LESSON 2
Biodiversity and the Forest Connection

NUTSHELL

In this lesson, students develop a definition for biodiversity. They analyze pictures of three ecosystems (forest, prairie, wetland) to determine their unique qualities and interconnections and then represent this on a Venn diagram. Finally, they use a jigsaw puzzle as a metaphor to illustrate why biodiversity is important and discuss Wisconsin's role in world biodiversity.

BIG IDEAS

- Forest ecosystems are interconnected with other terrestrial (e.g., prairies) and aquatic (e.g., wetlands) ecosystems. (Subconcept 15)
- Biodiversity (or biological diversity) encompasses the variety and variability of all life on earth. It includes three levels: ecosystem diversity, species diversity, and genetic diversity. (Subconcept 16)
- There is biodiversity within a forest. Different forests have different levels of biodiversity. (Subconcept 17)
- Regions in Wisconsin differ in climate (e.g., precipitation, temperature) and the results of glaciation (e.g., soil, topography). These variations lead to different forest communities with differing species, thereby contributing to biodiversity. (Subconcept 18)

OBJECTIVES

Upon completion of this lesson, students will be able to:

- Identify what biodiversity is and that it exists within a forest.
- Explain how interconnections between forest ecosystems and other ecosystems contribute to biodiversity.
- Recognize how Wisconsin forests are a part of world biodiversity.

SUBJECT AREAS

Language Arts, Science

LESSON/ACTIVITY TIME

- Total Lesson Time: 110 minutes
- Time Breakdown:

Introduction	10 minutes
Activity 1	50 minutes
Activity 2	25 minutes
Conclusion	25 minutes

TEACHING SITE

Classroom

FIELD ENHANCEMENT CONNECTIONS

This lesson ties closely with Field Enhancement 3, *Forest Diversity*.

BACKGROUND INFORMATION

BIODIVERSITY

Biodiversity is short for biological diversity and refers to the variety of life on Earth. It encompasses not only the organisms themselves, but also their habitats and the many ecological processes that support them. In fact, some say that biodiversity is the key to maintaining our planet as a healthy and productive place.

Biodiversity is often measured on three levels. **Species diversity** is the variety of different species in a given area. It is assessed by total numbers, relative abundance, and distribution of species. **Genetic diversity** is the range of genes within a population or species. It can be assessed on three levels: within breeding

VOCABULARY

Biodiversity: The variety and complexity of all life on earth, including genetic, species, and ecosystem diversity.

Biome: A regional ecosystem of the world characterized by distinct seasonal climatic differences, vegetation, and animals.

Community: A group of plants and animals living and interacting with one another in a given area.

Ecosystem: An area that contains organisms (e.g., plants, animals, bacteria) interacting with one another and their non-living environment. Ecosystems can be of any size (e.g., forest, meadow, log).

Ecosystem Diversity: Variety of biologic communities or ecosystems in a given area over time.

Ecotone: The transition zone between two adjacent ecological systems.

Genetic Diversity: Genetic variation within a population or species.

Limiting Factor: A factor that limits the growth, abundance, or distribution of a population of organisms in an ecosystem.

Species Diversity: The variety of species present in a given area.

MATERIALS LIST

FOR EVERY 3 TO 4 STUDENTS

- Copy of either Student Page **1**, *Forest Ecosystem*, Student Page **2**, *Prairie Ecosystem*, OR Student Page **3**, *Wetland Ecosystem*
- Copy of Student Page **4**, *Ecosystem Investigation*
- Plastic bag, envelope, or other container to hold puzzle pieces

FOR THE CLASS

- Several dictionaries or glossaries
- Marker/chalk board
- Additional ecosystem pictures or posters (optional)
- Textbooks, reference books, or access to the Internet or library for further ecosystem information (optional)
- One jigsaw puzzle (250-500 pieces) depicting a recognizable scene

TEACHER PREPARATION

- Divide jigsaw puzzle pieces so that each group in the class will have a set containing an approximately equal number of pieces. Place the puzzle box out of sight so the students cannot see the completed puzzle picture.

populations, between breeding populations, and within species. **Ecosystem diversity** has to do with the different biological communities of an area, and also with how they interact with their abiotic environment. Each of these types of diversity is constantly changing.

Biodiversity can also be studied on different scales. There is biodiversity within an ecosystem (all of the organisms in the forest, prairie, or wetland), but an even greater biodiversity when all of the organisms in multiple ecosystems are considered together. For example, Wisconsin's forests contain biodiversity because of the variety of plants and animals within them. Wisconsin's forests also contribute to biodiversity on a larger scale when you consider they are just one part of all the forests in the temperate forest **biome**.

FORESTS AS ECOSYSTEMS

A **community** is a group of plants and animals that live and interact with one another in a given area. The term **ecosystem** refers to a community interacting with the abiotic (nonliving) factors around it. Ecosystems can vary in size from a large forest to a single rotting log. The living things in an ecosystem may be subdivided into producers and consumers. Producers, or autotrophs, are mostly green plants that can make their own food. Consumers, or heterotrophs, are mostly animals, which need to consume other organisms to obtain energy. Some of the nonliving parts of an ecosystem include inorganic substances (e.g., carbon, nitrogen, carbon dioxide, water), organic compounds (e.g., proteins, carbohydrates), climatic factors (e.g., temperature, precipitation), and other physical factors (e.g., soils, topography, past glaciation).

Forest ecosystems play many essential roles. Forest plants use carbon dioxide and release oxygen during the process of photosynthesis. Trees keep us cooler by providing shade and also by releasing moisture through their leaves (transpiration). Forests provide food and shelter to many different types of wildlife, and they help control erosion. Forests also provide many useful products such as food, building materials, and paper.

