

Forest Stewardship

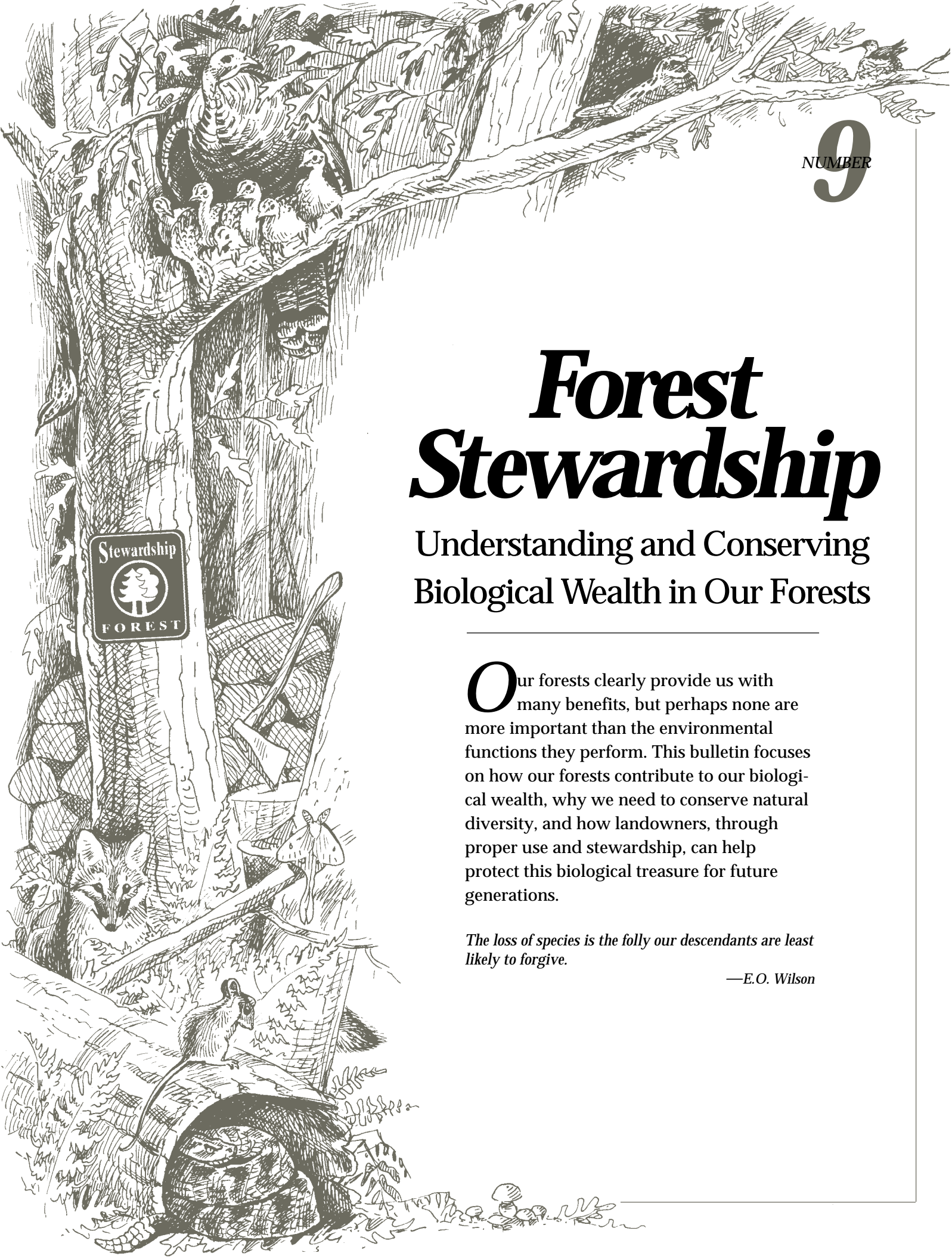
Understanding and Conserving
Biological Wealth in Our Forests



Our forests clearly provide us with many benefits, but perhaps none are more important than the environmental functions they perform. This bulletin focuses on how our forests contribute to our biological wealth, why we need to conserve natural diversity, and how landowners, through proper use and stewardship, can help protect this biological treasure for future generations.

The loss of species is the folly our descendants are least likely to forgive.

—E.O. Wilson



Understanding biological wealth in our forests

No series about the value of forests would be complete without addressing the issue of biodiversity. *Biodiversity*, a term used interchangeably with *biological diversity*, is often confusing and sometimes controversial. In general, biodiversity refers to the richness or variety of animal, plant, and other life in a given area, from the tiniest snail or moss to the largest predator. More comprehensively, biodiversity encompasses not only the species themselves, but also the complex interactions between species and the natural communities and ecosystems that they form. These interacting plant and animal species are like strands of a spider web, each adding to the delicate balance that fosters environmental stability. This rich and complex composite of life is our biological wealth, for it forms the living part of the natural resource base upon which humans depend and of which humans are an integral part. As new technology allows us to exert more and more control over our environments to suit our needs, it is important to keep this connection in mind. (See box at right.)

On a global level, the way we manage our biological diversity may, in the long run, determine our biological destiny. It is not likely that the actions of any one individual will cause a large-scale environmental catastrophe. But it is possible that the collective actions of people across the world will effect a gradual erosion of environmental stability and hence create an environment in which humans, among other species, would be unable to survive. To some, this view might seem alarmist, but it is important to see how individual actions contribute to the whole. The management section of this publication focuses on the need for individuals to make environmentally responsible decisions in the area in which they live or own land. It also provides suggestions on how biodiversity can be incorporated into long-range management planning.

UNDERSTANDING BIODIVERSITY

Because individual life-forms do not exist in a vacuum, we need to expand our concept of diversity to include more than just numbers of particular species. By examining the interactions between species at various levels, we can learn more about how natural communities function. In turn, we can learn how to influence these processes so that we can meet our growing needs in sustainable ways. Because the idea of biodiversity is so complex, it is useful to ask ourselves about this variety of animal and plant life, and why we are managing for it. The variety of biological diversity includes genetic diversity, species diversity, and ecosystem diversity. (See Figure 1 on page 3.)

GENETIC DIVERSITY

This is the level of biodiversity most people have difficulty understanding. Each individual organism is a unique chemical and genetic factory unlike any other of its species. No two humans are alike, for example. This reservoir of information has taken centuries to develop; it cannot be duplicated or retrieved once it has been lost. A diverse or varied gene pool provides a hedge against an unknown future. It allows a species to adapt to constantly changing environmental conditions.

SPECIES DIVERSITY

This is the level of biodiversity that usually receives the most attention. It is the many different kinds or varieties of plants, fungi, fish, amphibians, reptiles, mammals, birds, and other organisms that make up the living world around us. Pennsylvania has 186 native tree species, 288 shrub species, 64 native mammal species, 278 native birds, and more than 150 kinds of fish. An important part of species diversity comes with understanding how species change from place to place, and how they change over time in the same place.

ECOSYSTEM DIVERSITY

This kind of diversity involves the various species living in an area, the ecological processes that link them together, and the soil, air, and water that support the living organisms constituting the ecosystem. Many different kinds of ecosystems occur in different physical settings, and within each ecosystem many tiers exist that support additional diversity. We know ecosystems as a hardwood forest, a wetland, a prairie, a cave, or a stream, to name just a few. The multiple layers of plant growth in a hardwood forest, from herbaceous to shrub to the forest canopy, are an example of the tiers within an ecosystem.

All these components of biodiversity—genetic, species, and ecosystem diversity—are interconnected. As we begin to better understand the complex processes that occur at these different levels, we need to consider how our management decisions affect each of these biodiversity components. Since ecosystems rarely, if ever, follow management boundaries or property lines, the issue of scale becomes especially important in this process.

