
	yellow-throated vireo	<i>Vireo flavifrons</i>	B	
	warbling vireo	<i>Vireo gilvus</i>	B	
	Philadelphia vireo	<i>Vireo philadelphicus</i>	N	
	red-eyed vireo	<i>Vireo olivaceus</i>	B	
JAYS, CROWS: FAMILY CORVIDAE				
	blue jay	<i>Cyanocitta cristata</i>	B	
	American crow	<i>Corvus brachyrhynchos</i>	B	
	fish crow	<i>Corvus ossifragus</i>	B	
	common raven	<i>Corvus corax</i>	B	
LARKS: FAMILY ALAUDIDAE				
	horned lark	<i>Eremophila alpestris</i>	B	
SWALLOWS: FAMILY HIRUDINIDAE				
	purple martin	<i>Progne subis</i>	B	
	tree swallow	<i>Tachycineta bicolor</i>	B	
	northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>	B	
	bank swallow	<i>Riparia riparia</i>	B	
	cliff swallow	<i>Hirundo pyrrhonota</i>	B	
	barn swallow	<i>Hirundo rustica</i>	B	
TITMICE: FAMILY PARIDAE				
	Carolina chickadee	<i>Poecile carolinensis</i>	B	
	black-capped chickadee	<i>Poecile atricapillus</i>	B	
	boreal chickadee	<i>Poecile hudsonicus</i>	A	
	tufted titmouse	<i>Baeolophus bicolor</i>	B	
NUTHATCHES: FAMILY SITTIDAE				
	red-breasted nuthatch	<i>Sitta canadensis</i>	B	
	white-breasted nuthatch	<i>Sitta carolinensis</i>	B	
CREEPERS: FAMILY CERTHIIDAE				
	brown creeper	<i>Certhia americana</i>	B	
WRENS: FAMILY TROGLODYTIDAE				
	Carolina wren	<i>Thryothorus ludovicianus</i>	B	
	Bewick's wren	<i>Thryomanes bewickii</i>	A	X
	house wren	<i>Troglodytes aedon</i>	B	
	winter wren	<i>Troglodytes troglodytes</i>	B	
	sedge wren	<i>Cistothorus platensis</i>	B	T
	marsh wren	<i>Cistothorus palustris</i>	B	R

TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
KINGLETS: FAMILY SYLVIIDAE				
	golden-crowned kinglet	<i>Regulus satrapa</i>	B	
	ruby-crowned kinglet	<i>Regulus calendula</i>	N	
	blue-gray gnatcatcher	<i>Poliptila caerulea</i>	B	
THRUSHES: FAMILY TURDIDAE				
	eastern bluebird	<i>Sialia sialis</i>	B	
	veery	<i>Catharus fuscescens</i>	B	
	gray-checked thrush	<i>Catharus minimus</i>	N	
	Swainson's thrush	<i>Catharus ustulatus</i>	B	R
	hermit thrush	<i>Catharus guttatus</i>	B	
	wood thrush	<i>Hylocichla mustelina</i>	B	
	American robin	<i>Turdus migratorius</i>	B	
MIMIC THRUSHES: FAMILY MIMIDAE				
	gray catbird	<i>Dumetella</i>	B	
	northern mockingbird	<i>Mimus polyglottos</i>	B	
	brown thrasher	<i>Toxostoma rufum</i>	B	
STARLINGS: FAMILY STURNIDAE				
	European starling	<i>Sturnus vulgaris</i>	B	O
PIPITS: FAMILY MOTACILLIDAE				
	American pipit	<i>Anthus rubescens</i>	N	
WAXWINGS: FAMILY BOMBYCILLIDAE				
	cedar waxwing	<i>Bombycilla cedrorum</i>	B	
WOOD WARBLERS: FAMILY PARULIDAE				
	blue-winged warbler	<i>Vermivora pinus</i>	B	
	golden-winged warbler	<i>Vermivora chrysoptera</i>	B	
	Tennessee warbler	<i>Vermivora peregrina</i>	B	
	orange-crowned warbler	<i>Vermivora celata</i>	N	
	Nashville warbler	<i>Vermivora ruficapilla</i>	B	
	northern parula warbler	<i>Parula americana</i>	B	
	yellow warbler	<i>Dendroica petechia</i>	B	
	chestnut-sided warbler	<i>Dendroica pensylvanica</i>	B	
	magnolia warbler	<i>Dendroica magnolia</i>	B	
	Cape May warbler	<i>Dendroica tigrina</i>	N	
	black-throated warbler	<i>Dendroica caerulescens</i>	B	
	yellow-rumped warbler	<i>Dendroica coronata</i>	B	
	black-throated gray	<i>Dendroica nigrescens</i>	N	
	black-throated green warbler	<i>Dendroica virens</i>	B	
	blackburnian warbler	<i>Dendroica fusca</i>	B	
	yellow-throated warbler	<i>Dendroica dominica</i>	B	
	pine warbler	<i>Dendroica pinus</i>	B	
	prairie warbler	<i>Dendroica discolor</i>	B	
	palm warbler	<i>Dendroica palmarum</i>	N	

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TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
WOOD WARBLERS: FAMILY PARULIDAE (continued)				
	palm warbler	<i>Dendroica palmarum</i>	N	
	bay-breasted warbler	<i>Dendroica castanea</i>	N	
	blackpoll warbler	<i>Dendroica striata</i>	B	
	cerulean warbler	<i>Dendroica cerulea</i>	B	
	black-and-white warbler	<i>Mniotilta varia</i>	B	
	American redstart	<i>Setophaga ruticilla</i>	B	
	prothonotary warbler	<i>Protonotaria citrea</i>	B	R
	worm-eating warbler	<i>Helmitheros vermivorus</i>	B	
	ovenbird	<i>Seiurus aurocapillus</i>	B	
	northern waterthrush	<i>Seiurus noveboracensis</i>	B	
	Louisiana waterthrush	<i>Seiurus motacilla</i>	B	
	Kentucky warbler	<i>Oporornis formosus</i>	B	
	Connecticut warbler	<i>Oporornis agilis</i>	N	
	mourning warbler	<i>Oporornis philadelphia</i>	B	
	common yellowthroat	<i>Geothlypis trichas</i>	B	
	hooded warbler	<i>Wilsonia citrina</i>	B	
	Wilson's warbler	<i>Wilsonia pusilla</i>	N	
	Canada warbler	<i>Wilsonia canadensis</i>	B	
	yellow-breasted chat	<i>Icteria virens</i>	B	
TANGERS: FAMILY THRAUPIDAE				
	summer tanager	<i>Piranga rubra</i>	B	R
	scarlet tanager	<i>Piranga olivacea</i>	B	
	western tanager	<i>Piranga ludoviciana</i>	A	
FINCHES: FAMILY FRINGILLIDAE				
	northern cardinal	<i>Cardinalis cardinalis</i>	B	
	rose-breasted grosbeak	<i>Pheucticus ludovicianus</i>	B	
	blue grosbeak	<i>Guiraca caerulea</i>	B	
	indigo bunting	<i>Passerina cyanea</i>	B	
	dickcissel	<i>Spiza americana</i>	B	T
	eastern towhee	<i>Pipilo erythrophthalmus</i>	B	
	American tree sparrow	<i>Spizella arborea</i>	N	
	chipping sparrow	<i>Spizella passerina</i>	B	
	clay-colored sparrow	<i>Spizella pallida</i>	N	
	field sparrow	<i>Spizella pusilla</i>	B	
	vesper sparrow	<i>Poocetes gramineus</i>	B	
	lark sparrow	<i>Chondestes grammacus</i>	A	
	Savannah sparrow	<i>Passerculus sandwichensis</i>	B	
	grasshopper sparrow	<i>Ammodramus savannarum</i>	B	
	Henslow's sparrow	<i>Ammodramus henslowii</i>	B	
	fox sparrow	<i>Passerella iliaca</i>	N	
	song sparrow	<i>Melospiza melodia</i>	B	
	Lincoln's sparrow	<i>Melospiza lincolnii</i>	N	
	swamp sparrow	<i>Melospiza georgiana</i>	B	
	white-throated sparrow	<i>Zonotrichia albicollis</i>	B	
	white-crowned sparrow	<i>Zonotrichia leucophrys</i>	N	
	dark-eyed junco	<i>Junco hyemalis</i>	B	

