Preface

Our survival depends on the web of life created by the interactions of the millions of different animals, plants, fungi, and other microscopic organisms that share the Earth with us. All of these species together make up our natural heritage, which we call biological diversity, or "biodiversity." Because of human activities that pollute or destroy natural habitats, we are losing species at an alarming rate. For the sake of both present and future generations, we must protect biodiversity in Pennsylvania, the nation, and the world.

This publication highlights how our existence depends on the web of life. We will explore the diversity of life, see how closely our lives are linked to those of other organisms, learn how all species together make natural processes function, and discover what we can do to help protect our natural partners in life. Conserving biodiversity helps maintain our quality of life. It is an investment in Pennsylvania's future. By actively supporting the preservation of our rich natural diversity, we all can play a part in creating a sustainable society.

— *Ke Chung Kim*

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The Web of Life Connects Us All

The planet Earth provides the physical base for our life-support system, the *biosphere* in which all life exists. Surrounded by an envelope of air, along with soil and water, Earth teems with millions of different kinds of plants, animals, fungi, and microorganisms. Together, these species make up the natural diversity of life, or *biodiversity*. A person strolling through a flower garden, a honey bee visiting a flower, a cow grazing on a pasture, or a woodpecker pecking on a tree trunk are all parts of the interconnected whole of our living world. No species can survive alone—we are all connected in an intricate web of life. The interactions among the world's species form the strands of the web.

Despite all of our technological advances, our survival still depends completely on the web of life. The world's species supply basic necessities such as food, breathable air, and drinkable water, as well as fuel, fibers, building materials, medicines, and natural areas where we enjoy a variety of recreational activities.

Scientists have identified approximately 1.7 million different kinds of organisms, but the actual number could be in the tens of millions. Unfortunately, as habitat destruction and environmental degradation continue, many species will be lost without our even realizing they existed.

Invaluable strands in the web of life are being lost at an alarming rate. Since 1600, at least 1,140 plant and animal species have disappeared from the planet, and 31,500 species are currently endangered or threatened with extinction. This loss of biodiversity has caused massive, destructive changes in the world's climates, landscapes, water resources, and atmosphere.

This serious damage to the web of life is a direct result of the activities of an expanding human population. In the last 200 years, the human population has increased six-fold—from 1 billion people in 1800 to more than 6 billion today. This has placed an increased demand on natural resources, and we continue to damage or destroy habitats that plants, animals, fungi, and microorganisms need. As a result, many species have been driven to extinction and many others are threatened.

Pennsylvania alone has lost over 156 native plant and animal species since the arrival of European settlers. Today, nearly 800 Pennsylvania species are endangered, threatened, or of special concern.

WHAT IS BIODIVERSITY?

Biodiversity is the variety and variation of all species of plants, animals, fungi, and microbes, including their genetic makeup, their ecological roles, and their interrelationships in biological communities throughout the world ecosystems. Biodiversity is therefore the natural biological capital for our life-support system on the planet Earth.

What does the loss of these strands in the web of life mean to our health, economy, and future? When a species becomes extinct, a unique partner in our life-support system is gone *forever*. This loss deprives humanity of a vital resource and weakens the web of life.

We must protect biodiversity because our very existence depends on it. Conserving biodiversity protects our life-partners and preserves vital resources that ensure the viability of the web of life. Each of us can help keep the web intact by doing simple things to help preserve biodiversity. The first step is to become better informed about how biodiversity affects our lives.

Humanity Depends on the Natural Diversity of Life

We share Earth with millions of different species of plants, animals, fungi, and microorganisms, and this biodiversity provides us with the basic necessities of life. The activities of all these organisms together maintain the atmosphere, develop new soils, break down wastes, store and filter water, pollinate our crops, provide us with food, and protect us from disease. Without these ecological services, we cannot have abundant food, natural fibers for our clothes, lumber for our homes and furniture, and a clean environment and good health.

The species that inhabit a common area form a natural community. Each species plays a role in the survival of the other partners, and together they maintain the life of their natural community. In a group of natural communities, or an "ecosystem," the complex interactions of living organisms with their environments sustain their life-support system. When species are lost, ecosystems cannot function properly, and the lives of all partners—including humans—are disturbed.

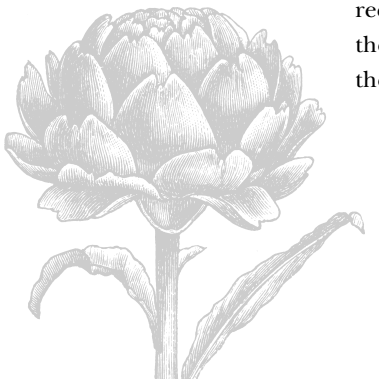
WHAT IS A BIODIVERSITY ACCOUNT?

A biodiversity account is the number of species of plants, animals, fungi, and microorganisms involved in producing products for human use. It also may refer to the number (and kinds) of species involved in maintaining ecological services that support humans and other species. The biodiversity accounts of the products we use and the ecological services we require involve thousands of species.

WHY DO WE NEED

Photosynthesis

Trees, plants, and algae turn the sun's energy into carbohydrates. All animals, including humans, depend directly or indirectly on plants for food.



A healthy atmosphere

Trees, plants, and algae release tons of oxygen and remove carbon dioxide from the atmosphere. Trees and plants also store water and slowly release it back into the atmosphere. Plants recycle over two-thirds of the water directly back to the atmosphere.

Soil development and waste decomposition

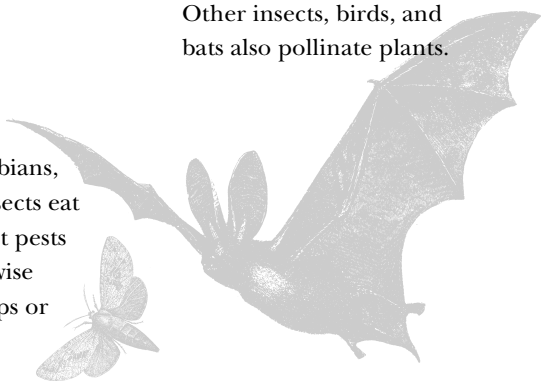
Insects, worms, bacteria, and fungi break down animal and plant wastes into tiny particles that enrich soil and help plants grow. These tiny organisms keep the world from being overwhelmed with dead plant and animal remains.

BIODIVERSITY?

Water purification
Aquatic plants, animals, and microorganisms break down wastes and help keep water clean.