Figure 1. Levels of biodiversity

Genetic Diversity

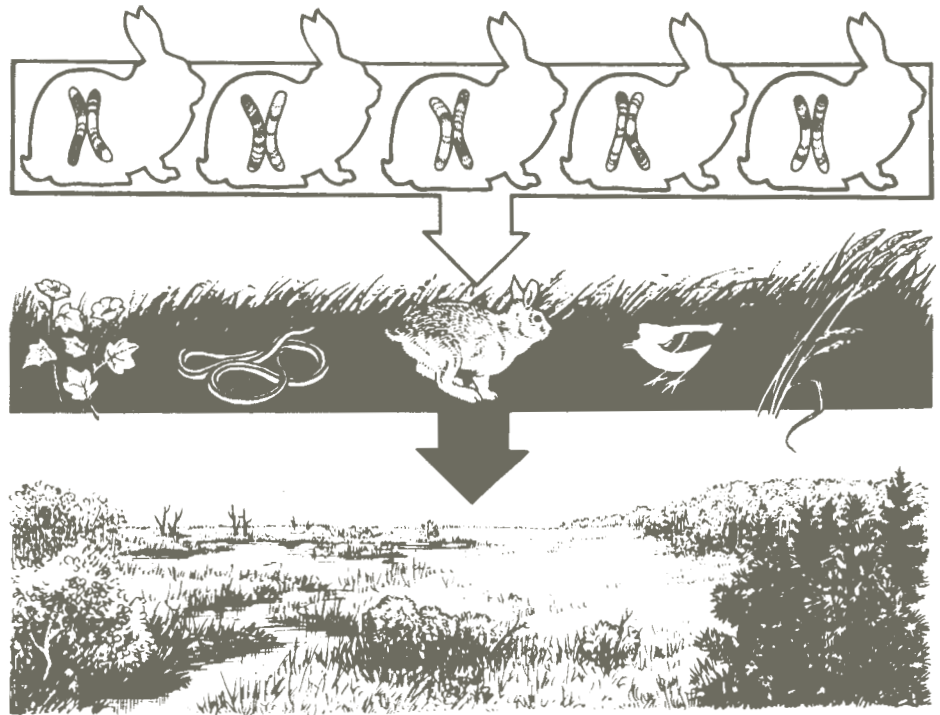
The variation in genetic composition of individuals within and among species (e.g., variation within a population of rabbits).

Species Diversity

The variety of different species found in an area (e.g., the variety of species found in a prairie).

Ecosystem Diversity

The variety of physical environments and biotic communities over a landscape (e.g., the variety of forests, grasslands, wetlands, and aquatic systems over a region).



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MAINTAINING BIODIVERSITY IS AN INVESTMENT IN THE FUTURE

The many ways that we benefit from biodiversity are not readily apparent, but they are important. These values can be categorized into four general areas: economics, ecological stability, personal values, and enjoyment.

■ **Economics**

While many may think that biodiversity has little relevance to our daily lives, it does in fact contribute to many products we use each day—including food, fiber, medicine, paper, and plastics. Yet all the plant and animal products that fill our homes are just a minute representation of the world’s biodiversity. Are you aware, for example, that the world’s agricultural base today relies on only a few wild plant species, while almost half of our nation’s prescription medicines come from just a fraction of plant species and lower animals? Although some of nature’s chemical compounds can be replicated in the lab, there is no replacement for the many tangible products, both known and unknown, that each species contributes to the overall system.

Although humans have benefited a great deal from a few cultivated species, a wealth of information awaits discovery. For instance, mollusks might seem to be an expendable species. Scientists recently discovered, however, that certain types of snails and mollusks do not get cancer, and they are now in the process of searching for the chemicals that produce this natural immunity. Many overlooked species,

in their own way, contribute much to our lives and to the lives of other species. (See Table 1.)

■ **Environmental benefits**

As mentioned earlier, biodiversity is also the source of many ecological benefits. All species depend on our natural environment for survival. Biodiversity is the basis for life-sustaining ecological services such as nutrient cycling, photosynthesis,

Table 1. Examples of benefits derived from other species.

SPECIES OR GROUP	TYPE	USE BY PEOPLE
Bacillus thuringiensis	bacteria	gypsy moth control
Penicillium	mold	medicine (penicillin)
Foxglove	plant	heart medicine (digitalis)
Snails/mollusks	invertebrates	cancer research
Brown bat	mammal	transplant research
Wheat	plant	food
Rhesus monkey	mammal	medical research
Loblolly pine	plant	paper
Rosy periwinkle	plant	anti-leukemia medicine
Acinetobacteria	bacteria	oil spill cleanup
Freshwater mussel	invertebrate	indicator of water quality
White ash	plant	furniture products
Atlantic squid	invertebrate	nervous system research

decomposition, soil creation, climate regulation, removal of pollutants, and insect control. All these processes contribute to the stability of the earth's environment, on which we rely for the air we breathe, the water we drink, and the food we eat. Mollusks, in addition to their possible benefit to medicine, are also sensitive indicators of changes in environmental quality. Currently, more than one-half of all the United State's freshwater mussels are threatened or endangered, indicating that high-quality sources of fresh water for human consumption possibly have been degraded.

■ **Personal values**

Many people support biodiversity because it satisfies some personal value. These personal values are as varied as the people who hold them. Some believe that the preservation of diversity is warranted through the right of existence of humans and other plants and animals. Conservationists today vary in their approaches to the ethical dimensions of resource management. However, most people agree that we have a responsibility to ensure that future generations have all the pieces needed to sustain life on earth. As Aldo Leopold once said, "The first rule of intelligent tinkering is to save all the cogs and wheels."

■ **Enjoyment**

Biodiversity contributes to our enjoyment of natural beauty, outdoor recreation, and peace of mind. Some people are drawn to nature to escape the hurried pace of city life. Others may rarely see natural places in their day-to-day lives, but find pleasure just in knowing they're there. Even though some people will never see a bog or an Indiana bat, knowing they exist is important to them. Will your children and grandchildren have the chance to know and enjoy the environment that you now enjoy? That, in part, depends on the collective decisions we make today.

THE EXTINCTION DISTINCTION

Now that we've covered how we benefit from biodiversity, let's examine some of the issues that

make managing for biodiversity so controversial. One frequently cited argument against preserving biodiversity is that extinction is a natural process and that trying to prevent the loss of species is futile. The total number of species is unknown, but reports show only one-tenth of the estimated total number of species has been identified. Some scientists estimate that 90 percent of all species that ever existed are now extinct, but does that make the loss of species natural? Well, yes and no. Losing species that can no longer adapt to an area is a natural process. But losing them at the rate we are today is not. What has caused scientists concern in recent years is not that extinction is occurring, but how quickly it's occurring. The rate of species loss is higher than in the past, including times of mass extinction. This tremendous difference in the rate of species facing extinction is what is meant by the *extinction distinction*.

An example is the passenger pigeon. At one time the most abundant bird in the world, passenger pigeons were so numerous in Pennsylvania that a flock of 300 million could fly overhead in one hour. Some nesting colonies occupied more than 40 square miles. But because of a combination of overhunting and habitat loss, the last one died in 1912. When a species goes from abundance to extinction in such a short time, it draws attention to the possibility that humans might be affecting the environment in ways we do not understand. Because we have a lot to learn about how the web works and what species are the "cornerstones" of our environmental system, we should assume that each species plays an important role in the natural world and work to maintain as much of the biodiversity around us as we can.

Another argument against saving endangered species (species in danger of extinction), is the enormous economic costs usually involved. Some people believe that protecting biodiversity means putting plants and animals before people. However, the cost of saving

species would be greatly reduced if some basic environmental management principles were applied proactively, that is, before environmental degradation is so severe as to cause the rapid decline of species. To effectively preserve biodiversity, we must expand our approach to managing natural systems to encompass long-term and long-range perspectives. This will entail leaving behind a reactive management approach that narrowly focuses on only those species already threatened or endangered. By attempting to understand the interactions of plants, animals, microorganisms, and fungi in their natural communities and managing with an ecosystem perspective over large areas, we will be better prepared to respond to both anticipated and unanticipated changes in the surrounding environment. Currently, partnerships are developing among private citizens, government agencies, industry, and conservation organizations to develop and implement ecosystem management plans across ownership boundaries.

WHY ARE WE LOSING BIODIVERSITY?

Why we are losing species at such an accelerated rate? A number of factors contribute to the decline and loss of species. Historically, humans directly caused the loss of many species through overexploitation for food or profit or through habitat destruction, such as in the case of the passenger pigeon. Today, however, the reasons for species decline are more indirect and involve complex ecological interactions that are not always easy to determine. Some of these more indirect causes include habitat loss and fragmentation, introduced species and disease, overpopulation of certain species, pollution, and poor management practices. (See box on page 5.) The Appendix on page 15 provides more information on federal and state definitions.