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TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
FINCHES: FAMILY FRINGILLIDAE (continued)				
	lapland longspur	<i>Calcarius lapponicus</i>	N	
	snow bunting	<i>Plectrophenax nivalis</i>	N	
	bobolink	<i>Dolichonyx oryzivorus</i>	B	
	red-winged blackbird	<i>Agelaius phoeniceus</i>	B	
	eastern meadowlark	<i>Sturnella magna</i>	B	
	rusty blackbird	<i>Euphagus carolinus</i>	N	
	brewer's blackbird	<i>Euphagus cyanocephalus</i>	N	
	common grackle	<i>Quiscalus quiscula</i>	B	
	brown-headed cowbird	<i>Molothrus ater</i>	B	
	orchard oriole	<i>Icterus spurius</i>	B	
	Baltimore oriole	<i>Icterus galbula</i>	B	
	purple finch	<i>Carpodacus purpureus</i>	B	
	house finch	<i>Carpodacus mexicanus</i>	B	
	red crossbill	<i>Loxia curvirostra</i>	B	U
	white-winged crossbill	<i>Loxia leucoptera</i>	N	
	common redpoll	<i>Carduelis flammea</i>	N	
	hoary redpoll	<i>Carduelis hornemanni</i>	A	
	pine siskin	<i>Carduelis pinus</i>	B	
	American goldfinch	<i>Carduelis tristis</i>	B	
	evening grosbeak	<i>Coccothraustes vespertinus</i>	B	
	house sparrow	<i>Passer domesticus</i>	B	O

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Special Concern Codes:
E-Endangered, **T**-Threatened, **A**-Candidate-At Risk, **R**-Candidate-Rare,
U-Candidate-Undetermined, **X**-Extirpated, **O**-Established Exotic.

been observed in the watershed. Only two Pennsylvania breeding bird species are listed under the Federal Endangered Species Act: the peregrine falcon and bald eagle are threatened.

The OTC also lists Candidates to the Pennsylvania Endangered and Threatened bird species list. The Breeding Bird Species of Special Concern list (SSC) comprises the Endangered and Threatened species list and the Candidates to that list. It includes only species with a regular history of nesting in the state. The Candidate list has no legal authority, but serves as an indication of species that deserve attention for inventory, management, research, and conservation efforts. Most Candidate species have declining or low populations that merit concern for their continued existence in the state. Fifty-six % of the SSC list are wetland obligates and an even higher percentage of these species use wetlands as a significant part of their life cycle (Brooks and Croonquist, 1990). Most birds on the SSC list are relatively large with substantial feeding ranges or specialized foraging or nesting requirements. Many SSC birds need extra efforts for population monitoring and are not currently tracked for population trends by standardized surveys.

The bird species present in the watershed are listed in Table 5-7. In addition, there is a wealth of information available specific to the Lehigh River watershed area including *Birds of the Lehigh Valley* (Saenger, Malt, and Crilley, 2002), *A Century of Bird Life in Berks County, Pennsylvania* (Ulrich, 1997), *The Atlas of Breeding Birds in Pennsylvania* (Brauning, 1992), and *The Lehigh Valley, A Natural and Environmental History* (Halma and Oplinger, 2001). Finally, a searchable database of breeding birds is available at <http://www.pasda.psu.edu>.

The Important Bird Area (IBA) Program was started by Birdlife International in Europe in the 1980s.

Birdlife International is a global coalition of partner organizations in over 100 countries. The National Audubon Society is the United States partner designate and administers the IBA program in the U.S. The IBA program was established to reverse the declining trend in bird populations. The mission of Audubon Pennsylvania is "To restore natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth's biological diversity."

Pennsylvania formed the first statewide IBA program in the country in 1996. A group of scientific advisors has identified 78 IBAs encompassing over one million acres of public and private lands. This list is by no means an entire directory of important bird habitat areas. The list will be modified as new areas are nominated and habitats and species are documented.

IBAs are part of a global network of places recognized for their value for bird conservation. An IBA can be large or small, public or private, and must meet several objective criteria. IBAs are voluntary and thus there are no legal or regulatory restrictions. Once a site is designated as an IBA, volunteer monitoring efforts are initiated, focusing on nesting seasons, to track the numbers and varieties of birds utilizing the site. Currently, there are four designated IBAs in the Lehigh River Watershed: the Kittatinny Ridge/Blue Mountain, Hickory Run State Park, Pocono Lake Preserve, and Long Pond Preserve.

Exotic Bird Species

There have been many attempts to introduce exotic birds in the state, especially by sportsmen and those who admired European birdlife. However, only five exotic bird species regularly nest in Pennsylvania. Three of these are abundant and widespread pests: rock dove (pigeon), European starling, and house sparrow. The remaining exotics are mute swan, an ornamental waterfowl, and ring-necked pheasant, an upland gamebird. Starlings and house sparrows compete with native birds for cavities and prey on eggs and nestlings. Mute swans can alter wetlands to the disadvantage of native waterfowl and other water birds.



While it has been determined that 71 species of mammals are native to Pennsylvania, 11 of them appear to have been extirpated. Extirpation does not seem to be a threat with the white-tailed deer, however. Currently, numbers are on the increase despite measures to reduce the state's herds.

e. Mammals

Status of Mammals

Seventy-one species of mammals are native to Pennsylvania. These represent 7 orders and 16 families. As a group, mammals are only a small percentage of the state's native species of plants and animals. However, because mammals are familiar to so many citizens of Pennsylvania, they are important as symbols of the Commonwealth's native biological diversity.

Of the 71 native species, 11 appear to have been extirpated in historic times. Most of these are large mammals, including the gray wolf, mountain lion, lynx, bison, wolverine, moose, and marten (Williams et al. 1985). Three other large species that were once extirpated--the beaver, elk, and most recently, fisher--have been successfully re-established. The only inconspicuous species that is presumed extirpated is the marsh rice rat.

Three species, or subspecies, of mammals are state-listed as Endangered within the Commonwealth: Indiana bat, Delmarva fox squirrel and least shrew (Pennsylvania Game Commission 1995). Both the Indiana bat and the Delmarva fox squirrel are also listed as Endangered under the Federal Endangered Species Act. Another three are state-listed as Threatened: small-footed myotis (bat), West Virginian water shrew, and the Eastern woodrat. Of these threatened and endangered species, the least shrew (Halma and Oplinger, 2001) and the eastern woodrat (Pa. Game Commission, 1995) are the only mammals to have been observed in the watershed area.

Despite the breadth of our knowledge of the mammals of Pennsylvania, a considerable amount of research remains to be done in order to ascertain the status and distribution of many species. These include Threatened and Endangered mammals, and those identified in a review by Kirkland and Krim (1990) as species or subspecies "at risk" or "status undetermined". This set includes the least weasel, the New England cottontail; several bat species, and the eastern spotted skunk.

Compared to other taxonomic groups, the status of most mammal species in Pennsylvania can be relatively well understood with data that already exist. There are some inventorying gaps to fill, and it will be important to continue monitoring both overall mammal diversity and the dynamics of select species in relation to environmental variables. Current efforts by the Pennsylvania Biological Survey, including the Important Mammal Areas Project (see <http://www.pawildlife.org/imap.htm>) and a developing Biodiversity Monitoring Network, highlight the importance of accessible databases. With increasing consensus about the importance of such resources, and newly emerging practical guidelines to build them, there is good reason to be optimistic about the stewardship of mammal biodiversity in Pennsylvania's future.