Pollination
Bees pollinate flowering plants, including many fruit and vegetable species. Other insects, birds, and bats also pollinate plants.

Pest control
Birds, bats, fish, mammals, amphibians, and predatory insects eat many of the insect pests that might otherwise devastate our crops or harm our health.



OUR INBORN NEED FOR NATURE

As early humans interacted with other species, they learned to use plants and animals for food and clothing and as materials for shelter. This led to the development of early human culture, including agricultural and iron technology. Humans became a unique species, with both biological and cultural aspects. The cultural aspects of human life—science, technology, and art—all depend on the biological base of our environment.

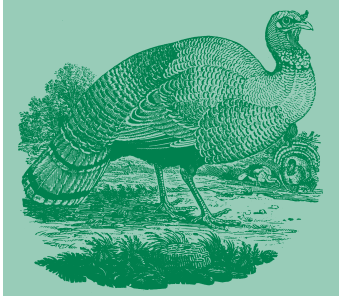
Humans have an innate need for nature, called "biophilia." This love of nature provides inspiration for art and music and gives us a sense of environmental ethics. The splendor of our state's landscapes provides a natural setting for Pennsylvanians to enjoy outdoor life. However, as natural habitats are continually transformed for human use, our inherent need for nature gets shortchanged.

ACCOUNTING BIODIVERSITY FOR A FURNISHED HOME

It takes a large number of organisms to produce the food, fibers, and materials we use. Consider how many species it takes to sustain the trees we use to construct and furnish an average home. A single acre of forest supports—and depends on—many hundreds of different species of fungi, bacteria, animals, and plants. The combined activities of these different organisms make the growth and reproduction of trees possible. The list of all the species involved in the life cycle of trees would number in the hundreds, even thousands.

BIODIVERSITY ACCOUNT OF THE EASTERN WILD TURKEY

No species can exist without interacting with other species. The Eastern Wild Turkey needs a habitat that includes both mixed forests and open vegetation to survive and breed. Many different plants and animals within these habitats provide food and shelter for wild turkeys. Turkeys nest in leaf litter and in fallen logs. They feed on seeds and nuts of various trees and shrubs, and also eat more than 50 species of mosses and grasses. Wild turkeys also eat around 267 species of insects, spiders, snails, millipedes, and centipedes. Hundreds of other organisms are essential to the existence of the plants and animals that provide food and shelter for wild turkeys. The biodiversity account of the Eastern Wild Turkey includes at least 317 species.



The Little Things that Run the World

The Earth is full of many different kinds of small organisms, including bacteria, algae, protozoa, fungi, slime molds, lichens, liverworts, mosses, worms, snails, and insects and their relatives. These small organisms together make up most of global biodiversity, and they are found in astronomical numbers throughout the world. Just 2.5 acres of pasture may contain about 8.5 tons of different tiny organisms. We often overlook their importance because of their size, but life on Earth could not survive without these small living things. All natural communities ultimately depend on them.

These small organisms do their important ecological work "behind the scenes." Before the invention of the microscope, we could not observe their activities and life cycles. In many cases, we did not even know they existed. Today, we have a greater understanding of the critical roles "little things" play in maintaining the web of life.

TINY ORGANISMS AND FOOD CHAINS

Tiny organisms are essential links in *food chains*, the series of connections between *predators* and their *prey*. When a newly hatched caterpillar feeds on plant leaves and later becomes a butterfly, for example, the food chain begins. When a bird eats a caterpillar or a butterfly, a link is added to the food chain. Another link is added when a dragonfly eats an adult butterfly. A frog eats the dragonfly. A snake eats the frog. Finally, a hawk eats the snake. Losing a link in this food chain leads to problems for the other species.

Other relationships between tiny organisms and larger ones are not so easily observed. For example, bacteria and small animals such as termites and earthworms help maintain and enhance soil fertility.

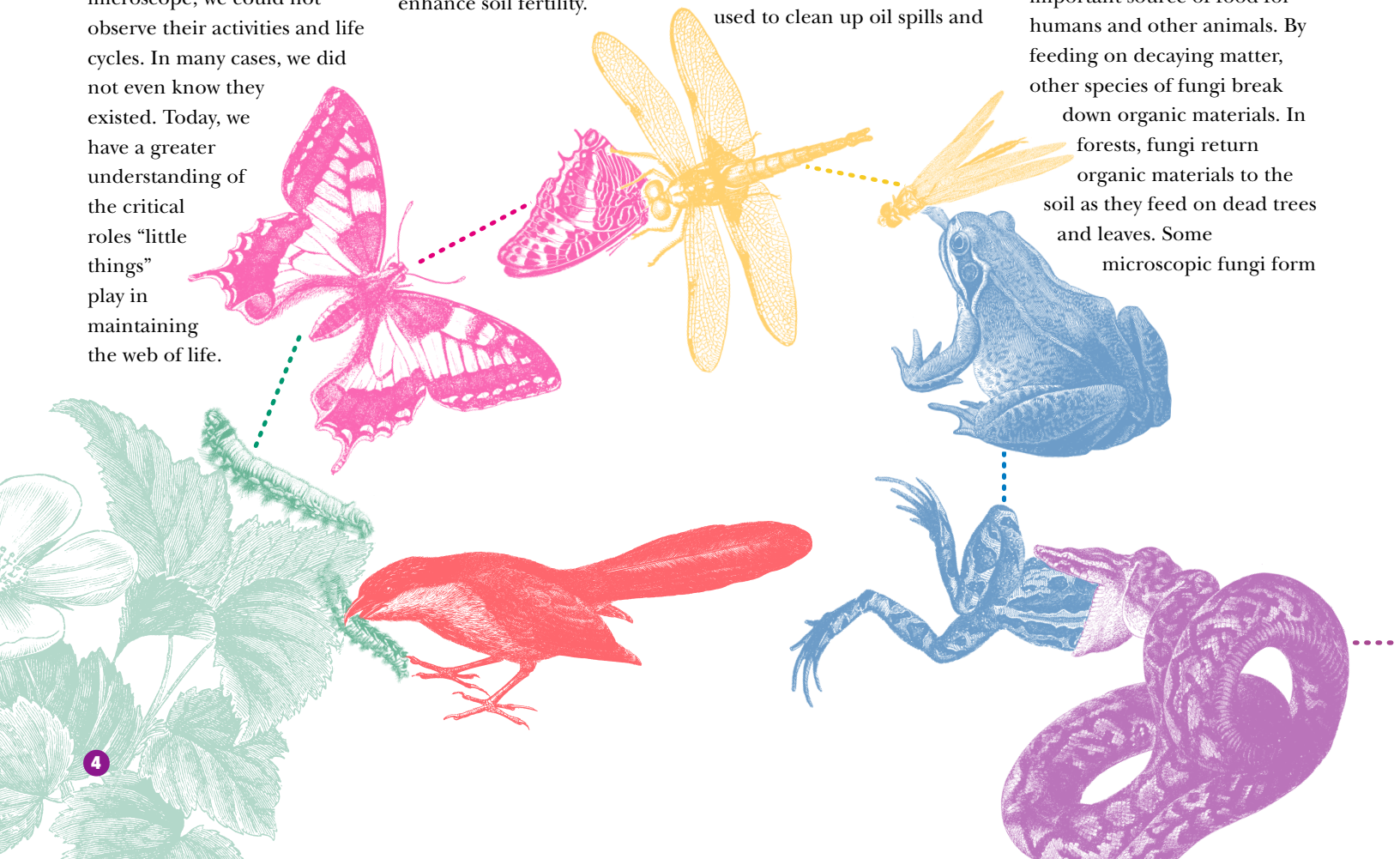
Bacteria are invisible to the naked eye, but they are essential to life on Earth. Many people mistakenly think all bacteria are harmful to humans, but only a very small number of the estimated 1 million species harm humans, animals, or plants. Most bacteria actually help us survive. They:

- help protect us from disease
- help us digest food and eliminate wastes
- make basic elements like carbon and nitrogen available for use by other living things
- break down plant and animal waste, recycling basic nutrients other organisms need
- help us produce antibiotics and other medicines

Certain bacteria can even be used to clean up oil spills and other pollutants. A soil-dwelling species, *Bacillus thuringiensis*, has been used to control insect pests.

Protists (algae, protozoa, and slime molds) are one-celled organisms that play a major role in the world's ecosystems. For example, algae generate a large proportion of the world's oxygen and form a key link in aquatic food chains. Other protists, like protozoa and slime molds, decompose organic matter by feeding on it. Protozoa also feed on bacteria and help prevent the overgrowth of bacterial populations.

Fungi play a key role in maintaining the health of our ecosystems. This unusual group of organisms includes yeast, molds, and mushrooms. Many mushroom species are an important source of food for humans and other animals. By feeding on decaying matter, other species of fungi break down organic materials. In forests, fungi return organic materials to the soil as they feed on dead trees and leaves. Some microscopic fungi form



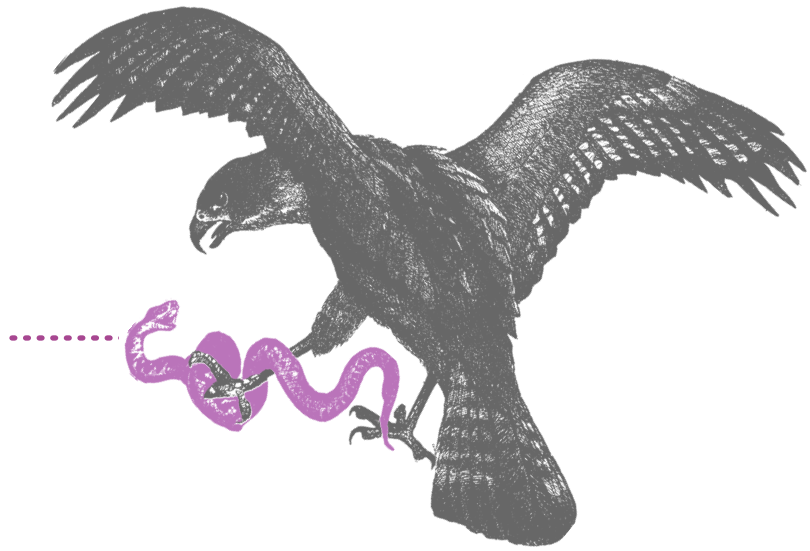
associations with the roots of plants, including almost all tree species. This partnership helps both survive. The plant provides food for the fungi, while the fungi help the plant absorb sufficient water and minerals and protect it from drought and disease. Many plants depend on certain fungal species for seed germination and growth.

Lichens are unusual associations between a fungus and a photosynthetic organism, such as green algae, that live together and make a joint life. Lichens can absorb moisture directly from the air and can withstand prolonged drought. They are commonly found in relatively moist places. Some are found even in harsh environments—atop the highest mountains, or in extreme cold. They often colonize areas of bare rock, where they contribute to the breakdown of rock and the formation of soil. After soil forms, other organisms can begin to colonize it. Some lichens provide food for invertebrate animals. They also provide forage for deer, elk, and other grazing animals.

Mosses and liverworts are relatively simple, small plants that provide habitats for small animals such as roundworms and insects. These tiny plants also help prevent soil erosion.

Insects and their relatives, such as spiders, are the most successful forms of life on Earth. Also known as arthropods, these creatures make up more than 65 percent of all known species—there are more species of insects than all other species of animals combined. Over 1 million arthropod species are known, but the actual number that exists may be closer to 10 million. They are found everywhere on the planet, including aquatic habitats such as streams, rivers, ponds, lakes, wetlands, and underground waters.

When we consider all the ways tiny organisms help maintain life on earth, it is clear that we must preserve the conditions they need to survive. Without these "little things that run the world," humans could not survive.



INSECTS AND ARTHROPODS: NATURE'S IMPORTANT PARTNERS

Insects and their relatives form a vital link in the food chain.

They are the main source of food for many animals. A variety of birds, bats, reptiles, amphibians, fish, and other vertebrates depend on these tiny creatures and would die without them. In some parts of the world, they are an important food source for humans.

Many plants need insects for pollination.

Pollination is necessary for plants, including many fruits and vegetables, to reproduce. Humans and other creatures depend on plants for food.

Many parasitic and predacious arthropods are natural pest-control agents.

Spiders, some mite species, praying mantids, ladybeetles, and many other arthropods feed on the insect pests that cause millions of dollars in crop damage each year. Many parasitic insects, such as tiny wasps and tachinid fly species, lay their eggs inside the bodies of insect pests. As the larvae grow, the pests eventually die.

Insects help decompose dead plants and animals.

Many insects feed on dead organic matter. If they did not, the Earth would soon be overwhelmed with slowly rotting plants and animals.

Arthropods are natural recyclers that return nutrients to the soil and help create new soil.