Habitat loss occurs when the habitats of animals and plants are changed or significantly reduced. An extreme example of habitat loss is when a forest is converted into a parking lot or housing development.

If you are a forest landowner, you play a vital part in conserving our state's biological wealth, simply because private landowners own most of Pennsylvania's forest land. Like pieces of a puzzle, what you and other landowners choose to do with your land will affect the management efforts already under way by state agencies such as the Game Commission, the Fish and Boat Commission, and the Bureau of Forestry, as well as conservation organizations and the timber industry.

No one is suggesting that you should lock up your land as a biodiversity preserve. Quite the contrary. This publication, as part of the Forest Stewardship series, is intended to provide you with the background necessary to make informed judgments. We encourage you to become more knowledgeable about the values your land has to offer, and to actively manage it to meet as many of your objectives as possible. The background information presented here is provided to help you better understand and implement the management steps suggested in the second part of this publication, *Conserving Biological Wealth in Our Forests*.

A related problem is habitat fragmentation, which occurs when a large habitat is broken into a number of smaller habitat patches, or fragments. Patches isolated from each other by areas that are very different from the original habitat restrict species movement and interactions. Three groups of species are adversely affected by habitat fragmentation.

- *Species with large home ranges*, such as bears or other large carnivores, which require extensive areas of habitat to survive
- *Species unable to disperse easily*, such as many amphibian and reptile species, which do not move over large areas (Fragmentation of their preferred habitat isolates small populations and disrupts their breeding patterns.)
- *Habitat interior species*, such as many of our forest songbirds, which breed most successfully in extensive areas of the forest but raise few young in small forest patches

In Pennsylvania, fragmented forests often benefit generalists, such as deer and raccoon, which do not have exacting habitat requirements. But fragmented forests negatively affect populations of species such as wood thrush and other types of songbirds that require the protected interior of forests. Forest fragmentation is considered a major threat to the biodiversity of forested habitats in this state.

Another threat to biodiversity is competition from introduced species (animal or plant species that have been brought into areas where they never existed before), such as the gypsy moth. Introduced species can oppress native species and have negative effects on a forest ecosystem. Examples of exotic invasive plant species include Japanese honeysuckle and multiflora rose, which are both prolific and tenacious competitors. Yet another threat to our forests' ecological stability is pollution. Air pollution and acid rain can have detrimental effects on the productivity of a forest ecosystem, and can make certain species more

susceptible to damage from insects or disease.

When a species, even a native species, explodes to the point of overpopulation, other species in the natural community are adversely affected. High populations of white-tailed deer across the state are diminishing plant diversity on a dramatic scale. The resulting change in plant communities is consequently affecting other organisms that rely on our forests for nesting and food. Perhaps of greatest concern to the forest landowner is that high deer densities across the state have created regeneration problems in hardwood stands and have the potential to lower the quality of the future timber resources. (See box on page 6.)

The final threat we'll discuss is poor management practices. For instance, improper timber harvesting can cause adverse environmental effects, such as soil erosion and stream sedimentation, damage to residual stands, long-term regeneration problems, and low species diversity. All of these negative impacts combine to reduce biodiversity in our forest ecosystems. As our human population continues to grow and more and more land is developed or converted for human use, it is essential that we each embrace a stewardship ethic as we manage the natural resources in our care.

WHAT MAKES CERTAIN SPECIES PRONE TO EXTINCTION?

Certain types of plants and animals are more likely to be adversely affected when the area in which they breed or find food and shelter is substantially altered. These species generally fall into one or more of the following categories.

■ *Specialized species*

These species have evolved highly specialized habitat requirements. They may have adapted to a particular habitat to avoid competition from other species. Often such species have developed characteristics that serve them well when they are living in one area, such as eating a certain kind of food, but if they are forced outside that area or if that area changes significantly, these species

might begin to decline. A specific example in Pennsylvania is the decline in wetland-dependent species, such as migratory waterfowl, and many rare plants and invertebrates that need these wet, productive areas to survive. (See box on page 7.) Also, many amphibians, such as the spotted salamander, are dependent on seasonal pools and have difficulty successfully reproducing if the pool is altered or their dispersal routes are modified.

■ **Species sought by people**

Certain species are declining because they either interfere with human activities or have commercial value. “Pest” species are vulnerable to extinction because they are frequently

poisoned, shot, or harmed in some other way. Some Pennsylvania farmers, for example, consider coyotes to be pests, while some anglers dislike certain birds, such as herons and kingfishers, that consume large quantities of fish. Other species are sought for their valuable fur, skin, meat, or other special quality. In addition, species such as the timber rattlesnake, perceived as posing a danger to humans, are sometimes destroyed indiscriminately regardless of their actual threat. Although the timber rattlesnake is not listed as endangered, it is thought to be declining throughout its central Pennsylvania range and currently is a candidate species for

state protection. Over the years, development has fragmented more of its habitat, contributing to the problem. Researchers who work closely with timber rattlesnakes have found that rattlesnakes have remarkable homing abilities, although the mechanisms remain a mystery. They also have learned rattlesnakes pose very little threat to humans. Rattlesnakes prefer to leave people alone and almost always do. Unfortunately, most people consider rattlesnakes a nuisance to be removed, and they are hunted for sport in many areas of Pennsylvania. Recognition of the rattlers’ value in the web of life may perhaps elicit a change in people’s attitude.

■ **Rare species**

Another factor contributing to certain species’ decline is the fact that they are naturally rare. A rare species has a small number of individuals and/or a limited range. In both cases, these species are often vulnerable to habitat modification or other changes in their environment, such as the introduction of competing species. Sometimes the fact that a species is rare makes it more vulnerable to other pressures, such as collecting. This is true in the case of many plants, such as Pennsylvania’s only native cactus, the prickly pear. One-third of all cacti in the United States are now endangered.

■ **Species dependent on “partner” species**

Sometimes species have “partners” or other species they depend on to help fill one or more of their ecological needs. When human actions affect one species, they indirectly affect its partner as well. An example of paired species in the United States is the black-footed ferret and the prairie dog. The ferret’s main source of food is the prairie dog, which is considered a pest by Western ranchers and is frequently hunted and poisoned. The ferret is endangered in large part due to declining numbers of prairie dogs, its main prey, and the frequent ingestion of poisoned meat. Pennsylvania may have dependent species relationships of which we are unaware. Scientists have studied only a small percentage

POPULATION LEVELS DETERMINE WHETHER DEER ARE FOREST FRIENDS OR FOES

Some foresters, and perhaps some frustrated forest landowners, too, refer to deer as “mountain maggots” because of their relentless appetite for spring wildflowers, agricultural crops, hardwood seedlings, suburban landscaping, and other browse. Deer consume a variety of plant material ranging from broadleaf plants to lichen. One study found that deer consume close to 100 different plant species. Deer change foods with the seasons, as their nutritional needs change and as browse availability varies. In winter deer are forced to eat less nutritious woody browse, such as hemlock or pine boughs. By eating the buds, stems, and leaves of shrubs and young trees, deer greatly influence the types and abundance of trees, shrubs, and herbaceous plants that grow in our forests. The change in forest plant communities that this creates in turn affects wildlife species that depend on this vegetation for shelter and food.

So how many deer can our forests sustain without adversely affecting a number of plant and animal species? According to the Pennsylvania Game Commission, the average deer density in Pennsylvania during the last 10 years has been about 27 deer per square mile. The USDA Forest Service recently completed a 10-year study of the impact of deer density on forest resources in the Allegheny National Forest. The study found that at the average statewide deer density (27 per square mile), compared to control areas which had 10 deer per square mile, valuable wildlife food species such as aspen, sugar maple, and cucumber tree were lost; the ground cover was reduced by 27 percent; and the two wildflower species jack-in-the-pulpit and goldenrod were completely removed. Songbird abundance declined by 12 percent, and the least flycatcher, wood pewee, phoebe, cerulean warbler, and black-billed cuckoo were eliminated. In summation, density levels greater than 20 deer per square mile negatively affected the diversity of woody vegetation, wildflowers, and songbirds in the study areas. Researchers believe that maintaining the diversity of plant and animal species will require reducing the state’s deer herd to no more than 20 deer per square mile.