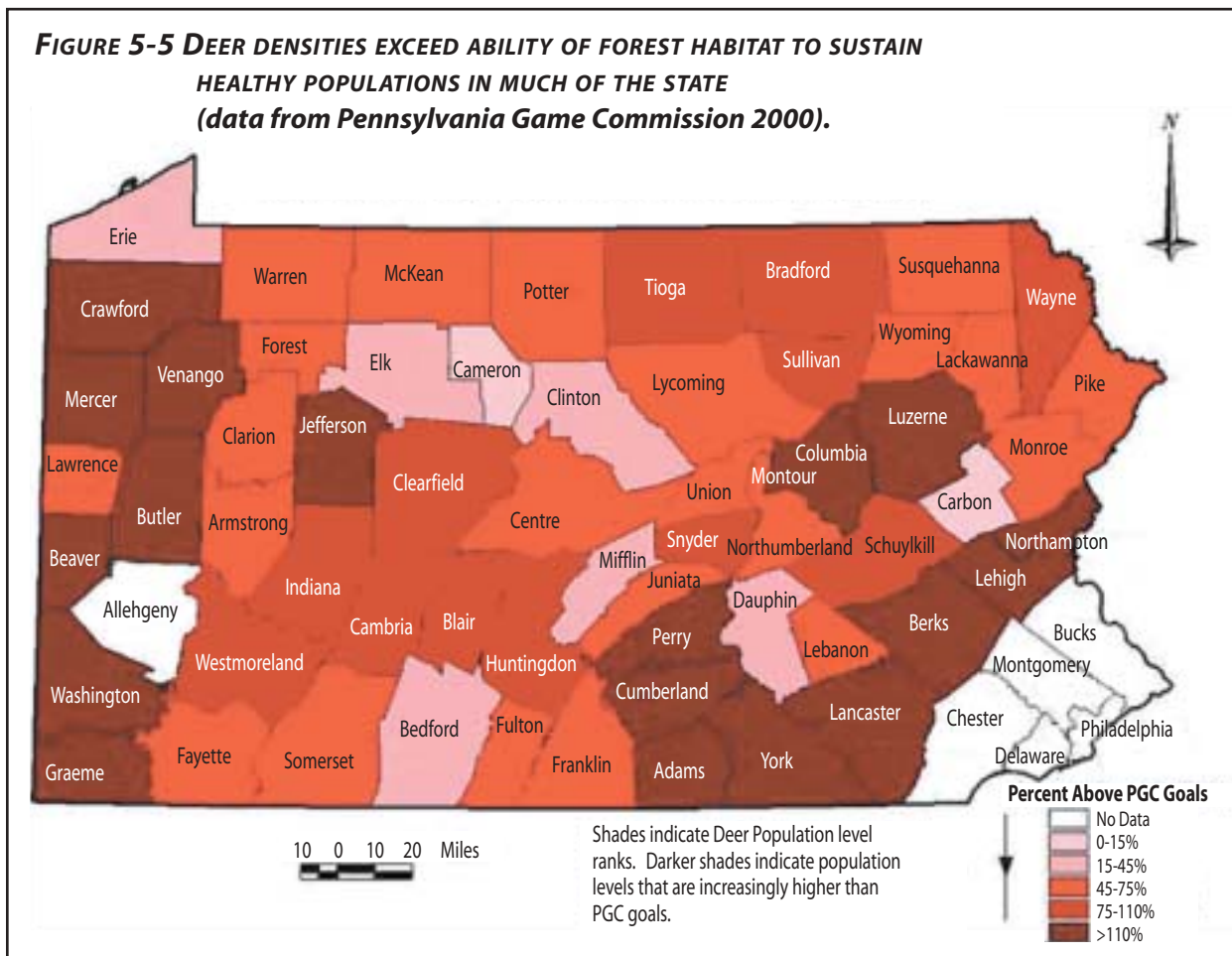


TABLE 5-8 MAMMALS OF THE LEHIGH RIVER WATERSHED
(Pennsylvania DCNR, www.dcnr.state.pa.us/pabs/mammals;
Tom Fegley, personal communication, 2003)

Family	Common Name	Scientific Name	Status	Habitat	Behavior
NEW WORLD OPOSSUMS: DIDELPHIDAE					
	Virginia opossum	<i>Didelphis virginiana</i>	C	G	N,C
SHREWS: SORICIDAE					
	masked shrew	<i>Sorex cinereus</i>	C	M,B,	N,C
	water shrew	<i>Sorex palustris</i>	R,T	M,S	A
	smokey shrew	<i>Sorex fumeus</i>	C	M	A
	long-tailed shrew	<i>Sorex dipar</i>	I	M,R	U
	pygmy shrew	<i>Sorex hoyi</i>	S	G	A
	northern short-tailed shrew	<i>Blarina brevicauda</i>	C	G	A
	least shrew	<i>Cryptotis parva</i>	E	A,N	A
	Maryland shrew	<i>Sorex fontinalis</i>	U	M, B, N	U
MOLES: TALPIDAE					
	hairy-tailed mole	<i>Parascalops breweri</i>	C	G	A,Y
	eastern mole	<i>Scalopus aquaticus</i>	C	G,R	A,Y
	star-nosed mole	<i>Condylura cristata</i>	C	W,S	A,Y
PLAIN-NOSED BATS: VESPERTILIONIDAE					
	little brown bat	<i>Myotis licifugus</i>	C	C,S	H
	long-eared bat	<i>Myotis keenii</i>	R	C,S	H
	pink-faced bat	<i>Myotis sodalis</i>	E	C,S	H
	small-footed bat	<i>Myotis leibii</i>	T	C,S	H
	silver-haired bat	<i>Lasionycteris noctivagans</i>	R	X	M
	eastern pipistrelle	<i>Pipistrellus subflavus</i>	S	C,S	H
	big brown bat	<i>Eptesicus fuscus</i>	C	C	H
	red bat	<i>Lasiurus borealis</i>	U	X	M
	hoary bat	<i>Lasiurus cinereus</i>	U	X	M
	evening bat	<i>Nycticeius humeralis</i>	R	G	T,H
	Seminole bat	<i>Lasiurus seminolus</i>	U	?	Y
RABBITS AND HARES: LEPORIDAE					
	eastern cottontail	<i>Sylvilagus floridanus</i>	C	B,G	A,C,Y
	New England cottontail	<i>Sylvilagus transitionalis</i>	A	M	U,Y
	snowshoe hare	<i>Lepus americanus</i>	A	M	N,Y
SQUIRRELS: SCIURIDAE					
	eastern chipmunk	<i>Tamias straitus</i>	C	G	D,H
	woodchuck	<i>Marmota monax</i>	C	W,A,R	D,H
	gray squirrel	<i>Sciurus carolinensis</i>	C	D,G	D,T
	fox squirrel	<i>Sciurus niger</i>	R,E,C	D,A	D,T
	red squirrel	<i>Tamiasciurus hudsonicus</i>	C	D,X	D,T
	southern flying squirrel	<i>Glaucomys volans</i>	C	D,X	N,T
	northern flying squirrel	<i>Glaucomys sabrinus</i>	I	X,C	N,T
BEAVERS: CASTORIDAE					
	beaver	<i>Castor canadensis</i>	C	S,L	N,Y
NATIVE RATS, MICE, AND VOLES: CRICETIDAE					
	deer mouse	<i>Peromyscus maniculatus</i>	C	G	N
	white-footed mouse	<i>Peromyscus leucopus</i>	C	G	N
	eastern woodrat	<i>Neotoma magister</i>	T	M,R	N
	southern red-backed vole	<i>Clethrionomys gapperi</i>	C	X,C,R	N

TABLE 5-8 MAMMALS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Habitat	Behavior
NATIVE RATS, MICE, AND VOLES: CRICETIDAE (continued)					
	rock vole	<i>Mictotus chrotorrhinus</i>	A	X,R	D,Y
	pine vole	<i>Microtus pinetorum</i>	C	G	A,Y
	southern bog lemming	<i>Synaptomys cooperi</i>	I	N,W	A,Y
	muskrat	<i>Ondatra zibethicus</i>	C	W,L,S	N
OLD WORLD RATS AND MICE: MURIDAE					
	Norway rat	<i>Rattus norvegicus</i>	C	H,A	N
	house mouse	<i>Mus musculus</i>	C	H,A	H
JUMPING MICE: ZAPODIDAE					
	meadow jumping mouse	<i>Zapus hudsonius</i>	C	N,S	H,N
	woodland jumping mouse	<i>Napeozapus insignis</i>	C	M,C,	H,N,C
NEW WORLD PORCUPINES: ERETHIZONTIDAE					
	porcupine	<i>Erethizon dorsatum</i>	C	M,C,	N,Y
DOGS AND FOXES: CANIDAE					
	eastern coyote	<i>Canis latrans</i>	S	G	A
	red fox	<i>Vulpes vulpes</i>	C	B, A	N
	gray fox	<i>Urocyon cinereargenteus</i>	C	B,D	N
BEARS: URSIDAE					
	black bear	<i>Ursus americanus</i>	C	M,C,D	N
RACCOONS: PROCYONIDAE					
	raccoon	<i>Procyon lotor</i>	C	G	N
WEASELS, SKUNKS, AND OTTERS: MUSTELIDAE					
	ermine	<i>Mustela erminea</i>	I	B,A	N
	least weasel	<i>Mustela nivalis</i>	U	B,A	N
	long-tailed weasel	<i>Mustela frenata</i>	C	G?	N
	mink	<i>Mustela vison</i>	C	W,S	C
	striped skunk	<i>Mephitis mephitis</i>	C	G	N
	river otter	<i>Lutra canadensis</i>	C	G	C,A
CATS: FELIDAE					
	bobcat	<i>Felis rufus</i>	A	M,B,A, R	N
DEER: CERVIDAE					
	white-tailed deer	<i>Odocoileus virginianus</i>	C	G	C,A
Notes:					
Status:		Habitats:		Behavior:	
U (Undetermined)-Species of concern for which insufficient data are available for adequate assessment		M -mountain woodlands		N -nocturnal (active at night)	
R (Rare)-Species found in either a few restricted areas or over a broad area at low numbers		R -rocky areas		D -diurnal (active in day)	
A (At Risk)-Species particularly vulnerable to further habitat modifications or exploitation		B -brush thickets, hedgerows		C -crepuscular (active at dawn and dusk)	
T (Threatened)-Species that are likely to become Endangered within the foreseeable future		W -marshes		A -active day and night	
E (Endangered)-Species of imminent danger of extinction in Pennsylvania		S -streams, rivers		T -nests in tree hollows	
X (Extirpated)-Species that disappeared from Pennsylvania since 1600		L -lakes, ponds		M -migratory	
		N -grasslands		H -hibernator	
		C -coniferous forests		Y -active year-round	
		D -deciduous forests			
		X -mixed forests			
		A -agricultural lands, old fields			
		H -near human/suburban areas (barns, attics)			
		G -generalized habitat requirements (found in a variety of habitats)			

Mammals present in the Lehigh River watershed are shown in Table 5-8. Some relatively common mammals that are found in the watershed include the opossum, eastern mole, star-nosed mole, short-tailed shrew, least shrew, little and big brown bats, raccoon, long-tailed weasel, mink, striped skunk, red fox, woodchuck, eastern chipmunk, eastern gray squirrel, red squirrel, southern flying squirrel, white-footed mouse, deer mouse, meadow vole, muskrat, house mouse, Norway rat, meadow jumping mouse, woodland jumping mouse, eastern cottontail rabbit, and white-tailed deer.