The nutrients that arthropods obtain from feeding on living plants, as well as dead plants and animals, are returned to the soil, helping to maintain fertility and create new soil.

Biodiversity is a Basic Economic Resource

BIODIVERSITY SUPPORTS PENNSYLVANIA'S ECONOMY

Biodiversity directly contributes to Pennsylvania's economy through industries and activities based on natural resources.

- **Pennsylvania agriculture generates more than $4 billion annually and provides hundreds of thousands of jobs.**
- **Nearly one out of five Pennsylvanians hunts or fishes. They spend more than $1 billion every year on these activities.**
- **Almost half of all Pennsylvanians over age 16 photograph, feed, or observe wildlife. Statewide, over $1 billion is spent annually on these interests.**
- **Our forest products industry is valued at $4.5 billion per year and employs more than 100,000 people.**
- **Tourism, our second largest industry, generates over $18.7 billion per year and supports more than 290,000 jobs.**

Biodiversity provides the most basic economic resources, including food, fuel, timber, fiber, medicines, and recreation. Plants and animals provide a multitude of useful products, such as gums, resins, shellac, rubber, dyes, waxes, spices, and natural pesticides. These products alone contribute $3 to $8 billion to the U.S. economy and $84 to $90 billion to the global economy each year. The benefits derived from the world's ecosystems are valued at an average of $33 trillion per year, supporting the generation of the world's wealth (by global Gross National Product) of $18 trillion.

Many medicines and health-care products come from global biodiversity. In the United States, the commercial value of pharmaceuticals derived from the world's species is more than $36 billion annually. Worldwide, sales of over-the-counter drugs based on plants alone total $84 billion per year.

Some native Pennsylvania plants have medicinal value. Ginseng root stimulates the cardiovascular and central nervous systems and also lowers blood sugar, while witch hazel is used to treat bruises and skin problems such as inflammation.

To date, only 5 percent of known plants have been examined for their medicinal properties. Who knows what cure may be discovered among the remaining plant species? However, habitat destruction across the world threatens many plants with extinction. Other organisms with medicinal potential also are threatened. In view of their possible medical value, we cannot afford to lose any more species.

Natural ecosystems also provide many indirect economic benefits. For example, forests play a critical role in maintaining our water supply. By absorbing the bulk of heavy rains and retaining moisture during dry spells, these natural water storage areas provide flood control and lessen the effects of drought.

Pennsylvania's forests serve as a 17-million-acre water treatment plant and air purification system. Trees and plants in forests release tons of oxygen daily, remove carbon dioxide, and filter and release water back into the atmosphere. The extensive root mass in forests prevents soil erosion, reducing sediment levels in surface water. Trees also keep summer temperatures lower and help to regulate rainfall cycles.

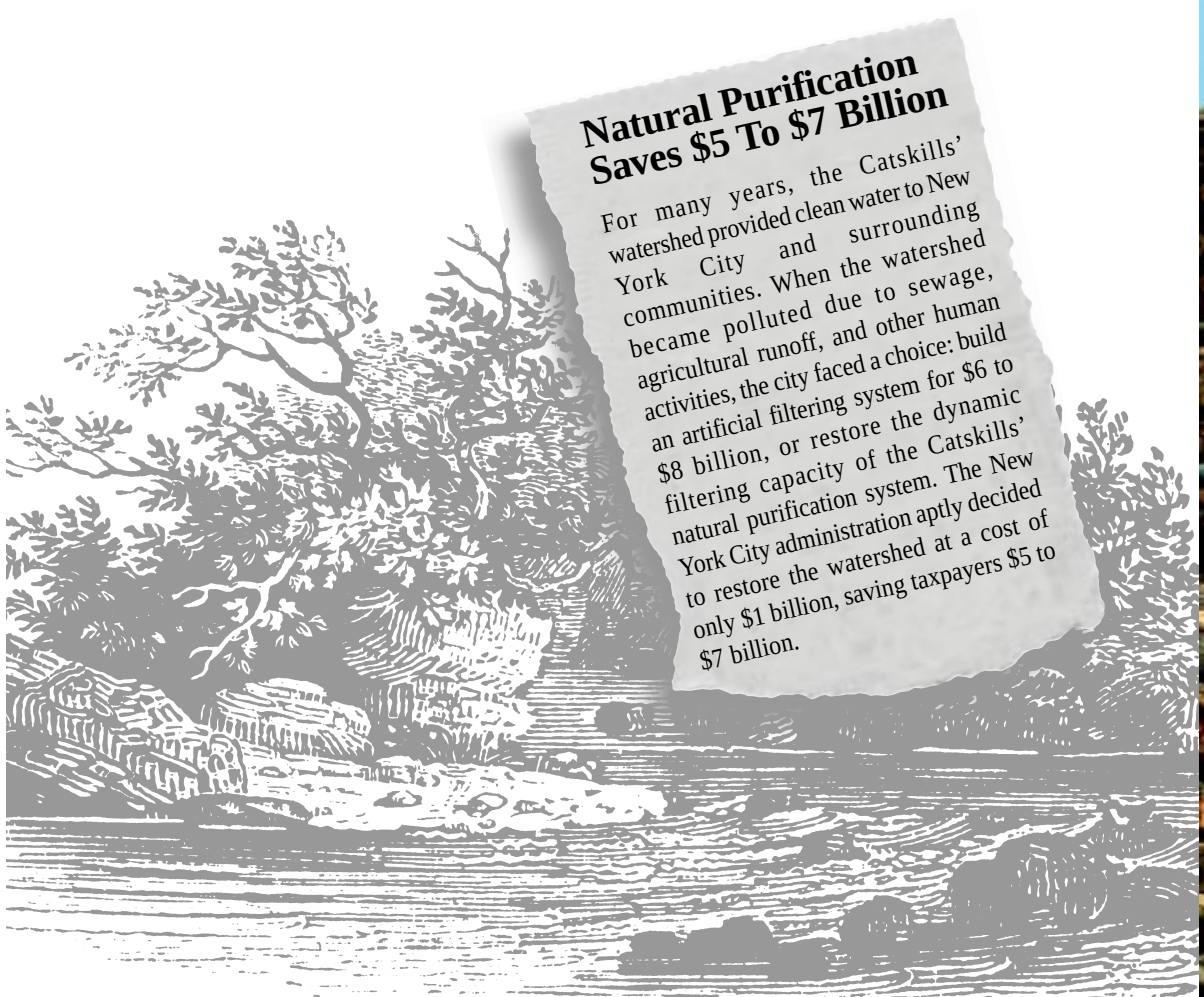
Wetlands act as natural filtration systems and remove silt, heavy metals, and other contaminants from water; they absorb and retain rainwater, gradually make it available to plant roots, and move it into aquifers and surface streams. Natural ecosystems provide all of these benefits at no cost to us. Preserving biodiversity not only provides jobs and maintains our economy, it saves money.