All life has its roots in the meeting of earth and water. —T.H. Watkins

Wetlands are among Pennsylvania's most undervalued natural resources. Covering less than 2 percent of the state, they provide benefits that far exceed their limited distribution. Over the past 200 years, agricultural expansion and urban development have destroyed or degraded 56 percent of our state's original wetlands. What are wetlands and why do we need to protect them? Wetlands are areas of land saturated by water for varying periods of time during the growing season. They include marshes, swamps, wet meadows, sloughs, floodplains, bogs, fens, mud flats, and shallow ponds. Wetlands act as a vital link between dry land and open water and provide us with a number of invaluable environmental benefits.

Most people think of wetlands as swampy areas that support grasses, sedges, rushes, and other plants. In reality, two-thirds of Pennsylvania wetlands are either brush-shrub or forested wetlands. Forested wetlands are dominated by large trees (over 20 feet in height) such as silver maple, river birch, red maple, elm, spruce, blackgum, green ash, tamarack, and hemlock. Almost one-half of Pennsylvania's wetlands are located in the northern part of the state and close to 45 percent (221,000 acres) are forested. Other wetland types associated with forests include temporary (vernal or autumnal) ponds, spring seeps, and streamside wetlands.

Why all the concern about wetlands? Today there is a growing awareness that Pennsylvania's wetlands are more than wastelands or sinks for agricultural runoff, refuse, or industrial wastes. Wetlands check the destructive power of storms and floods and act as filters to purify polluted waters. They stabilize shorelines from erosion, recharge groundwater, and provide critical habitat for fish, wildlife, and migratory birds. Marshes, swamps, and forested wetlands are diverse ecosystems that provide habitat for countless species including many of Pennsylvania's threatened, rare, and endangered species. In fact, approximately one-third of all plants and animals that are endangered or threatened in North America make their homes in wetlands. But wetlands also have more visible values. Each year they attract hundreds of hunters, anglers, bird watchers, and other enthusiasts for the recreational opportunities they provide.

One type of wetland especially important to forest landowners is the streamside or "riparian" forest. Streamside forests are highly productive and diverse systems that act as valuable filters for trapping and absorbing nutrients, waterborne pollutants, and runoff. Sycamore, alder, silver maple, and river birch are some of the more common streamside tree species. Their roots help stabilize streambanks, and the woody debris they deposit create pools and eddies used by fish and other aquatic organisms. A tree-lined bank may help keep water temperatures cool enough for favored species such as trout. Careful management of riparian forest zones is essential during farming and timber harvesting activities. If you have crop, pasture, or fallow land next to a stream, you can help improve water quality and habitat by planting a 50-foot-wide buffer strip alongside the stream. Streambank fencing is another important technique you can use to protect or establish streamside vegetation and improve water quality.

Following guidelines for controlling erosion and sedimentation pollution can help you protect wetlands during logging and road building activities. A Bureau of Forestry service forester, conservation district representative, or private resource professional can help you better understand what regulations apply to your particular situation. If you work with a professional to develop a forest stewardship plan, you might qualify for available cost-sharing to help you properly manage your forested wetlands.

of the world's plant and animal species, and little is known about how species ultimately depend on each other.

■ **Species at the top of the food chain**

Certain species are vital to the functions of their ecosystems. Among these are large predators, which require expansive home ranges to meet their biological needs. As human populations continue to grow, more wild areas that provide habitat for plants and animals are converted to suburbs and cities. When this happens, predators like cougars, wolves, and bears are some of the first species to disappear from an area. Did you know that wolverine and lynx once inhabited Pennsylvania? Species at the top of the food chain are also more vulnerable to pollutant bioaccumulation (the gradual build-up of contaminants within the body). A well-known example involves the DDT effect on birds of prey. DDT, a powerful and long-lasting pesticide, was used on crops for many years in the United States before being banned in 1972. This chemical entered the food chain through small mammals and fish. Birds like ospreys, eagles, and pelicans were attracted to the dying animals because they were easy to kill. Because of their large size, few of these birds were killed outright. However, the buildup of DDT in the birds' tissues disrupted reproductive behavior and led to improperly formed eggs, reducing the birds' ability to reproduce successfully. Banning DDT and implementing ecosystem-wide recovery efforts successfully halted the rapid population decline of the osprey and the eagle. However, DDT is still used in developing countries, so its potential to affect biodiversity on a global level remains high.

■ **Species with low reproduction rates**

These species are vulnerable to extinction because, compared with other species, they can't reproduce as quickly. Have you ever noticed how quickly insects can multiply? Animals like elephants and bats, on the other hand, give birth to only one or two young every year or two. When

animals like these decline in number, it takes substantially more time for their populations to recover. Pennsylvania's endangered Indiana bat is particularly vulnerable during hibernation; a mother may abort her young if disturbed, which further contributes to its low reproductive rate. An additional factor is that sometimes it takes many years for species to reach reproductive maturity. If the environment changes rapidly or if these species are heavily pursued by humans, individuals sometimes die without leaving any offspring at all. Because they can't reproduce fast enough to replace the individuals that die, these species are vulnerable to extinction.

PUTTING THE PIECES TOGETHER:
CUMULATIVE EFFECTS

When you combine mounting pressures such as habitat loss and fragmentation with characteristics that make certain species prone to extinction, you can see why we are losing so many species globally. The issues are complex and the solutions uncertain. Balancing human needs with natural concerns almost always involves trade-offs, and management actions sometime have unforeseen effects. Take, for example, the white-tailed deer. Past policies limiting large predators in Pennsylvania no doubt have contributed to the deer overpopulation problem now affecting our woodlands. Although hunting and vehicular accidents certainly play a role in reducing deer numbers, the population remains high in many areas of the state. Solving multifaceted resource dilemmas like these involves research, planning, and compromise. We still have much to learn about interactions between species and even more to learn about developing long-term management strategies that will maintain, rather than offset, the balance found in natural communities.

WHAT SPECIES HAVE WE LOST IN PENNSYLVANIA?

As you read earlier, the passenger pigeon is one example of a species that went from abundance to extinction in a relatively short time. Table 2

Table 2. A look at species diversity in Pennsylvania (1994)

SPECIES OR GROUP	NATIVE SPECIES	ENDANGERED OR THREATENED	EXTINCT OR EXTIRPATED	% NATIVE SPECIES LOST OR IN JEOPARDY
Mammals	63	6	12	28
Birds	203	14	6	10
Amphibians	36	3	1	11
Reptiles	37	5	2	19
Fish	159	18	27	28
Invertebrates	10,000+/-	?	68	?
Mussels (unionids)	65	2	20	34
Vascular plants	2139	306	107	19
Bryophytes and lichen	916+/-	?	?	?
Protists and fungi	?	?	?	?

Table adapted from information provided by the Pennsylvania Biological Survey and the US Fish and Wildlife Service

provides a quick review of species diversity in Pennsylvania. Some of the species that once inhabited Pennsylvania include:

- **Mammals:** gray wolf, timber wolf, eastern cougar, moose, bison, lynx, wolverine, mountain lion, pine marten, eastern elk, Delmarva Peninsula fox squirrel
- **Birds:** Bachman's sparrow, common tern, lark sparrow
- **Fishes:** mud sunfish, longjaw cisco, lake whitefish, skipjack herring
- **Mollusks:** butterfly mussel, dwarf wedge mussel
- **Insects:** American burying beetle, precious underwing moth, Karner blue butterfly, northeastern beach tiger beetle
- **Plants:** flame azalea, Carolina petunia, American barberry, small white lady's slipper, eastern prairie fringed orchid, Virginia spiraea, crested yellow orchid
- **Reptiles:** Blanding's turtle
- **Amphibians:** eastern tiger salamander

Overall, the statistics for plants are not encouraging. Of the 2,139 kinds of native higher plants known to inhabit Pennsylvania, well over 400

are already gone or are in jeopardy. More than 1,200 invading exotic plants now inhabit the state, and more are likely to be introduced. Purple loosestrife, a beautiful showy wetland invader, has squeezed out many native plant species. Another problem exotic is reed grass, or *Phragmites*, which spreads quickly in wet areas. Partly because of these two invasive plants, the nearly 40 species of rare wetland plants that existed near Philadelphia's Tinicum National Wildlife Refuge have been reduced to only four today. One federally threatened wildflower found in Pennsylvania is the small-whorled pogonia, which is known to exist in only 15 sites in the United States. In our state, it is found in one county, where it is primarily threatened by shifts in land use, but also by collectors who have intentionally dug up two of the remaining specimens in the county.