Forest regeneration is impacted in the watershed in part due to deer overbrowsing. Deer populations have grown significantly since the turn of the century (Kosack 1995, Yahner, 1995), and in some regions may be inhibited due to deer foraging on acorns and oak seedlings. Deer also have direct impact on saplings, browsing most vegetation within reach. As populations of deer have burgeoned in recent years, the impact on forest growth has grown increasingly critical (see Figure 5-5).

The Important Mammal Areas (IMAs) Project mentioned above is being carried out by a broad-based alliance of sportsmen, conservation organizations, wildlife professionals, and scientists. The primary concern is to help ensure the future of Pennsylvania's wild mammals, both game and non-game species. The focus is on species of concern and habitats that have high mammalian diversity. Several Important Mammal Areas (IMAs) are currently being identified for the first time in Pennsylvania and a map of these areas will be made available for review in late 2003 or early 2004. A few IMAs have been selected in the watershed and include an area near the Lehigh Gorge (eastern woodrat), a location near Hickory Run State Park (northern flying squirrel), an area near Two-Mile Run/Pocono Lake (northern flying squirrel/good wildlife habitat), an area near Tobyhanna and Gouldsboro State Parks (river otter/large carnivores/good wildlife habitat), and a location near Long Pond Preserve (beaver/muskrats/large carnivores/good wildlife habitat) (personal communication with Alicia Linzey, Project Director, Indiana University, October 2003).

Exotic Mammals

Of the mammal species in Pennsylvania today, only two, the Norway rat and house mouse, are exotic species. Two previously introduced species—the European hare and black rat—apparently are now extirpated (Doutt et al. 1973).

B. Wildlife Habitat

Wild animals require four basic habitat components—food, water, cover and space. The amount and distribution of these will influence the types of wildlife that can survive in an area. As the quantity, type and distribution of habitat components change, so do the types of wildlife species found within the habitat. Wildlife management often involves manipulating components of the habitat to favor a particular species or group of species.

Succession is the predictable change in a plant community over time. For example, a field left untouched will become covered with shrubs and eventually with a forest. As the plant community changes, so do the habitat components available for wildlife.

Bare soil, if left alone will become vegetated over time. Seeds are present in the soil and others arrive by wind, wildlife or other means. As a result, the unattended bare soil eventually becomes a grassy field, an early successional stage. Fields provide herbaceous food and cover as well as insects and seeds for small mammals such as meadow voles and cottontail rabbits. Red-tailed

hawks and red fox, which feed on small mammals, often hunt in open fields. Birds such as indigo buntings and field sparrows also are attracted to the food and cover found in fields.

The next stage in plant succession occurs when shrubs and small trees invade an old field. The resulting brushy habitat provides low cover and woody browse, as well as blackberry, sumac, elderberry, and hawthorne berries and seeds. This brush-stage forest is ideal for white-tailed deer, providing habitat components they need for reproducing, resting and feeding. Brush-stage forests also provide cover for cottontail rabbits and many other small mammals. Game birds like ruffed grouse and songbirds also find food and cover in brushy habitat.

Although these early successional stage habitats provide a variety of important habitat components, they typically do not include some critical elements. Large seeds, such as acorns and hickory nuts, produced by overstory trees and used as food by many species of wildlife, are generally absent. Cavity trees, which provide cover for birds and small animals, are also not present. Young habitats simply have not had time to develop some of the features present in more mature forest areas.

An un-managed brush-stage forest will become a pole-stage forest in 15 to 20 years. This type of forest contains trees 4 to 10 inches in diameter at breast height. Pole-stage forests are generally considered the least productive forest habitats for wildlife. They are a transitional stage between brush-stage and mature forests, and generally lack the thick understory cover and browse so abundant in the brush-stage forest. They also lack the large overstory and cavity trees associated with mature forests.

As a pole stage forest matures, cavity trees become more abundant, overstory trees produce more nuts, acorns and fruit; and dead wood and leaf litter collect on the ground. Woodpeckers, chickadees, squirrels and other small animals nest in tree cavities, and gray squirrels and wild turkey eat acorns and hickory nuts produced by mature forest trees. Species as large as the black bear and small as the masked shrew forage for insects in dead wood on the ground, and amphibians such as the red-spotted newt and the northern red salamander thrive in the moist environment created by the closed canopy overhead and the deep leaf litter underfoot.

In addition to the successional stage of the habitat, the size of the area influences which species will be found there. Many species are area sensitive, which means that they are absent from or rare in small patches of habitat and more abundant within extensive areas of undisturbed land. Some have large home ranges, whereas others must travel a considerable distance to meet mates. The northern goshawk, for example, does not inhabit small woodlots because it has a large home range and requires large forested areas free from human disturbance. Many songbirds are also sensitive. Although they do not have large home ranges, they rarely nest successfully in small patches of forest, where nest predation and parasitism occur more frequently than in large unfragmented forests. These species, including ovenbirds, scarlet tanagers and many warblers, are often called forest interior species because they need the insulating effect provided by the forest interior. Many forest-dwelling amphibians also require large tracts of mature forest in which to survive and reproduce successfully. In the Lehigh River watershed, large expanses of continuous forest are often found on ridge tops. These forests provide critical areas of habitat for species that cannot survive in small woodlots.

The arrangement of habitat patches also influences the presence of certain types of wildlife. Some species require large tracts of similar habitats, whereas others use a variety of habitats at different stages in their life cycle and require multiple habitat types in close proximity to one another. The scarlet tanager, for example, feeds and reproduces in continuous tracts of mature

forest habitat. Conversely, ruffed grouse use a variety of different habitats, including herbaceous open areas for feeding their young, brushy habitat for cover, pole stage forests for drumming, mature forested areas for nesting and evergreen habitat for winter cover.

Sometimes a habitat may seem suitable for a species, but that species is not abundant there or even is entirely absent from the area. This may be due to the type of habitat in the surrounding landscape. For example, a wetland, stream, or pond surrounded by mowed and manicured lawn probably will not support the wildlife that it could if it were surrounded by a buffer of grasses, shrubs, and trees. The surrounding landscape may also influence habitats on a larger scale. Small woodlots within an agricultural landscape will support a community of wildlife different from that found in woodlots surrounded by commercial or industrial areas.

1. RIPARIAN BUFFERS/CORRIDOR CHARACTERISTICS

Riparian buffers are vegetated zones of protection located along streams or rivers. These strips of grass, shrubs, and/or trees along the banks of rivers and streams filter polluted runoff and provide a transition zone between water and human land use. Buffers are also complex ecosystems that provide habitat and improve the stream communities they shelter. Protection or establishing a forest buffer along a stream is the single most important thing streamside landowners can do to improve and protect our aquatic resources. Map 5-1 shows the portion of the river and streams in the watershed with and without a forest riparian buffer. Riparian buffers serve several very important functions for wildlife protection as described below:

FOOD SOURCE: Streambank vegetation provides food and energy for aquatic insects when leaves, woody debris and seeds fall into the stream. Preserving buffers to maintain an aquatic insect food source is important, as these insects are critical links in the food chain.

HABITAT: Streambank vegetation provides habitat not only for terrestrial life, but also for aquatic life. Overhanging branches and fallen logs from trees often provide much needed shelter to protect fish from predators. In addition, deep pools are frequently created when streambanks are scoured below the root mass of vegetation, which holds the upper streambank in place. These pools are the preferred habitat of fish as the water is cooler and they have protection from the overhanging bank and vegetation. Macro-invertebrates also use the vegetation for habitat purposes. Many insects build homes out of detritus that enters the stream from the surrounding buffer zone.