BIODIVERSITY PROVIDES GOOD MEDICINE

More than 40 percent of all prescription drugs—and 9 of the top 10 used in the United States—come from plants, animals, fungi, and microorganisms.

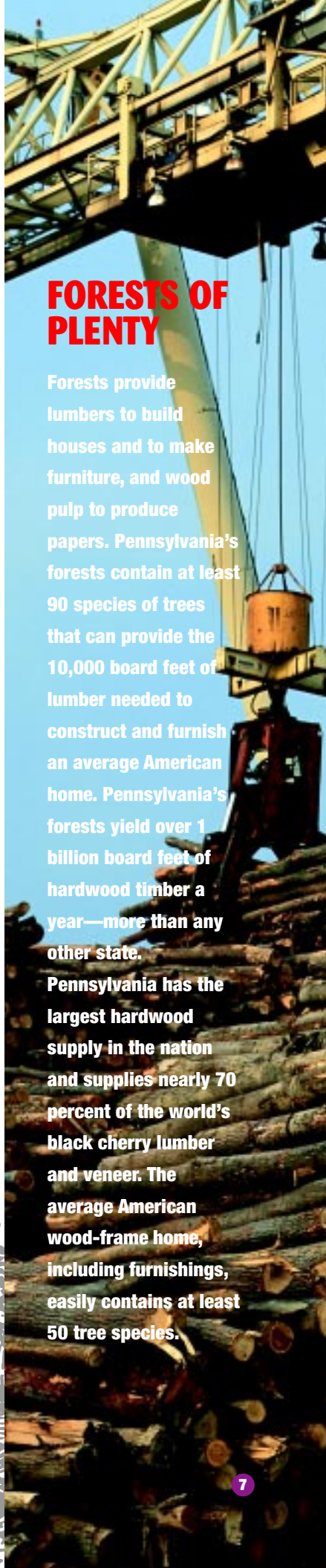
MEDICINE	USE	MATERIAL SOURCE*
Aspirin	painkiller	willow bark
Penicillin	antibiotic	bread mold
Vincristine	cancer treatment	periwinkle
Vinblastine	cancer treatment	periwinkle
Digitalis	heart stimulant	foxglove
Quinine	anti-malarial	Cinchona (coffee family)
Bacitracin	antibiotic	bacteria
Erythromycin	antibiotic	bacteria
Streptomycin	antibiotic	bacteria
Tetracycline	antibiotic	bacteria
Morphine	painkiller	opium poppy
Codeine	painkiller	opium poppy
Taxol	ovarian and breast cancer treatment	Pacific yew

** Materials from these species are specifically processed to make all prescription drugs.*



Natural Purification Saves $5 To $7 Billion

For many years, the Catskills' watershed provided clean water to New York City and surrounding communities. When the watershed became polluted due to sewage, agricultural runoff, and other human activities, the city faced a choice: build an artificial filtering system for $6 to $8 billion, or restore the dynamic filtering capacity of the Catskills' natural purification system. The New York City administration aptly decided to restore the watershed at a cost of only $1 billion, saving taxpayers $5 to $7 billion.



FORESTS OF PLENTY

Forests provide lumbers to build houses and to make furniture, and wood pulp to produce papers. Pennsylvania's forests contain at least 90 species of trees that can provide the 10,000 board feet of lumber needed to construct and furnish an average American home. Pennsylvania's forests yield over 1 billion board feet of hardwood timber a year—more than any other state. Pennsylvania has the largest hardwood supply in the nation and supplies nearly 70 percent of the world's black cherry lumber and veneer. The average American wood-frame home, including furnishings, easily contains at least 50 tree species.

Food Doesn't Grow In Supermarkets

All of our food comes from biodiversity. The world's species provide fruits, vegetables, legumes, mushrooms, seeds, nuts, grains, milk, cheese, butter, eggs, poultry, fish, meat, and even the spices, syrups, honey, and sugar we add to our food. The lives of these species are sustained by close partnerships with other species in their ecosystems. This web of life links all the organisms that provide our food supply.

Today, most of us buy food at grocery stores rather than growing or raising it ourselves. We rarely see the interactions between species we eventually eat and their partner species in a natural community.

Consider how many species contribute to the life of a dairy cow. When a cow eats plants, bacteria that live in the cow's stomach make digestion of the plants possible. The plants depend on millions of bacteria, fungi, and insects in the soil to decompose dead vegetation and make nutrients available. Earthworms aerate and help create the soil plants need to grow. Dead plant material provides food for these tiny living things, and the cycle of life continues. When we drink the cow's milk, bacteria in our digestive systems help us digest it and also provide us with several B vitamins and vitamin K. All of these partners—bacteria, fungi, insects, earthworms, plants, and cows—benefit from the activities of other members in this "cow ecosystem."