WHAT SPECIES ARE RECOVERING FROM RAPID POPULATION DECLINE?

Not all species that experience population decline become extinct. In Pennsylvania, several species that once were in decline have made a noticeable recovery in recent years. These include the great blue heron,

osprey, bald eagle, river otter, bobcat, and wild turkey. A few plant species also have made some progress. These success stories are a result of conservation strategies that focused not only on the species but also on restoring or cleaning the ecosystems on which they depend. Helping species recover takes a combined effort of government and private initiatives, which can include the following:

- **protective government regulations** such as banning the pesticide DDT in the case of the osprey and bald eagle
- **agency actions that maintain or restore certain ecosystems**, such as the Game Commission program to promote streambank fencing, and the Fish and Boat Commission program to install in-stream habitat improvement structures
- **public support**, such as voluntary tax donations to the Wild Resource Conservation Fund, and contributions to conservation agencies
- **management efforts of landowners** including government, industry, and private individuals

The second part of this bulletin will help you take steps to conserve biodiversity while implementing management plans.

Conserving biological wealth in our forests

You might feel overwhelmed by the complexity of biodiversity and its implications for management. In this section we discuss some practical steps that landowners can take to help conserve biodiversity while meeting their primary objectives for owning land. Managing for biodiversity is not incompatible with managing for economic return. Forest managers who practice sustainable forestry already incorporate many of the same management principles. Any management activity affects the ecosystem in which it is implemented. Certain plant and animal species will benefit from the

changed environment, while others might suffer temporary or long-term setbacks. Management decisions almost always involve trade-offs. Thus, our goal in managing for biodiversity is to choose the trade-offs that maintain, minimize the loss of, or improve the habitat and ecosystems of native species, especially those whose populations are declining.

FOUR BASIC STEPS FOR LANDOWNERS JUST GETTING STARTED

The following is an outline of four steps to help you incorporate biodiversity objectives into your management decisions.

STEP ONE: **Get to know your land.**

You may have owned your forestland for years, or perhaps you acquired it recently. In either case, it's a good idea to walk your land periodically to see the changes that take place over time. Become familiar with the plant and animal species that live there and how they interrelate. Look for unique or special areas that you might have previously overlooked, such as a seasonal pool. As you more fully appreciate the richness of your small parcel, take a moment to think how your land relates to your neighbors' land and to the region as a whole. Is your land bordered by hundreds of acres of a similar forest type? Is it fragmented by development or agricultural lands? The answers to these questions will help you formulate reasonable long-term management objectives.

STEP TWO: **Re-evaluate your reasons for owning land.**

Have your primary reasons for owning land changed over the years you've owned it? What are the things you and your family value most about the land? Are you uncertain about the potential economic, recreational, and ecological benefits your forest land holds? A professional forest manager can help you better understand your options and assist you in developing a long-term plan for your property.

STEP THREE: **Engage a professional and develop a stewardship plan.**

Whether your primary interest is to preserve species or generate income,

qualified stewardship resource professionals can help you to meet your goals. Contacting your Bureau of Forestry service forester is a good way to start. A forest stewardship plan provides you with an overview of your land's ecological makeup, describes various land-use potentials, and highlights any rare or unique features. This information empowers you to make informed management decisions with the help of the professional resource manager developing your plan. For more information on developing a cost-shareable Forest Stewardship Plan, see Forest Stewardship Bulletin Number 1, *Pennsylvania Forest Stewardship: Our link to the past, our legacy for the future*, and Forest Stewardship Bulletin Number 6, *Planning Your Forest's Future*. Also contact the Bureau of Forestry service forester for your county. When your plan is complete, review it and see that it is in keeping with your interests and plans for the land. A plan is effective only when it's followed! Forest stewardship plans are flexible, and your resource professional can help you modify the plan if your needs and objectives change.

STEP FOUR: **Incorporate biodiversity objectives into your management practices.**

As we discussed earlier, trade-offs are an inevitable part of management. As you plan your management activities with your resource professional, keep the following rules of thumb in mind.

RULES OF THUMB FOR BIODIVERSITY MANAGEMENT

■ **Think of your land as one piece of a much larger whole.**

Forest management activities alter forest composition and structure, changing the composition, abundance, and diversity of wildlife communities. For example, if you choose to clearcut a large tract connecting two other forested areas, you will reduce the habitat available for species that need large areas of uninterrupted forestland, such as large predators and forest interior birds. If the site regenerates to forest,

forest habitat loss will be temporary, but the area will be changed for at least 25 to 30 years. A preferable solution is to consider with your resource professional ways that harvesting could have less impact on regional biodiversity. If, on the other hand, your surrounding region has very little habitat for early successional species like woodcock, clearcutting might be a preferable management option. An ideal approach to the maintenance of biodiversity would consider all types of species, such as interior, edge, and wide-ranging species. Again, your resource professional will be able to suggest various alternatives that meet your management objectives.

■ **Manage with the future in mind.**

Habitat components can be affected by forest management, but the magnitude and direction of the effects depend on the type and intensity of the activities. Management practices, such as shaping harvesting units to reduce the amount of edge, retaining snags, developing buffer strips, and connecting wooded corridors, can ameliorate potential negative impacts on wildlife while enhancing potential benefits. Any forest disruption, such as timber harvesting, will likely reduce habitat suitability for one or more species but improve suitability for others. These will change with time as the plant community grows and changes. For example, the availability of certain food sources (e.g., acorns) and canopy layers might be reduced following harvest, while downed woody cover increases. As the downed material rots, habitat for beetles, grubs, and other sources of protein-rich food increases. As the forest plant community changes in age and composition, components of wildlife habitat, such as food, cover, and activity areas (e.g., decaying logs, canopy layers) also change.

■ **Balance trade-offs to favor species and habitats of special concern.**

When managing forests, primary consideration should be given to habitats or species that are rare, threatened, or endangered. Very often, managing for these species can be done in conjunction with other

objectives. For example, suppose one of your management objectives is to place a recreational trail through your woodlot, and one of the proposed routes goes close to a seasonal pool. Choosing to run the trail near the pool without disturbing it might take additional planning, but benefits include providing a pool for reproduction of species such as salamanders and fairy shrimp and encouraging observation and enjoyment for trail users. In general, special areas to protect include wetlands, barrens, riparian areas, old growth stands, extensive areas of contiguous forest, and rare habitats such as a heron rookery or a bald eagle nesting site. If one of your primary objectives is to actively enhance your land for protected species, you might qualify for cost-share assistance under the federal Wildlife Habitat Incentives Program. Check with your Bureau of Forestry service forester for more information.

■ **Manage for regional biodiversity, not local species diversity.**

Many people assume that managing for biodiversity means managing to maximize diversity on a local scale—that is, trying to get as many species on your property as you can. This is generally done by creating a patchwork of successional stages and trying to maximize edge—the transitional zone between two vegetation types. Because many of our game species frequent the edges, management practices that maximize edge are promoted. Management that maximizes species richness locally often favors generalist species over habitat specialists. Generalists usually are least vulnerable to extinction. Adding generalists at the local level is unlikely to add new species to regional diversity because these generalists are often abundant throughout the region. In contrast, many of the habitat specialists are rare regionally, and their loss on a local level has a negative impact on regional biodiversity. As a result, if all managers strive for local diversity, they might collectively impoverish regional diversity.

■ **Don't assume that no management is best for biodiversity.**

With problems such as deer overpopulation and invasive exotic plants and insects, not doing anything to your forest land might still lead to the decline of native species, simply because they are buckling under the weight of these growing pressures. Regardless of how pristine an individual parcel of land might seem, there is no escaping human influence on the natural world. Active management might be necessary to adjust certain imbalances that occurred in the past. Making the choice to let nature take its course is, in itself, a management decision, and on some sites this might be the course of action that best meets a landowner's needs at a given time. By far, poor management practices have a much greater negative effect on forest health than a hands-off management approach, but landowners should still consider how different species and habitats could be affected over time, in both active and passive management approaches.