TEMPERATURE MODERATION: The establishment of riparian buffers is a key to the fight against thermal pollution. Buffers shade the stream from sunlight and therefore help to keep water temperatures below levels that are detrimental to the life, growth, and reproduction of coldwater fishes. Maintaining buffers in urban areas is extremely important because they can help mitigate the negative impact of stormwater runoff from heated surfaces such as paved roads, parking lots, sidewalks, and roofs.

STREAMBANK STABILIZATION: The roots of vegetation act as an anchor for the soil and hold soil particles together to help resist erosion. When located along a stream, the roots will help preserve the structural integrity of the streambank and prevent accelerated rates of erosion and scouring of the banks.

SEDIMENT AND NUTRIENT REDUCTION: The extensive root system of vegetated buffers helps prevent sediment and nutrients contained in stormwater runoff and overland

flow from entering the stream. The roots and vegetation impede the flow of runoff, slowing down the water and allowing sediments to drop out and be deposited on the floodplain. Riparian buffers also reduce nutrient loading in the creek. Once deposited in the riparian zone, these nutrients are available for uptake by the vegetation, which needs nutrients to grow. Plants in a forest community play a major role in the retention of nutrient elements and a natural forest can be extremely efficient in conserving its mineral elements. In the nitrogen cycle the tissues of dead plants and animals is decomposed to ammonia or ammonium ions, which are then acted on by nitrifying bacteria to produce nitrates, the form in which nitrogen is usually assimilated by plants. If there are not enough plants present near a waterway, nitrate ions are not held in the soil and eventually enter the stream. As a side effect, the stream polluted with nitrates supports an algal bloom, which blocks sunlight from reaching more beneficial forms of aquatic plants. Excessive algal growth may result in rapid dissolved oxygen and pH fluctuations in the stream due to the processes of photosynthesis, decomposition, and respiration.

2. FOREST FRAGMENTATION

Forest fragmentation and parcelization have become serious concerns throughout the country, and especially in the urban-suburban corridor of the northeastern United States. Fragmentation is the disruption of the forested landscape into smaller blocks by the increasing proximity of human development. Parcelization, while maintaining the biological extent of the forest, fragments it into increasingly smaller tract sizes of diverse ownerships that create difficulties from a management perspective.



Biodiversity in our forests is threatened by many things, some of which we can control through proper management. Some threats, however, seem to be beyond our ability to craft a solution. The management of our white-tailed deer population continues to be one of the most significant deleterious impacts on our forests.

C. Species of Special Concern

Some species listed as endangered or threatened in Pennsylvania are so distinguished because their range barely extends into the state, or their population has a fragile foothold here. Common terns, for example, have really only ever nested at Erie County's Presque Isle State Park. They are listed as endangered to ensure additional management considerations for these habitat specialists, as well as to heighten awareness of their very limited population status. The common tern's listing helps to ensure the state's wildlife species diversity.

There have also been tremendous success stories in Pennsylvania's endangered/threatened species management program. Pennsylvania's bald eagle population numbers more than 40 nesting pairs – up from three in 1980 – because of bald eagle reintroduction program in the 1990s. Other beneficiaries of specialized management include the osprey and peregrine falcon.

The last word in ignorance is the man who says of an animal or plant "what good is it?". If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of eons has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.

—Aldo Leopold (1949)

Profiles of the Lehigh River Watershed Species of Concern

The following information is from

<http://www.pgc.state.pa.us/wildlife/endangered/index.asp>.

BOG TURTLE

Current Status: Pennsylvania Endangered, Federally Endangered

Biology-Natural History: Mating takes place in May and early June. Each female then digs a nest and lays a clutch of three to five eggs during June or July. Eggs receive no parental care, and hatchlings leave the nest several months later. Adults and young feed on a variety of plant and animal food, such as berries, insects, and even carrion. They do not wander far from hibernating sites in spring seepage, which they leave in April or May and return to in late summer. Summer hibernation (aestivation) may occur during July and August; individuals are otherwise encountered basking on sedge tussocks or moving slowly about in spring runs under concealing vegetation. When danger threatens, individuals burrow rapidly into the mucky bottom of spring runs.

Preferred Habitat: Bog turtles live in relatively open portions of sphagnum bogs, swamps or marshy meadows with slow moving, spring fed streams or spring runs with soft bottoms.

Reasons for Being Endangered: The primary reason for the bog turtle's status is the draining or other destruction of its habitat. Because bog turtles have always been considered the rarest of North American turtles, they are highly valued by turtle fanciers in this country, and possibly twice as much overseas. Many, therefore, have been illegally removed for commercial purposes. Since their habitats are widely separated, other turtles are not likely to move in and replace those removed.

Management Practices: Informal agreements concerning the continued occurrence of the turtles have been made with owners of private property where bog turtles exist. Field surveys have determined the status of historical and new sites. Also, permit review and commentary concerning public use projects where bog turtle habitat is involved is ongoing.

LEAST SHREW

Current Status: In Pennsylvania, endangered; nationally, no special protection.

Population Trend: The least shrew was thought to be widespread throughout much of Pennsylvania, albeit mainly in localized populations, during the mid 1900s. During that period, surveys conducted across the state by mammalogists found this mid-sized insectivore in every region of Pennsylvania except the north-central. Recent surveys now suggest, however, the least shrew has disappeared from many of the sites where it was once present and is now restricted to southeastern counties. Post 1970s surveys have found the least shrew at isolated sites within York and Adams counties with possibly one of the most extensive populations occurring within the Eisenhower National Historic Site near Gettysburg. Isolated populations may occur at other sites across Pennsylvania but remain in jeopardy of localized extinction from myriad factors ranging

from changing landscapes and land-use patterns to loss of habitat. The least shrew was listed as endangered in 1990.

Identifying Characteristics: The total length of the least shrew is from 3 to 3 ½ inches. Its tail length ranges from ½ to ¾ inches, which is the shortest tail of all Pennsylvania shrews. It has a black to ash-gray belly. The only other species of shrew with a short tail, the more common northern short-tailed shrew, is larger (total length is 4 to 5 inches) and is dark slate-gray colored.

Biology-Natural History: The least shrew is found throughout much of the eastern United States, ranging from New York south to Florida and through the midwest into Central America. A grassland species, the least shrew is restricted to non-forested habitats that are free from grazing and intensive agricultural practices. Although much of the biology of this species in Pennsylvania remains unknown, it is believed to have up to three litters per year, averaging five young per litter, between March and November. Like other insectivores, they feed primarily on insects and their larva, earthworms, spiders and sometimes snails. Several researchers have noted that the least shrew appears to be a colonial or somewhat social shrew in forming nests occupied by several adults, rather than occurring singly. In Indiana, it is sometimes referred to as the "bee mole" as it has been found to infrequently enter bee hives and feed on the brood.

Preferred Habitat: Unlike other shrews, the least shrew prefers non-forested habitats. It is often found in old sedge meadows and non-agricultural fields. Although the soil substrate of an area does not appear to be important, this species occupies subsurface runways and uses areas where building such runways is easier. In many cases, the areas where these shrews are found are in loose shales and non-compacted soils.

Reasons for Being Endangered: Intensive agricultural methods are practiced throughout much of the least shrew's former Pennsylvania range. In many areas, the use of rotation practices has lessened and untilled or non-pastured fields are lacking. This coupled with the regeneration of forestlands and development of other lands has reduced the amount of the least shrew's preferred habitat. In many cases, where the habitat does exist, the populations remain isolated, increasing the possibility of chance events leading to localized eradication of these populations.

Management Practices: Management practices beneficial for grassland species should also benefit the least shrew. Surveys to find this species need to be intensified and populations found should be protected. Habitat studies in the vicinity of known populations on public lands should be carried out before any restoration efforts are planned.

EASTERN WOODRAT

Current Status: In Pennsylvania, threatened; nationally, status change pending.

Population Trends: The eastern woodrat was once considered a common resident of Pennsylvania's mountains. The species, first discovered among specimens taken from a cave near Carlisle in 1858, has disappeared from the southeastern portion of the state and has declined in much of the rest of the state. At present, populations exist throughout much of Pennsylvania's south-central and southwestern counties, with a few remnant populations in eastern counties. The reasons for these declines are not well understood, but may be the result of a combination of several factors including fragmentation of habitat by road-building, increased susceptibility to parasitic infestations and the loss of primary food sources such as the American chestnut.