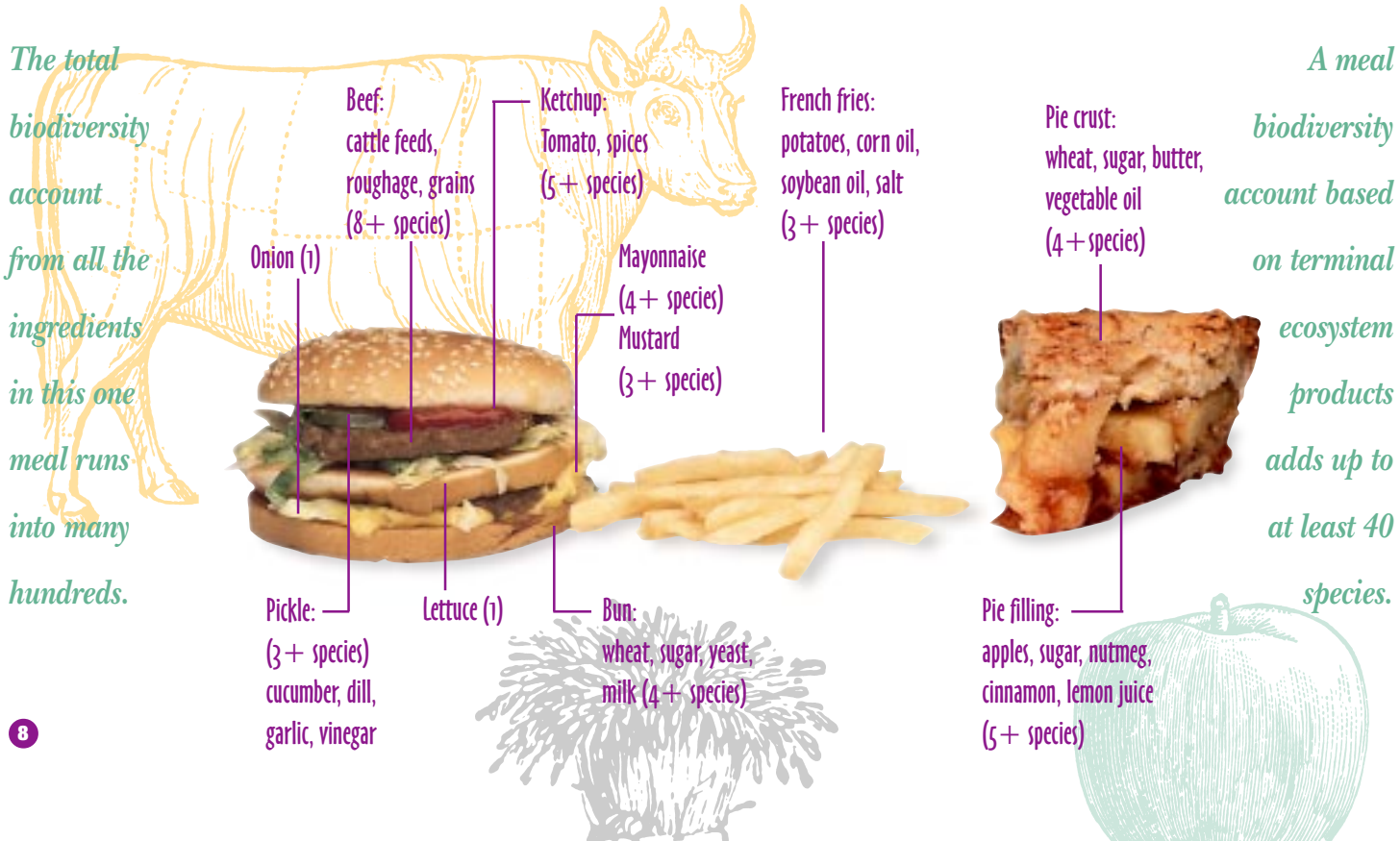
A surprisingly large number of species are involved in producing a typical meal. Let's say you had a hamburger, french fries, and an apple pie for lunch. What is the biodiversity account of this one meal? Ground beef comes from cattle that eat pasture plants, roughage, and stored grains. Pasture in the eastern U.S. is composed of at least five grasses, seven legumes, and at least five weed species. Innumerable species, including insects, spiders, earthworms, fungi, bacteria and other microbes, support the life of these grasses, grains, and legumes.

The remaining items come directly from at least 15 other species. The bread for hamburger rolls uses flour from wheat, sugar from sugar cane, and yeast fungus. French fries are made from potatoes, and one or more corn or soybean species are needed to make the oil used to fry them. If the hamburger includes lettuce, tomato, pickles, and onion, four more species can be added to the meal's biodiversity account. Catsup (from tomatoes) and mustard (a plant species) may each contain additional spices from plant species. The apple pie filling is made from one or more apple varieties, spices from several plant species, butter or margarine made from milk or vegetable oil, and sugar. The crust is made of flour from wheat and vegetable shortening from several plant species.

All of these food items rely on an immense community of other species. Without pollinators, there would be no apples, potatoes, or tomatoes. Countless other species are necessary for the energy and nutrient recycling that make all plant growth possible. The biodiversity account of this *one* meal runs into many hundreds, possibly *thousands*, of species.

ALL OF OUR FOOD COMES FROM BIODIVERSITY.

The total biodiversity account from all the ingredients in this one meal runs into many hundreds.



A meal biodiversity account based on terminal ecosystem products adds up to at least 40 species.

Nearly 80 percent of the global diet comes from just four plant species: wheat, corn, rice, and potatoes.

FOOD BIODIVERSITY ACCOUNT

In this country, food is so plentiful and accessible that many of us take it for granted. Yet, to feed the rapidly increasing human population, we need to find new food sources and make our crops more resistant to disease, drought, and pests. How can this be accomplished? Biodiversity may help provide an answer.

Many of our crops were domesticated by our ancestors thousands of years ago. These wild species were originally rich in variation in size, yield, and resistance to drought and disease. Over time, crop varieties were selected for the largest size, highest yields, and the flavors humans prefer. At the same time, other valuable traits, such as greater resistance to disease, pests, or drought, were often unknowingly eliminated. This process has resulted in crop uniformity. Since the individual plants that make up a modern crop are genetically alike, an entire crop may be wiped out if the plants lack resistance to drought, pests, or disease. Adding genes from the wild plants our crops were developed from can help modern crop plants withstand insect infestation, unfavorable weather, or disease.

Currently, only 20 plant species provide 90 percent of the world's food. Nearly 80 percent of the global diet comes from just four plant species: wheat, corn, rice, and potatoes. There are, however, over 30,000 edible plant species. These untapped wild crop species could be introduced and made part of our agricultural systems. Sadly, many of these wild plants are rapidly disappearing worldwide, while 6 billion people must be fed.

To safeguard our food supply, we need to utilize a variety of food species and incorporate the natural strengths of wild relatives into our staple crops. The wild relatives of many crop plants still survive, but their numbers have steadily decreased. Many species are now threatened with extinction, leading to the rapid decline of global genetic stocks.

FOOD FROM THE WATER

Many people enjoy eating a tuna sandwich. Tuna does not come from a can, but from the ocean. The tuna is part of a marine ecosystem that includes many other organisms, and it relies on a number of these for food. Tuna fish feed on other fishes, mostly mackerels and herrings. Mackerels feed on small fishes, crustaceans, squids, worms, and plankton. Herrings eat mostly plankton, but also small fishes and crustaceans. Thus, the biodiversity account of a tuna easily involves 50 species of animals as food. Tuna populations can suffer if these other marine animals are lost due to pollution or other human causes.

The marine fish catch adds $2.5 billion to the U.S. economy, and $82 billion worldwide, but modern fishery practices are not sustainable. Fish stocks throughout the world are being depleted rapidly by overfishing, threatening many species. Our marine fish stocks need to be safeguarded.