■ **Manage for uncommon species or features rather than common ones.**

Again, any habitat manipulation involves a balance between species that benefit from the change and those that don't. If the species that are harmed by a given management action are rare or more imperiled than the ones that benefit, or if the manipulation eliminates one of the few regional occurrences of a species, community, or process, then biological diversity is reduced. If your management actions eliminate an element that is common elsewhere in the landscape and provide an opportunity for an uncommon element in the landscape to increase, then biological diversity is more secure. In a region where conifers are uncommon, harvesting a hardwood stand while leaving the understory hemlock to grow is an example of a balance that could benefit biodiversity. Remember, it is always important to consider the scale of the impact in time and space when assessing an action's effect on biodiversity.

■ **Manage for vertical structure diversity.**

The vertical arrangement of vegetation in a forest is as important to many species as the size of the forest itself. Introduced wildlife species depend on different vegetative layers in the forest—subterranean, understory, midstory, and canopy layers. (See Figure 2.) Each layer offers a unique set of habitat features. Fallen logs, snags, and cavity trees also add to vertical structure and enhance biodiversity. Leaving standing snags and cavity trees after a timber harvest is a good way to benefit different species. It is generally

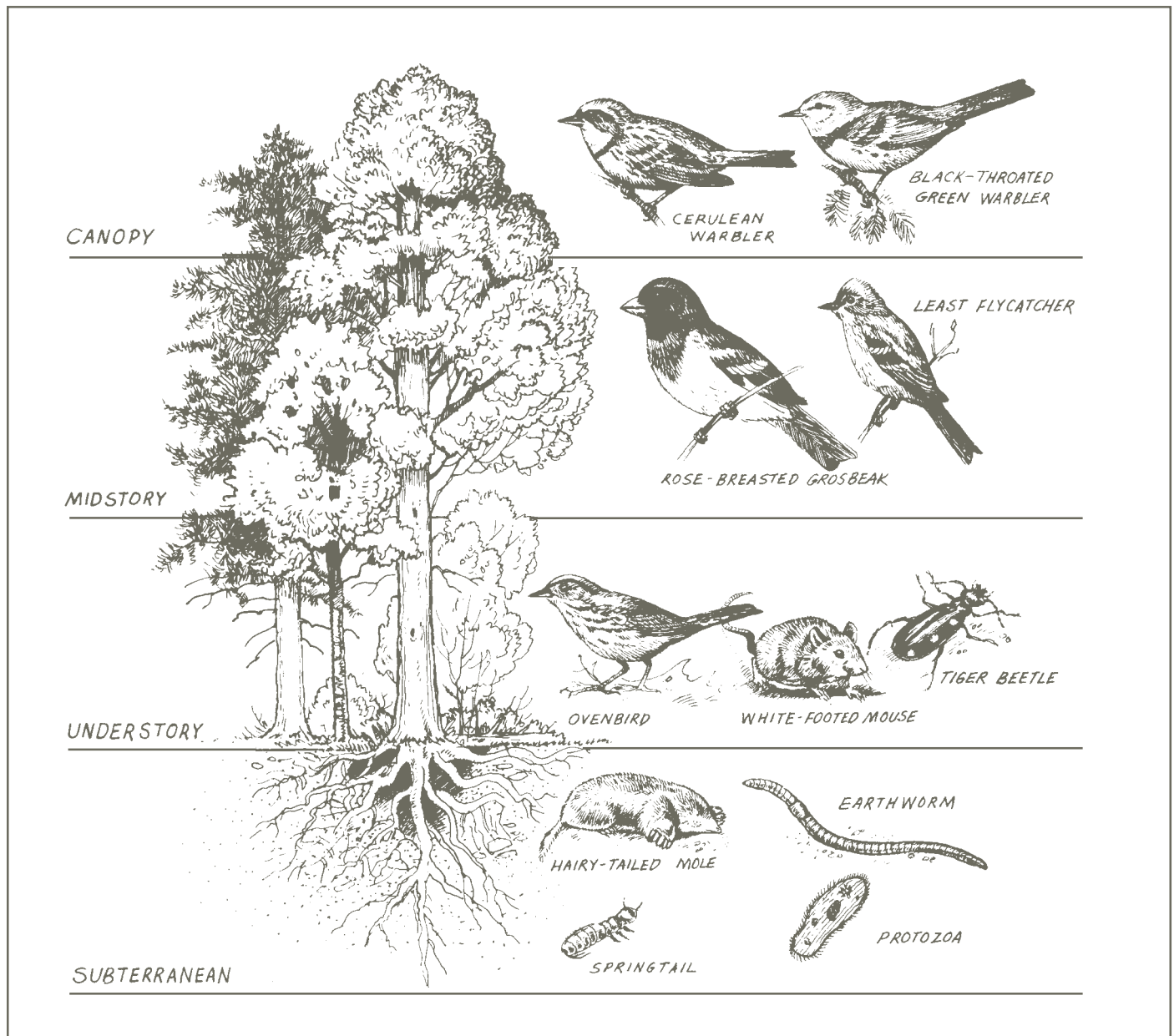
estimated that snags and fallen trees directly support up to 20 percent of the vertebrate species in a typical temperate forest. Woodpeckers use snags to scavenge for insects, and hawks use them as perches while hunting prey. Leaving the tops of the fallen trees on-site rather than “cleaning” them up will also add cover for smaller mammals and birds and add to the site’s diversity. In addition, retaining conifers in areas where they are uncommon also enhances structural diversity. *Note:* Standing dead trees, such as snags, pose serious hazards during timber harvesting. Make sure that

your decision to leave snags recognizes the hazard and allow the logger flexibility to avoid it.

■ **Maintain corridors between habitats.**

Last, when reviewing your management options, consider how your actions might influence the migration pathways and travel corridors of certain species, such as migratory waterfowl and large predators. When at all possible, maintain connections between forest patches to serve as corridors linking similar habitat types together. Because so many large habitats have been broken into smaller, discontinuous

Figure 2. Vertical stratification



parcels, individual efforts to keep habitats connected will play increasingly important roles in regional biodiversity management efforts.

To review, keep in mind the following guidelines as you develop a long-term management plan for your property.

- Think of your land as one piece of a much larger whole.
- Manage with the future in mind.
- Balance trade-offs to favor species and habitats of special concern.
- Manage for regional biodiversity, not local species diversity.
- Don't assume that no management is best for biodiversity.
- Manage for uncommon species or features rather than common ones.
- Maintain or enhance vertical structure.
- Maintain connections or corridors between habitats.
- Protect wetlands and riparian areas.
- Identify and protect threatened, rare, and endangered species.

WHAT OTHER PROGRAMS ASSIST WITH BIODIVERSITY MANAGEMENT IN PENNSYLVANIA?

The Forest Stewardship program is not the only program helping landowners better understand and manage for biodiversity. A key program is the Pennsylvania Natural Diversity Inventory (PNDI), which is funded in part by the Wild Resource Conservation Fund. The program is a cooperative effort of the Department of Conservation and Natural Resources (DCNR) Bureau of Forestry, The Nature Conservancy, and the Western Pennsylvania Conservancy. Biologists locate and identify threatened and endangered flora and fauna and unique natural communities throughout the Commonwealth. This information is maintained in the PNDI database, which stores location, biological, historical, and ecological data on computer, map, and manual files. PNDI uses historical specimen information and secondary sources to target where threatened and endangered species might exist today. Field surveys are

conducted to verify the species' current status. The site-specific and dynamic nature of PNDI offers an efficient starter tool for use by environmental planners, resource managers, and conservation groups to protect Pennsylvania's remaining natural heritage. (See box on right.)

County-based Natural Heritage/Natural Areas Inventories, funded in part by the Pennsylvania Department of Community Affairs, provide additional information to supplement PNDI. These inventories, which identify significant natural areas and ecological sites at the county level, serve as planning tools for local governments. The inventories are conducted in the west by the Western Pennsylvania Conservancy (Natural Heritage Inventories) and in the east by The Nature Conservancy (Natural Areas Inventories). The Department of Conservation and Natural Resources, county residents, and conservation groups provide input into this process. Check with your county planning commission to find out if a Natural Heritage Inventory Report and inventory maps are available for your area.