Biology-Natural History: The eastern woodrat occurs along the Appalachian Mountains from southwestern New York and northern New Jersey through most of Pennsylvania and southwest into Tennessee and northeastern Alabama. A resident of caves, rock outcrops and talus slopes along mountains, this animal is one of the state's more interesting woodland inhabitants. Colonies of woodrats can be recognized by the large fecal piles, called latrines, these rodents deposit on protected flat rocks scattered throughout the colony area. Another feature common to areas inhabited by woodrats is the large caches of foodstuffs found crumpled and stuffed into cracks and crevices in the rocks. These caches, which used as winter food supplies, are built by woodrats during summer. The nests of woodrats are spherical balls of shredded bark generally found within an area of leaves, twigs, and materials gathered by woodrats that may include tinfoil, bottlecaps, and other discarded junk. Although the woodrat is nocturnal and appears to be rather shy, hikers have noted that it will sometimes appear above ground and chew at packs left lying around. The breeding season runs from February until September but may begin a bit later at the northern limits of distribution. Two to three litters of from one to six young are produced annually.

Preferred Habitat: The eastern woodrat prefers rock outcrops, caves and talus slopes with a southerly exposure. Surrounding forest vegetation is usually deciduous in nature, although several populations have been noted to occur in areas composed predominately of hemlock. Preferred food consists of grapes, acorns, tulip poplar heads and many other common items found throughout the forest. In several instances, large acorn mounds have been found in caves occupied by woodrats.

Management Practices: Although there is relatively little existing information concerning the eastern woodrat's requirements, it is believed that fragmentation of habitat, which increases the isolation of individual populations, may be one of several contributing factors to the woodrats' decline. Small, localized populations disappear through time and are not repopulated because other woodrats are unable to cross barriers such as multi-lane roads, large clearcuts, and other large-scale forest openings. More research is needed to understand the relationships between these factors, possible increases in parasitic infestation and changes in overall foodtypes before any long-term management can be initiated.

BALD EAGLE

Current Status: In Pennsylvania, endangered; nationally, threatened.

Population Trend: Pennsylvania's nesting bald eagle population has been on the rise in recent years. As recently as 1980, the state's known nesting population numbered three pairs. From 1997 to 1999, the nesting population doubled from 20 to 43 pairs. Despite this remarkable recovery, which was fueled by the Game Commission's eagle reintroduction program from 1983-89, bald eagles remain an endangered species in Pennsylvania because eagles still are not occupying significant portions of available habitat. Still, the bald eagle's future in the commonwealth is brighter than ever.

Identifying Characteristics: Bald eagles (*Haliaeetus leucocephalus*) are among the largest birds of prey. They may weigh up to 14 pounds and have seven-foot wingspans. Bald eagles are most readily identified by their white heads and tails, however, they don't attain this characteristic plumage until five years of age. Until that time, they are dark brown with varying amounts of white mottling.

History: Bald eagles are found throughout North America, most often around water where they catch and scavenge fish. Other carrion, and live, small animals are also among their prey. Eagles don't reach adulthood and begin nesting until age four or five. They nest in large trees near water, and normally produce one to three young per year. Adults will continue using and seasonally add to the same nest for years. Today, thanks to recovery efforts, bald eagles are nesting across the state. Non-breeding adults and sub-adults may be found throughout the state at any time of year. In winter, dozens of eagles are typically found along the Delaware River between Matamoras and Hancock, NY. Other concentration points include the lower Susquehanna River – south of Harrisburg – and Pymatuning Reservoir in Crawford County.

Preferred Habitat: Bald eagles thrive around bodies of water where adequate food exists and human disturbance is limited. Nesting eagles are particularly sensitive to human intrusions or disturbances. These activities could compel eagles to abandon a nest.

Reasons For Being Endangered: Water pollution made many areas of the state-and continent-unsuitable for eagles, and many former nesting sites have been lost to human development and encroachment. But the primary reason for the eagle's decline was the effect of the pesticide DDT and its derivatives on eagle reproduction. It accumulated in eagles and caused their eggs to be too thin to withstand the hen's weight during incubation. As a result, the bald eagle population plummeted. In 1972, the use of this pesticide in the United States was outlawed, and this drastic decline bottomed out.

Management Programs: The Game Commission annually monitors bald eagle nests – both existing and new – to measure nesting population trends. Since 1990, more than 200 eaglets have taken flight from Pennsylvania nests. During the reintroduction effort in the 1980s, the Game Commission captured, raised and released 88 eaglets from Saskatchewan. A good number of these birds have since returned to build nests and raise young. When discovered, new nest sites are protected and production is monitored.

OSPREY

Current Status: In Pennsylvania, threatened; nationally, no special protection.

Population Trend: Pennsylvania's nesting osprey population has been on the rise in recent years. As recently as 1986, the state had one known nesting pair of ospreys. Today, about 40 pairs have established nests in the state. The osprey was listed as extirpated in Pennsylvania in 1979. Reintroduction attempts in the Poconos prompted a reclassification as endangered. Ospreys were downlisted from endangered to threatened in 1998.

Biology-Natural History: The osprey is one of the world's most widely distributed birds. They are found along seacoasts and major waterways on every continent except Antarctica. They prey almost exclusively on fish. Ospreys nest in colonies and singly. Their stick nests are large and usually built near water. A breeding pair adds to the nest every year it is occupied. They usually nest in large trees, but they may be found nesting on channel markers, telephone poles, chimneys, and manmade platforms built specifically for their use. Usually three eggs are laid.

Preferred Habitat: Ospreys prefer lakes, ponds, rivers, and marshes bordered by trees. They require open water containing adequate fishing opportunities. In recent years, ospreys have produced young near lakes and rivers across most of the state. During spring and summer, non-breeding sub-adults can be found throughout the state. The world's largest nesting population of ospreys – approaching 2000 pairs – occurs in the

Chesapeake Bay area each spring. Osprey pairs typically return to Pennsylvania in late March to early April to nest.

Reasons for Being Threatened: In the early 1900s, ospreys nested along the state's larger waterways, but habitat destruction and water pollution made these areas unsuitable. Shootings also seem to have played some role in the bird's decline. Osprey populations were further decimated through the effects of insecticides such as DDT on their reproductive capabilities. Use of DDT in the late 1940s had a dramatic negative impact on ospreys and other birds of prey. By eating contaminated prey, the birds ingested the insecticide that, in turn, induced them to lay eggs with extremely thin shells – shells often so fragile, they broke when sat upon. Unable to reproduce, ospreys, which historically were never found in large numbers here, soon disappeared.

Management Programs: Between 1980 and 1996, 265 ospreys – obtained as nestlings from Chesapeake Bay nests – were released in Pennsylvania. The reintroductions occurred in three geographic areas: the Poconos, Tioga County reservoirs, and Moraine State Park (Butler County). Management plans include monitoring and protecting nest sites and continued erection of artificial nest platforms where needed.

AMERICAN BITTERN

Current Status: In Pennsylvania, endangered; Migratory bird of special concern in the Northeast.

Population Trend: American bitterns are uncommon to rare regular migrants in most of Pennsylvania. In Crawford County, however, they are regular breeding residents in scattered large wetlands, especially Geneva Marsh on State Game Lands 213. Nesting activity has been confirmed or suspected in 17 counties in the twentieth century. The American bittern has suffered greatly from the loss of wetland habitat, especially in southeastern Pennsylvania, where many marshes once used by breeding bitterns have been filled for development or choked by sedimentation. This species was listed as a threatened species from 1979 until 1997, when it was downgraded to endangered.

Biology-Natural History: American bitterns nest in marshes across the northern United States and southern Canada. They winter across the southern United States, through Mexico and into Central America. They nest singly, not in colonies like many other herons. This bird may be found year-round in Pennsylvania, but bitterns are most often seen here during spring and fall migrations. A few nest in scattered marshes across Pennsylvania, particularly, in the Pymatuning region. American bitterns build platform nests of reeds and grasses near the water, and normally lay a clutch of three to seven buff or olive-brown eggs. Young hatch in 24 to 28 days and leave the nest after another two weeks. They are often seen stalking along shorelines and marshes where they prey on frogs, fish, snakes, crayfish, insects, and other aquatic organisms.

Preferred Habitat: American bitterns require large wetland habitats. They are most likely found in marshes and wetland borders along lakes, ponds, rivers and streams. American bitterns seem to prefer to breed in extensive freshwater marshes, especially those with dense stands of cattails and thick patches of bulrushes, grasses, and sedges and pockets of open water.

Reasons for Being Endangered: The American bittern is endangered because of its dependency on specialized marshes; wetlands have declined by more than 50% in Pennsylvania over the past two centuries. Marshes remain at risk from sedimentation

and, to a lesser degree, encroachment. Habitat is key to any population augmentation of this species.

Management Programs: Areas in Pennsylvania where American bitterns regularly nest have been identified and are being protected when possible from development. Protection efforts include easements, land acquisition, and public education. Game Commission biologists and others who routinely perform bird survey/census work monitor the species for changes in distribution and nesting occurrences.