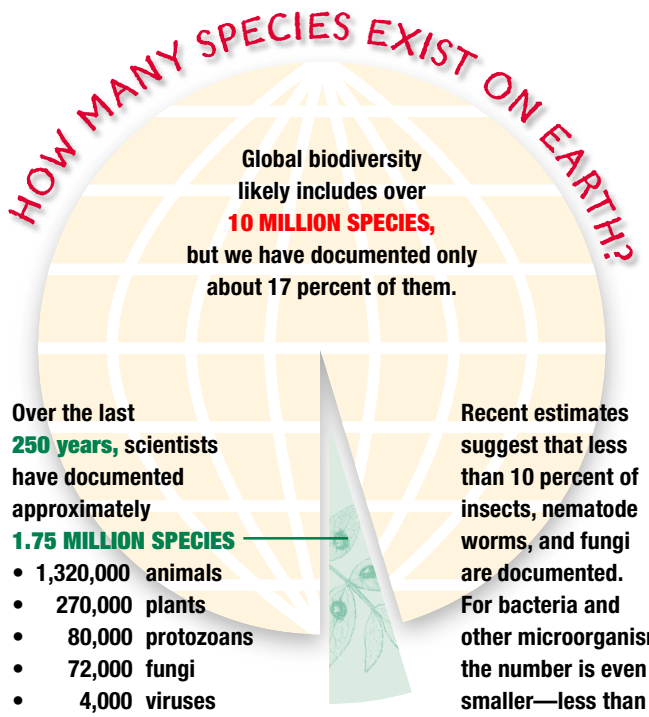
Biodiversity, Our Little-Known Natural Heritage

Biodiversity did not develop overnight. The great diversity of plants, animals, fungi, and microorganisms reflects an evolutionary history that spans 3.5 billion years. Over that time, many species died out and new species replaced them, shaping the composition and structure of today's biodiversity. Every species, molded over time by genetic forces, other species, and the surrounding environment, occupies a specific habitat with a definite range of distribution and specific ecological roles to play in the ecosystem. Together they weave an intricate web of life, in which every species matters.

More than half of global biodiversity occurs in tropical rain forests, but only a very small fraction of this vast biodiversity is known. Even in North America, where biodiversity is relatively better known, the documented species of insects and arachnids represent barely 50 percent of the estimated total of 200,000 species. Many of these species, both known and undescribed, have become extinct or endangered.

Rivers, lakes, and wetlands provide rich resources for biodiversity, although they cover less than 1 percent of the Earth's surface and take up only 0.01 percent of the world's total water resources. Freshwater biodiversity accounts for more than 12 percent of the known species of animals and 41 percent of all known fishes in the world—scientists are continually discovering new species in rivers, lakes, and wetlands. Rivers and lakes in the United States contain the largest biodiversity of several invertebrates, such as crayfishes, mussels, snails, and aquatic insects. Freshwater biodiversity suffers from pollution much more than land-based plants and animals.

During a recent event at Frick Park in Pittsburgh, 1,500 volunteers explored the area, searching for all the species they could find in one day. In this small area, they found 1,471 species of plants, animals, and fungi. An estimated 24,000 different plants and animals inhabit Pennsylvania, including species found nowhere else. Unfortunately, many species in Pennsylvania have disappeared, and a great number of the remaining species are endangered or threatened.



BIODIVERSITY IN PENNSYLVANIA

Lichens, Mosses, and Liverworts

351 lichen species, 350 moss species, and 115 liverwort species

Fungi

7,447 species

Vascular Plants

2,103 native species

— 116 are believed to have disappeared from Pennsylvania

— 368 are endangered or threatened

— 52 are considered rare

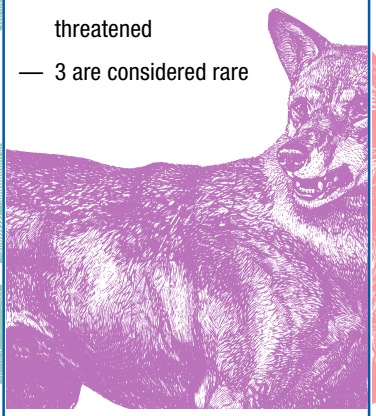
Mammals

73 native species

— 11 have disappeared from Pennsylvania, including the gray wolf, mountain lion, lynx, bison, wolverine, moose, marten, and the marsh rice rat

— 6 are endangered or threatened

— 3 are considered rare



Birds

394 species

— 11 are endangered

— 5 are threatened

— 9 are rare

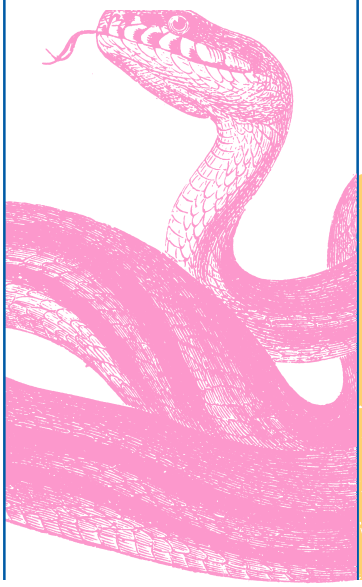
— 1, the passenger pigeon, is extinct

Reptiles

37 species

— 2 have disappeared from Pennsylvania

— 5 are endangered or threatened



Amphibians

36 species

— 1 has disappeared from Pennsylvania

— 4 are threatened or endangered

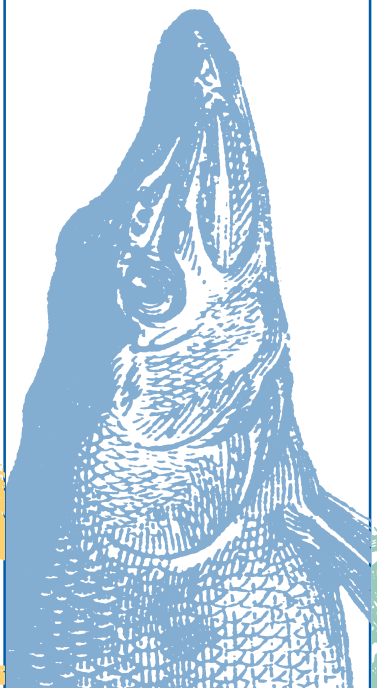
Fish

160 native species

— 15 have disappeared from Pennsylvania

— 21 are threatened or endangered

— 1, the blue pike, may be extinct



Invertebrates

Up to 20,000 species; only 11,702 have been documented

— Invertebrates make up 61 percent of Pennsylvania's biodiversity

— Of 65 freshwater mussel species, over half are endangered or gone from Pennsylvania

— Approximately 282 species (including sponges, mollusks, crayfish, amphipods, pillbugs, sowbugs, ostracods, and insects) are considered Species of Special Concern

— 37 species have disappeared from the state

NATURAL DIVERSITY IS RAPIDLY DECLINING

Together, millions of different species of plants, animals, fungi, and microorganisms support the wonders of life. Their intricate interactions among themselves and with surrounding environments provide clean air and water, food, and other materials we need for survival. Yet every day we lose more species. We lose them both to extirpation, when a species is gone from one area but still exists elsewhere, and to extinction, the permanent loss of a species.