If you are interested in learning more about biodiversity or natural history in your area, a good way to start is to visit conservation organizations, environmental centers, libraries, and natural history museums. For additional information, consult the organizations listed in the Appendix.

HOW DO WE MANAGE FOR BIODIVERSITY BEYOND OUR BOUNDARIES?

The very fact that biodiversity extends past our human-erected boundaries poses a complex forest stewardship challenge. How do we get government agencies, professional resource managers, industry representatives, conservation organizations, timber harvesters, scientists, and private landowners to all work together? Specific solutions to this complex issue will most likely evolve over time as groups develop more effective communication systems to plan and implement cooperative resource management efforts. Already some cooperative projects,

such as the American Tree Farm® System, the Sustainable Forestry Initiativesm, and the Forest Stewardship Program, are fostering better understanding. Although we tend to focus more on the differences than the similarities, all the forest land-use players, whether public or private, large or small, can benefit by managing for biodiversity.

Cooperative efforts that meet human needs while promoting sustainability might become more widespread as our tools for measuring biodiversity on its many levels become more sophisticated. Educating resource managers about biodiversity concerns is an essential part of the process. With better tools and a clearer sense of cooperation, the task of managing resources at ecosystem and regional levels appears less daunting.

Even landowners who have relatively small properties can play an active part in ecosystem-level management by staying on top of the emerging data. Landowners can share information through woodland owner associations, such as those for county forest landowners, which are becoming increasingly popular across the state. These associations provide landowners with the opportunity to work together with their neighbors and resource professionals, designing regional plans to minimize negative effects at the landscape level.

Conclusion

The way we manage biological diversity in our own backyards and woodlots will not significantly affect global biodiversity, but it will largely determine our quality of life and the quality of life that we pass on to our descendants. As caretakers of our forest resources, landowners have the responsibility to learn the effects of management on forest health and to make their management decisions wisely.

Many people who don't directly own land still want to take part in conserving resources. One way to become more actively involved is to join conservation organizations or land trusts. One such organization is The Northern Allegheny Conservation Association (NACA), which is one small group of conservationists that has accomplished a great deal over the years. Formed in Warren some thirty-three years ago, the NACA's basic mission is to support the preservation of scenic, geologic, historic, and wilderness areas for scientific, educational, recreational, aesthetic, and other purposes.

The Toplovich Bog, an 87-acre glacial bog bordering State Game Lands (SGL) 197 in Warren County, is but one of the impressive, high-quality tracts the group has acquired over the years. It contains many unique and rare bog plants.

NACA also owns the 65-acre Thomas Jefferson Mahaffey Wetlands Conservation Areas. Adjacent to SGL 282 near Russell, this extensive swamp is home to beavers, muskrats, mink, wood ducks, and many other forms of wildlife. Thanks to NACA, countless hunters, trappers, bird watchers, hikers, and others have enjoyed this wetland over the years.

NACA members also pride themselves on keeping these lands within the tax base of the local communities. The group pays property taxes on all lands they own.

In addition to its own acquisitions, NACA has helped other

groups purchase and improve wild lands. It contributed \$2,000 to the Jamestown Audubon Society, for example, for the enlargement of the Burgeson Wildlife Refuge, which lies in New York just north of SGL 282. NACA also helped the Western Pennsylvania Conservancy purchase the 60-acre Andes Run Natural Area.

Perhaps the group's most significant acquisition is Tamarack Swamp, 24 acres "in-holding" on SGL 197. This parcel contains at least 13 species of rare plants. One, the naked miterwort, hadn't been located in Pennsylvania since 1867. According to James Bissell, curator of botany at the Cleveland Museum of Natural History, the plant had never been found in western Pennsylvania. In terms of biodiversity, Bissell considers this purchase as one of the most significant acquisitions in Pennsylvania. NACA generously donated this parcel to the Game Commission.

Education is also a major focus of NACA. The group supports an environmental education specialist position for the Warren County Conservation District; has donated materials to the Warren County Library; and has sponsored teachers at the Advanced Pennsylvania Conservation Leadership School and students at a Youth Conservation Camp hosted by the Warren County Council of Sportsman's Clubs. They also have co-sponsored the county Envirothon, educational workshops for teachers, and tours on state game lands.

At times, education needs are

not as straightforward as books, personnel, or workshops. When Chapman Dam State Park needed electricity for a pavilion, for instance, NACA provided the wiring so the park could expand its environmental education program.

Although important, providing money and materials does not satisfy every need. Realizing this, many members have taken a hands-on approach. Bill Highhouse and Don Watts maintain a kestrel nest-box trail. Started in 1967, the route now boasts nearly 50 boxes and produces about 125 young kestrels a year. Thanks to Greg Burkett, NACA maintains a two-mile section of Warren county road in the Adopt-a-Highway program.

NACA is currently participating in Partners for Wildlife, a federal wetland restoration program coordinated here by the Game Commission. Members are also planting native warm season grasses on state game lands, providing predator guards for bald eagle nest trees, building wood duck and kestrel nesting boxes, and providing nursery stock for wildlife orchards.

It's encouraging to find a group interested in finding and providing solutions. I encourage people to support NACA and other local conservation groups. They truly make a difference and instill community pride. For more information on NACA, write P.O. Box 661, Warren, PA 16365.

SOURCE: Written by Shayne Hoachlander, *Game News*, November 1994.

Appendix

FEDERALLY LISTED SPECIES IN PENNSYLVANIA

COMMON NAME	FEDERAL STATUS ^a	DISTRIBUTION
Fishes		
Shortnose sturgeon	E	Delaware River and other Atlantic coastal waters
Birds		
Bald eagle	T	Recent nesting in Butler, Crawford, Dauphin, Lancaster, Pike, Tioga, and York Counties
Peregrine falcon (American)	E	Recent nesting in and around Philadelphia and Pittsburgh
Peregrine falcon (Arctic)	T	Migratory only; no nesting in state
Piping plover	E	Presque Isle. Migratory; no nesting in Pennsylvania since mid-1950s
Mammals		
Indiana bat	E	Summer range; possibly statewide in suitable habitat. Only one known hibernating site (south-central Pennsylvania)
Mollusks		
Clubshell mussel	E	French Creek and Allegheny River watersheds; Clarion, Crawford, Erie, Forest, Mercer, and Venango Counties
Northern riffleshell	E	French Creek and Allegheny River watersheds; Crawford, Erie, Forest, Venango, and Warren Counties
Plants		
Northeastern bulrush	E	<i>Current:</i> Blair, Centre, Clinton, Cumberland, Dauphin, Franklin, Huntingdon, Lackawanna, Lehigh, Monroe, and Union Counties <i>Historic:</i> Northampton County
Prairie white-fringed orchid	T	<i>Historic:</i> Crawford County
Small-whorled pogonia	T	<i>Current:</i> Centre County <i>Historic:</i> Berks, Chester, Greene, Monroe, Montgomery, Philadelphia Counties
Virginia spirea	T	<i>Historic:</i> Fayette County

^aE = endangered, T = threatened

Information provided by the U.S. Fish and Wildlife Service, 315 S. Allen St., Suite 322, State College, PA 16801

DEFINITIONS

Biological diversity	the variety of life and its processes. Biological diversity includes the number of species and populations in an area and the communities that they make.
Carrying capacity	the highest number of animals an area can support, usually determined by the amount of available food and cover.
Community	all the populations occurring in a particular area; for example, the plant and animal populations in a city park, backyard, or woodlot.
Ecosystem	an organism's surroundings including other living things, climate, water, and soils.
Endangered species	any species or subspecies in immediate danger of becoming extinct throughout all or a significant portion of its range.
Extinction	the death of the last individual of a species.
Extirpated species	species no longer surviving in regions that were once part of their range.
Habitat	the physical area where an animal lives and finds nutrients, water, shelter, and living space. Each species has a unique set of requirements for life.
Poaching	illegal hunting or trapping.
Population	an interbreeding group of animals or plants of the same species that live in a certain area at a certain time.
Rare species	species with small populations.
Species	a population or many populations of an organism with characteristics in common that make them different from individuals of other species populations. The members of a species share a common and unique inheritance. Members of a species interbreed with each other but not with members of other species.
Species richness	the number of species present in a community or an area.
Sustainable ways	manner or method of making each forest the source of sustained and uniform flow of benefits.
Threatened species	a species or subspecies whose numbers are so low or are declining so fast that it is likely to become endangered in the foreseeable future throughout all or a significant portion of its range.