LEAST BITTERN

Current Status: In Pennsylvania, endangered; Migratory Bird of Management Concern in the Northeast.

Population Trend: Least bitterns are locally uncommon breeders in the Tinicum area in Philadelphia County; at Presque Isle State Park in Erie County; and in larger emergent wetlands in the state's northwestern counties. They are rare in suitable habitat elsewhere in the state. Least bitterns are declining in areas where their largest historical populations have been found. At Tinicum, only a few pairs have been nesting in recent years. In the late 1950s, however, as many as 27 nests were recorded there. Least bitterns were first designated as a threatened species in 1979. In 1997, the species was downgraded to endangered.

Identifying Characteristics: The smallest member of the heron family, the least bittern is 11 to 14 inches in length and has a 16- to 18-inch wingspan. This primarily black and tan bird has a blackish-green cap and back, brown neck and underparts, and a white throat. The least bittern is most readily identified in flight by conspicuous, chestnut-colored wing patches. A rare, darker phase also exists. When disturbed, the least bittern is more likely to run than fly, and like its relative, the American bittern, it also has the habit of freezing with its bill pointed straight up when alarmed.

Biology-Natural History: The least bittern nests in wetland areas throughout the eastern United States and along the Pacific coast. It spends the winter from our southern states south to Colombia, South America. This species is a regular migrant through the state, but it nests regularly in our northwest and southeast corners only, and possibly in a few other scattered locations, but not regularly or in significant numbers. The least bittern arrives in Pennsylvania in April and builds its platform nest of reeds and grasses near open water. Four or five pale blue or green eggs are laid in the six-inch nest in mid or late May. The young hatch in just under three weeks.

Preferred Habitat: Least bitterns thrive in dense marshland environments containing cattails and reeds, along the coast and inland, where they feed primarily on small fish, amphibians, insects and small mammals. They frequent brushy wetlands more frequently than their larger cousin, the American bittern.

Reasons For Being Endangered: Nesting opportunities for this species in Pennsylvania are limited and decreasing as the wetland habitat it needs has been extensively drained or impounded. Loss of tidal marshes along the Delaware River has been key to the bird's decline in the state. Its future is largely dependent upon safeguarding the state's remaining large marshes.

Management Programs: Areas where this species is known to nest should be protected. Surveys to further determine where least bitterns nest are ongoing. Marshland habitats, when possible, should be managed to provide additional nesting habitat.

SEDGE WREN

Current Status: In Pennsylvania, threatened; Migratory bird of management concern in the Northeast.

Population Trends: Sedge wrens may appear and possibly breed in Pennsylvania almost any time from late spring to early fall. They are absent from much of their historic range in the state, even where there is suitable habitat. Sedge wrens are rare, irregular migrants and breeders, not known to occur at any particular location in Pennsylvania on a regular basis. Their apparent decline in Pennsylvania seems to parallel a slipping population in the northeastern United States. This presumed decline may be attributable to habitat loss, but could also be related to the difficulty in seeing them in their preferred habitat, dense grass. The bird was designated threatened in 1985's Species of Special Concern in Pennsylvania, published by the Pennsylvania Biological Survey. Its status has not changed since then.

Biology-Natural History: In summer, sedge wrens are found from southern Saskatchewan and Minnesota across the Great Lake states to the east. They winter along the Atlantic and Gulf coasts, as far south as Mexico. Sedge wrens arrive in Pennsylvania in April and May, and migrate south to brackish coastal marshes from August to October. Among the last birds to nest in the state, sedge wrens may be found nesting here as late as August. They nest in wetland areas; a typical clutch of six or seven white eggs is laid in a globular nest built up to two feet off the ground. Young hatch in 12 to 14 days, and leave the nest at two weeks of age. Two broods can be produced each year.

Preferred Habitat: For nesting, sedge wrens require damp meadows and marshes where sedges and grasses are interspersed with small shrubs. They apparently do not do well in cattail marshes.

Reasons for Being Threatened: Sedge wrens are rare throughout their range. They used to be found nesting in scattered locations across Pennsylvania. Over the past several decades, however, they have disappeared from many of their former haunts, and numbers have dropped significantly in others. The loss of habitat and changing agricultural practices are thought to be responsible for this decline.

Management Practices: The specific locations where sedge wrens currently nest in the state need to be determined and then, where feasible, protected.

YELLOW-CROWNED NIGHT HERON

Current Status: In Pennsylvania, endangered; nationally, no special protection.

Population Trend: Yellow-crowned night herons are rare, regular visitors or residents in the Piedmont Region of southeastern Pennsylvania, where they breed locally. In the coastal plain area along the Delaware River near Philadelphia, they are rare, irregular visitors. They are casual to accidental visitors elsewhere in the state. Most summer sightings are reported along the tributaries of the Susquehanna River in Cumberland, Lancaster and York counties. They nest singly and in loose colonies regularly along Conodoquinet Creek near its confluence with the Susquehanna. Nests are also found along Conestoga and Little Conestoga creeks in Lancaster County. Surveys in the 1990s counted not more than eight to 12 nests in any year in the state. Yellow-crowned night heron were first listed as threatened species in 1990 because of their limited population and restricted range. They were downgraded to endangered in 1999 because of their small population.

Identifying Characteristics: Adults are 22 to 28 inches in length, from bill tip to tail tip, gray with black head and a whitish cheek patch and crown. Eyes are red and legs yellowish. Their name identifies a distinguishing characteristic – the yellowish crown, or top of the head. Immature birds are brown, finely spotted and streaked with white buff.

Biology-Natural History: Pennsylvania lies at the northern fringe of this species' breeding range, which is mainly in the south-central United States. It nests singly or in small groups in the lower reaches of the Susquehanna River. A typical clutch contains three or four eggs. Nesting starts as early as April. By mid-summer most young have fledged. Crayfish are a major part of this bird's diet.

Preferred Habitat: Feeds mainly along small shallow streams. Nests in brush or trees, usually sycamores, found on islands or along streams. Most nests found in recent years are along the Susquehanna River and its tributaries in Lancaster County. Birds seem tolerant of human activities. They are known to nest within 100 yards of houses and roads.

Reasons For Being Endangered: As a breeding bird, the combination of rarity and tendency to nest in small groups makes this species particularly vulnerable to local habitat disturbance or loss. The largest nesting colony known in Pennsylvania, representing more than half the state's known breeding population, was on a small Susquehanna River island, located offshore of the Governor's Residence. It subsequently moved to the mouth of the Conodoquinet, but disturbance there appears to have dispersed the colony. The integrity of this site and nearby shallow-water feeding areas are threatened by a proposed dam. Degradation of water quality, along with loss of the primary food source – crayfish – is an ever-present threat.

Management Practices: Known nest sites for this species are monitored and potential new sites need to be surveyed. Whenever possible, nesting habitats need to be protected.

D. Review of Lehigh River Watershed Biological Components

Biodiversity is essential to the health of our natural environment and to sustaining the benefits that human beings derive from nature. The leading causes of biodiversity loss in Pennsylvania are loss and degradation/fragmentation of habitat, non-native invasive species, pollution, and the imbalance of native species such as the overabundance of white-tailed deer (DCNR, 2003).

The river crosses two major forest regions: the Hemlock-White Pine-Northern Hardwoods Forest Region and the Oak-Chestnut Forest Region. The northern ridges and slopes of the Lehigh River watershed contain some Canadian, northern plant species that are near their southern limit and a number of Carolinian or southern plants reach their northern extent near South Mountain.

In the Lehigh River, smallmouth and largemouth bass are well established in the lower stretches of the river as well as other species. In addition, shad have been successfully reintroduced to the Lehigh River.

Diversity among invertebrates, reptiles, amphibians, birds, and mammals is good within the watershed. Invertebrates are ecologically involved with virtually every biotic process occurring in natural communities, from pollination, herbivory, and predation to soil formation, disease

transmission, nutrient cycling and decomposition to name only a few. Amphibians, reptiles, and birds are excellent indicators of stream and watershed health. As a group, mammals are only a small percentage of the state's native species of plants and animals. However, because mammals are familiar to so many citizens of Pennsylvania, they are important as symbols of the Commonwealth's native biological diversity. It will be important to continue monitoring both overall diversity and the dynamics of select species in relation to environmental variables.

Species of concern in the watershed, which are either threatened or endangered, include the bald eagle, yellow-crowned night heron, American bittern, least bittern, least shrew, eastern woodrat, osprey, and sedge wren.