What is causing this loss of irreplaceable natural resources and the destabilization of our life-support systems? The primary culprit is the human species. Our activities degrade, fragment, and destroy habitats. We overexploit natural resources; we introduce non-native species; and we pollute air, water, and soil. Our activities are even causing the world's climates to change.

According to the fossil record, the average life span of a species is 4 million years. During the last century, though, as more species become extinct, the average life span of a mammal species has dropped to less than 10,000 years—the life expectancy of today's mammal is only 100 to 1,000 years. Throughout history, normally only 1 to 10 species became extinct each year. Today extinction occurs at an alarming rate—at least 1,000 species are lost every year. *This is 100 to 1,000 times the normal extinction rate.*

During past mass extinctions, at least 65 percent of all species became extinct, resulting in drastic changes in the composition of life forms on Earth. Natural communities and ecosystems could continue to function because the loss of species occurred gradually over hundreds of thousands of years. As species died out, new life forms arose to help carry out critical ecological services.

The current rapid extinction rate does not give ecological communities enough time to replenish the loss of species. Since species depend on one another, a chain-reaction of extinctions can occur as more species in a natural community disappear. This massive decline in biodiversity threatens the stable functioning of ecosystems.

Since the year 1600, more than 1,100 species have become extinct, including 484 animals and 654 plants. This does not include the large numbers of species that were never documented but nevertheless became extinct during this time.

As of 1994, over 31,000 of the world's species—5,366 animals and 26,106 plants—were considered threatened with extinction (threatened species), and 4,816 species were in danger of becoming extinct (endangered species). These numbers do not include vast numbers of tiny organisms that inhabit threatened habitats, but have not yet been discovered and named.

Like the rest of the world, Pennsylvania has experienced a serious decline in biodiversity. Although our state's population has remained around 12 million people for the last 20 years, shifts in where we choose to live and how we use land pose significant threats to our native biodiversity.

Many of Pennsylvania's natural habitats have been fragmented, altered, or destroyed by urban and suburban sprawl, lack of zoning and planning at the municipal level, road construction, and industrial activities. The destruction of 56 percent of our state's wetlands has been a major cause of loss of species, since 84 percent of native amphibians, 46 percent of native birds, 44 percent of native reptiles, and 37 percent of native vascular plants depend on wetlands. If the loss of wetlands continues, more species will be lost.

Forty percent of Pennsylvania's forests have been cleared to make way for agriculture and development. Most of the remaining forests are only 80 to

PRIMARY CAUSES OF TODAY'S EXTINCTION

- **Increasing human population and expanding economic development place exhaustively high demands on biological resources.**
- **People focus on short-term solutions and not long-term consequences when making decisions.**
- **Economic markets do not recognize the value of biodiversity and ecosystem functions.**
- **The use of natural resources is not properly regulated.**
- **Government policies do not address the exhaustive use of biological resources.**
- **Human migration and international travel and trade are rapidly expanding.**

100 years old and lack the rich diversity of species found in "old-growth" forests. Younger forests do not support species that need the unique conditions found in older forests.

Some larger mammals and many migratory birds require large, unbroken expanses of forest. Road construction and development have fragmented our landscape, resulting in both a loss of species and a decline in the number of individuals making up the remaining species.

Pollution is another major cause of biodiversity loss in Pennsylvania. Contamination from industry, agriculture, and other sources degrades natural habitats and results in the loss of local populations of many plants and animals. Fifty-seven percent of all endangered species in Pennsylvania became endangered due to pollution of aquatic habitats. Pollution is a leading cause of the declines in many native fish and mussel populations.

Many species of plants and animals in rivers, lakes, and wetlands are threatened with extinction. About 40 percent of freshwater fish and amphibian species are also at risk. Thirty-seven percent of 303 species of American freshwater fishes are at risk of extinction, and 17 species have already disappeared during the last century. In Pennsylvania, 13 native fish species are at risk. Sixty-seven percent of 300 freshwater mussel species in the Unites States are in jeopardy, and 1 in 10 species may already have disappeared. Similarly, half of all crayfish species in the United States are at risk of extinction.

Major threats to freshwater fishes include nonpoint source pollution, invasive plants and animals, and dams. Nonpoint source pollution includes many different chemicals, nutrients, and sediments from soil erosion caused by agriculture, some forestry activities, urban and suburban development, and highway construction. When invasive species of animals and plants enter our freshwater systems, they often outcompete native species for food and space. Dams create physical barriers to fish movement and disturb watershed systems.

In addition to habitat loss and pollution, the introduction of aggressive, non-indigenous species poses a major threat to many species and habitats. Pennsylvania has had its share of "exotic invaders," with disastrous consequences. Many of these species have not been harmful, but some have reproduced and spread to such an extent that they threaten the survival of native species.

EXOTIC INVADERS OF PENNSYLVANIA

	DATE OF INTRODUCTION INTO U.S.	PLACE OF ORIGIN	PROBLEMS CAUSED
Zebra mussel	1988	Asia	Outcompetes other aquatic mussels and fish
Chestnut blight fungus	1904	Asia	Destroyed chestnut forests
Dutch elm disease fungus	1930	Asia	Eliminated most of the American elms in the eastern United States
Purple loosestrife (plant)	1800s	Europe	Chokes wetlands, eliminating other plants and their associated animal communities
Brown trout	1884	Europe	Outcompetes many native fish, some of which now face local extinction
Gypsy moth	1869	Europe	Defoliates native trees, altering the composition of native forests
European starlings	1890	Europe	Compete with Eastern Bluebirds for nest sites
House or English sparrows	1853	Europe	Compete with Eastern Bluebirds for nest sites