ORGANIZATIONS

- **The U.S. Fish and Wildlife Service** is organized under the Department of the Interior and is the lead federal agency in the conservation of the nation's migratory birds, endangered species, certain mammals, and sport fishes. The Ecological Services branch provides technical assistance for restoring or creating wetlands and enhancing fish and wildlife habitat. Financial assistance for certain practices, such as wetlands restoration, is available to qualifying landowners. The service also issues certain environmental permits and disseminates wildlife management information. For more information, contact the Fish and Wildlife Service, Ecological Services, 315 South Allen St., State College, PA 16801. Phone: (814) 234-4090.
- **The Pennsylvania Bureau of Forestry**, organized within the Department of Conservation and Natural Resources (DCNR), offers a range of information and technical assistance to woodland owners. Service foresters, upon request and as schedules allow, will examine woodlands and make management recommendations. They will assist landowners in obtaining Forest Stewardship Plans and will provide technical assistance in implementing the plans. Service foresters can help you implement practices to conserve regional biodiversity, and they will authorize cost-share assistance for some related management activities. The bureau provides advice on erosion and sedimentation control, wildlife and native plant habitat improvement, insect and disease control, forest recreation, and urban and community forestry. The bureau also offers guidance in conserving biological diversity in the Commonwealth through the Pennsylvania Natural Diversity Inventory (PNDI). For more information about PNDI, contact PNDI Director, Pennsylvania Bureau of Forestry, Department of Conservation and Natural Resources, P.O. Box 8552, Harrisburg, PA 17105-8552. Phone: (717) 787-3444.
- **The Pennsylvania Game Commission** is responsible for protecting and managing birds and mammals in Pennsylvania. For more information, contact the wildlife conservation officer listed in the local telephone directory under "Government Services, Game Commission," or contact the Pennsylvania Game Commission, 2001 Elmerton Avenue, Harrisburg, PA 17110-9797. Phone: (717) 787-4250.
- **The Pennsylvania Fish and Boat Commission** is responsible for protecting and managing fishes, reptiles, amphibians, and all aquatic organisms inhabiting Pennsylvania's waters. The commission enforces Fish and Boat Code regulations dealing with the pollution and alteration of stream channels and the subsequent impact on aquatic life. You can contact the Waterways Conservation Officer in your locality or the Pennsylvania Fish and Boat Commission, P.O. Box 67000, Harrisburg, PA 17106-7000. Phone: (717) 657-4518.
- **Pennsylvania Registry of Biodiversity Specialists** is a directory of resource specialists interested in protecting Pennsylvania's significant biological heritage. Penn State's Center for Biodiversity Research, in collaboration with the Pennsylvania Biological Survey and the Wild Resource Conservation Fund, established the registry to identify professional botanists, wildlife biologists, taxonomists, systematists, natural historians, plant and animal collectors and breeders, commercial dealers of animals and plants, conservationists, and other resource professionals. To obtain a copy of the registry, contact the Director, Center for Biodiversity Research, Land and Water Research Building, The Pennsylvania State University Park, PA 16802. Phone: (814) 863-0159.
- **Pennsylvania Biological Survey** is a nonprofit scientific organization of professional and dedicated amateur biologists who volunteer their expertise and energies to increase the knowledge of and foster the perpetuation of the natural biological diversity of Pennsylvania.

- **Natural Lands Trust, Inc.** is a private, nonprofit corporation based in Media. The Trust preserves open space through simple fee acquisition (donations and purchases) and conservation easements. It also offers planning and management services to landowners who wish to maximize both the ecological and financial returns from their natural areas. For further information, call or write to Natural Lands Trust, Inc., Hildacy Farm, 1031 Palmers Mill Road, Media, PA 19063. Phone: (215) 353-5587.
- **The Nature Conservancy (TNC)** is a nonprofit international organization dedicated to preserving plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. In Pennsylvania, TNC has helped to protect over 36,000 acres of wild lands. TNC assists individuals interested in providing habitat for threatened and endangered species, and in protecting natural areas for future generations. TNC also offers advice on estate planning and tax savings. For more information contact The Nature Conservancy, 4245 North Fairfax Drive, Arlington, VA 22203, phone (703) 841-5300; or the Pennsylvania Chapter of TNC at Lee Park, 1100 East Hector Street, Suite 470, Conshohocken, PA 19428; phone (610) 834-1323. For information about County Natural Areas Inventories in eastern Pennsylvania contact The Natural Heritage Program (East), The Nature Conservancy, 208 Airport Dr., Middletown, PA 17057. Phone: (717) 948-3962.
- **The Northcentral Pennsylvania Conservancy** is a nonprofit, private association that strives to protect prime agricultural lands, forestlands, wildlife habitat, and wetlands. The conservancy protects land through conservation easements, a revolving fund for long-term stewardship of land, and other cooperative ventures. The conservancy can help landowners obtain professional assistance in estate planning, tax and conservation law, and environmental and land planning. As a landowner you may list your property in the *Northcentral Pennsylvania Conservancy Registry*, which recognizes landowners for protecting the special qualities of their land. You can contact The Northcentral Pennsylvania Conservancy at 454 Pine Street, Williamsport, PA 17701. Phone: (570) 323-6222.
- **Western Pennsylvania Conservancy** is the largest private land conservation organization in Pennsylvania. The conservancy's purpose is to conserve water, land, and wildlife. Since 1932, the conservancy has protected over 204,000 acres of prime natural lands for parks, forests, and game lands, which are now available for the enjoyment of all people, for all time. The conservancy has established a Farm and Woodlands Program which uses deed restrictions, conservation easements, and other tools to help landowners achieve their tax-saving, estate planning, and land protection objectives. For more information about the Natural Heritage Program (West), contact the Western Pennsylvania Conservancy, 209 Fourth Avenue, Pittsburgh, PA 15222. Phone: (412) 288-2777.
- **Wildlands Conservancy** is a nonprofit, member-supported organization serving eastern Pennsylvania to promote land and stream preservation and environmental education. To date, the conservancy has reserved over 31,000 acres of open space, much of it in cooperation with the Pennsylvania Game Commission. The conservancy shares its professional expertise with private individuals and communities by advising landowners and municipalities on habitat conditions, erosion control, and ecologically sound land development. Year-round environmental classes, field trips, and activities are offered for children and adults. For further information, contact the Wildlands Conservancy, 3701 Orchid Pl., Emmaus, PA 18049-1637. Phone: (610) 965-4397.

The statutory authority for Pennsylvania's animals and plants resides with three separate agencies. The Pennsylvania Department of Conservation and Natural Resources is responsible for managing the Commonwealth's native wild plants. The Pennsylvania Fish and Boat Commission is responsible for management of fish, reptiles, amphibians, and aquatic organisms within the Commonwealth. The Pennsylvania Game Commission is responsible for managing the state's wild birds and mammals.

For information on current species status, please consult the appropriate agency. Requests for information should be directed to:

Plants and PNDI, general

Plant Program Manager

Pennsylvania Department of
Conservation and Natural Resources
Bureau of Forestry
Forest Advisory Services
P.O. Box 8552
Harrisburg, PA 17105-8552
(717) 787-3444

***Fish, Reptiles, Amphibians,
Aquatic Organisms***

***Endangered Species and
Herpetology Coordinator***

Pennsylvania Fish and Boat Commission
Bureau of Fisheries and Engineering
450 Robinson Lane
Bellefonte, PA 16823
(814) 359-5113

Birds and Mammals

Pennsylvania Game Commission

Bureau of Wildlife Management
2001 Elmerton Avenue
Harrisburg, PA 17110-9797
(717) 787-5529

For information on species listed under the federal Endangered Species Act of 1973 occurring in Pennsylvania, contact:

Endangered Species Biologist
U.S. Fish and Wildlife Service
315 South Allen Street, Suite 322
State College, PA 16801
(814) 234-4090

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