References

BIOLOGICAL RESOURCES

- Andropogon Associates. Ecological Planning and Design. www.andropogon.com.
- Bier, C.W. A Survey of the Mussels (Unionidae) in Portions of the French Creek Basin of Northwestern Pennsylvania. Western Pa. Conservancy Report to the US Fish and Wildlife Service, 1994. 97pp.
- Boward, Danieal. From the Mountains to the Sea: The State of Maryland's Fresh Water Streams. US EPA/903/R-99/023, December 1999.
- Brauning, D.W. Atlas of Breeding Birds in Pennsylvania. Pittsburgh: University of Pittsburgh Press, Ed 1992.
- Brittingham, M.C. Effects of Timber Management Practices on Forest Interior Birds, in J.C. Finley and M.C. Brittingham, eds. Timber Management and its Effects on Wildlife. Pennsylvania State Univ., University Park, Pa., 1996. 163-170.
- Brooks, R.P., and M.J. Croonquist. Wetland, Habitat, and Trophic Response Guilds for Wildlife Species in Pennsylvania. J. Pa. Academy of Sciences, 1990. 64:93-102.
- Bucher, E.H. The Causes of the Extinction of the Passenger Pigeon. Current Ornithology, 1992. 9:1-36.
- Burke, D.M., and E. Nol. Influence of Food Abundance, Nest-site Habitat, and Forest Fragmentation on Breeding Ovenbirds. Auk, 1998. 115: 96-104.
- Conant, R., and J.T. Collins. Reptiles and Amphibians Eastern/Central North America. Houghton Mifflin Co., Boston, 1991.
- Cooper, E.L. Fishes of Pennsylvania and the Northeastern United States. The Pennsylvania State University Press, University Park, Pa., 1983. 183 pp.
- Dahl, T.E. Wetlands Losses the United States 1790's to 1980's. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 13 pp.
- DCNR. Pennsylvania's Wildlife and Wild Places, Our Outdoor Heritage in Peril. August 2003.

- Denoncourt, R. F. Key to the Families and Genera of Pennsylvania Freshwater Fishes and the Species of Freshwater Fishes of the Susquehanna River Drainage above Conowingo Dam. Proc. PA. Acad. Sci., 1975. 49:82-88.
- Doutt, J. K., C. A. Heppenstall, and J. E. Guilday. Mammals of Pennsylvania. Third ed. Pennsylvania Game Comm., Harrisburg, Pa., 1973.
- French, J.R.P., III. The Exotic Zebra Mussel - A New Threat to Endangered Freshwater Mussels. End. Spec. Tech. Bull., 1990. 15:3-4.
- French, T.W., and D.M. Pence. Endangered, Threatened and Special Concern Animal Species in the Northeastern States: A List of Species Recognized by State and Federal Laws. Compilation by Northeast Nongame Tech. Com., NE Wildlife Admin. Association and US Fish and Wildlife Service, 1996. 29 pp.
- Hagan, J.M. III. Decline of the Rufous-sided Towhee in the Eastern United States. Auk, 1993. 110:863-874.
- Halma, R. and C.S. Oplinger. The Lehigh Valley: A Natural and Environmental History. The Pennsylvania State University Press, 2001.
- Haney, J.C. Policy Aspects of Old-growth Forest Reserves in the Eastern U.S. in S.K. Majumdar, E.W. Miller and F.J. Brenner, eds. Forests--A Global Perspective. Pa. Acad. Sci., Philadelphia, Pa., 1996. 41-62.
- Hubricht, L. The Distributions of the Native Land Mollusks of the Eastern United States. Fieldiana (Zool.), New Series, 1985. 24:1-191.
- Kauffeld, C.F. Lacerta Melisellensis Fumana at Philadelphia. Copeia, 1931. 163-164.
- Keever, C. Distribution of Major Forest Species in Southeastern Pennsylvania. Ecological Monographs, 1972.
- Kim, K.C. Biodiversity, Conservation and Inventory: Why Insects Matter, Biodiv. and Conser., 1993. 2:191-214.
- Kirkland, G. L., Jr., and P. M. Krim. Survey of the Statuses of the Mammals of Pennsylvania. J. Pa. Acad. Sci., 1990. 64:33-45.
- Kirkland, G. L., Jr., and T. L. Serfass. Wetland Mammals of Pennsylvania, in S. K. Majumdar, R. B. Brooks, F. J. Brenner, and R. W. Tiner, Jr., eds. Wetlands Ecology and Conservation: Emphasis in Pennsylvania, Pa. Acad. Sci., Easton, Pa., 1989. 216-230.
- Kosack, Joe. The Pennsylvania Game Commission 1895-1995: 100 Years of Wildlife Conservation. Harrisburg, Pa., The Pennsylvania Game Commission, 1995. 233 pp.
- Lawrence, Kans. Check-list of North American birds, 6th Ed., Allen Press, American Ornithologists' Union, 1993. 877pp.
- Marinelli, J. and Randall, J.M., eds. Invasive Plants, Weeds of the Global Garden. Brooklyn Botanic Garden, Inc. Brooklyn, NY. 1996.
- Morris Arboretum of the University of Pennsylvania, Botany Department. The Pennsylvania Flora

- Database. www.upenn.edu/paflora. 2003.
- New, T.R. Angels on a Pin: Dimensions of the Crisis in Invertebrate Conservation. Amer. Zool., 1993. 33:623-630.
- Pennsylvania Natural Diversity Inventory (PNDI). The Nature Conservancy, Pennsylvania Science Office and The Bureau of Forestry, Department of Conservation and Natural Resources. Pennsylvania, Pennsylvania Game Commission, Harrisburg, Pa., 70pp.
- Pennsylvania Conservation and Natural Resources, Bureau of Forestry, www.dcnr.state.pa.us/forestry. 2003.
- Porzeluzi, P., J. Bednarz, L.J. Goodrich, N. Zawasa, and J. Hoover. Reproductive Performance of Territorial Ovenbirds Occupying Forest Fragments and a Contiguous Forest in Pennsylvania. Conserv. Biol., 1993. 7:618-622.
- Passoa, S. and C.S. Hollingsworth. Distribution, identification and rate of spread of Noctua pronuba (Linn.) (Noctuidae) in the northeastern United States. Entomol. News. 1996.
- Rawlins, J.E. Study of Nocturnal Macrolepidoptera in Forest Ecosystems Associated with Population Outbreaks of the Elm Spanworm on the Allegheny National Forest, Pennsylvania. Final rep. to US Forest Service, Allegheny National Forest, 1997. 414pp.
- Rhoads, A. F., and W. M. Klein, Jr. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia, Pa., 1993. 636pp.
- Rhoads, A. F. "Something Is Missing." Pennsylvania Game News, 1996.16:10-13
- Rosenberg, K.V., and J.V. Wells. Importance of Geographic Areas to Neotropical Migrant Birds in the Northeast. Cornell Laboratory of Ornithology, 159 Sapsucker Woods Road, Ithaca, N.Y, 1995.
- Ruhe, B. M., D. Buchanin, A. R. Croushore, and T. Reichard. Amphibians and Reptiles in the Lehigh Valley: A Checklist with Notes on Conservation Status. Distribution, and Identification. In Press 2004.
- Saenger, P.G., B.C. Malt, and K.F. Crilley. Birds of the Lehigh Valley and Vicinity. Lehigh Valley Audubon, 2002.
- Schaffer, R. Ihe. Vascular Flora of Northampton County. Pennsylvania, Ph.D., University of Pennsylvania.
- Schneider, K.J., and D.M. Pence. Migratory Nongame Birds of Management Concern in the Northeast, U.S. Dept. Interior Fish and Wildlife Service Region 5, Newton Corner, Mass, 1992.
- Tiner, R.W., Jr. Mid-Atlantic Wetlands: A Disappearing Natural Treasure. U.S. Fish and Wildlife and U.S. Environmental Protection Agency, Wash. D.C, 1987.
- Uhrich, W.D. A Century of Bird Life in Berks County Pennsylvania. Reading, Pa.: Reading Public Museum, ed 1997.
- Walck, J. L. Distribution, Life Forms, Taxonomic Categories, and Habitats of the Endangered and Threatened Vascular Plants in Pennsylvania: A Summary. Bartonica, 1996. 59:49-54.

White Paper on Conservation Science and Biodiversity. <http://www.dcnr.state.pa.us/info/shape-future/01-csb.aspx>. DCNR, November 2003.

Williams, S. L., S. B. McLaren, and M. A. Burgwin. Paleo-archaeological and Historical Records of Selected Pennsylvania Mammals. Ann. Carnegie Museum, 1985. 54:77-188.

Wilson, E.O. The Little Things that run the World: The Importance and Conservation of Invertebrates. Cons. Biol., 1987. 1:344-346.

Yahner, R. Eastern Deciduous Forest, Second Edition: Ecology and Wildlife Conservation. 1996.