Forest ecosystems do not stand alone, however. There are connections with other terrestrial ecosystems (such as prairies) and with aquatic ecosystems (such as wetlands). For example, many species find shelter in the forest, but get much of their food from adjoining open areas. Added sunlight along forest "edges" increases the habitat for sun-loving plants. Some organisms (notably amphibians) need a wetland for part of their life cycle, but can live other parts of their life in a terrestrial area. There can be a great deal of variability within and among ecosystems of all types. The interrelated nature of these ecosystems adds to diversity. Places where ecosystems overlap, called **ecotones**, can support a greater variety of organisms than would be found in either ecosystem alone.

WISCONSIN BIOLOGICAL COMMUNITIES

Wisconsin is fortunate to have a great deal of biodiversity. There are approximately 1,800 species of native vascular plants (those with specialized tissues for moving food and water throughout the plant) and more than 650 species of native vertebrates in Wisconsin. Thousands of species of nonvascular plants and invertebrates can be found in Wisconsin, as well. Due to its geographic location and a variety of physical factors, Wisconsin has prairies, temperate forests, and small areas of boreal-type forests in the north. It also has wetlands and a number of other aquatic communities such as springs, ponds, lakes, streams, and rivers.

Some of the **limiting factors** that affect where these communities will be found include climate (e.g., temperature, precipitation) and soils. For example, prairies and many of the forest communities dominated by oaks or jack pines will be found where conditions are warmer and drier. Boreal forest can only exist when temperatures are quite cool most of the year. Many of the pine species do well on sandy soils, but most maples need a richer, moister soil. Other natural factors also play a role. Glaciation has had a major impact on landforms, soils, and the location of bodies of water that, in turn, influence vegetation growth. Short-term disturbances (e.g., fire, drought, wind, rainstorms) can affect what species are present on a smaller scale and over a shorter timeframe. All these factors contribute to biodiversity.

THE IMPORTANCE OF BIODIVERSITY

Humans depend on the variety of species and ecosystems in Wisconsin and the world for clean air and water, food, shelter, and many raw materials for business and industry. We also value biodiversity for the beauty it brings and the opportunities for outdoor recreation. Over time, we have learned much that can be applied to humans by studying animals and plants. A wide array of useful products has been derived from plants. As our population grows, so does our need for resources, knowledge, and understanding. If biodiversity is not maintained, we may lose something valuable without even knowing it. One may argue that on a large time scale, biodiversity is dynamic. Paleontology has shown that some organisms have become extinct and new organisms have been created in response to catastrophic natural disturbances, such as volcanic eruptions, asteroids, plate tectonics, and major climate change. Human influence has, however, caused extinctions to occur at an accelerated rate.

Apart from human concerns, many living things simply cannot be successful without interactions with other organisms. Some of these organisms have symbiotic relationships, where each organism produces or provides something essential to the life of the other organism. Losing one of these organisms can have serious effects on related parts of an ecosystem. Biodiversity is a natural way to ensure against catastrophes caused by nature or humans. When there is a concentration of the same species of tree, a disease that affects that species can spread very rapidly. Having a mix of species will keep a forest more intact in the event one particular species is wiped out by disease. If drought, a flood, or another natural disturbance hits an area that is fairly diverse, chances are that a natural source for regeneration exists nearby. If populations are concentrated, however, the chances of a significant number of a certain species or subspecies being wiped out increases significantly.

An example of a disease that greatly affected tree populations was Dutch elm disease. In the 1960s and 1970s, Dutch elm disease spread rapidly through the eastern half of North America. This rapid spread led to the destruction of millions of trees in neighborhoods and cities. The disease spread in two ways – by insects or through interconnected root systems. When one tree in a large concentration of elms was affected, it wasn't long until others were affected. American elms were a popular tree planted in the urban environment. Having a concentration of the same tree species in one area allowed the disease to move rapidly and the destruction to be more significant than if a few elms had been scattered throughout a city.

THREATS TO BIODIVERSITY

Issues related to biodiversity need to be looked at from both a local and a global perspective. For example, many birds with habitat in Wisconsin forests migrate across much of the rest of the United States and into other countries. What is done in any of those places, whether good or bad for biodiversity, affects those birds and may determine their success or failure. Since there is interdependence among many species, current actions may lead to changes that might not be apparent for some time to come.

Our demand for products made from wood not native to Wisconsin means that we affect resource utilization elsewhere, and again, we may be having impacts we don't even realize. Take, for example, building materials that we use in our homes. Flooring and doors are made of a variety of types of wood from oak and pine (grown in Wisconsin) to mahogany (grown in South America). Choosing a wood product from forests that are more easily renewed, closer to home, and less impacted by logging will have less effect on biodiversity.

The introduction of non-native species is another way that biodiversity may be threatened. While a new species may at first seem to add to biodiversity, most non-natives have few natural enemies and often out-compete native species. Over time this reduces diversity. For example, exotic bush honeysuckle and buckthorn may initially add to forest cover; but eventually, they shade out native plants, reduce soil moisture and nutrients, and compete with native plants for pollinators. Since we may purposely or inadvertently bring species from one area to another, we need to be aware of the potential effects our actions may have.

PROCEDURE

INTRODUCTION - DEFINING BIODIVERSITY

1. Ask students (by a show of hands) how many have heard the term "biodiversity." If some students have, ask them to explain what they think it means. List their definitions on the board, leaving space to also write the definitions of biology and diversity.

2. Have several different student volunteers look up the meaning of biology and of diversity.

3. Add these definitions to the board. There may be various definitions for each word.

4. Discuss what seem to be the key parts of each definition. *(Biology refers to the study of life or living things; diversity refers to differences or variety.)*

5. Put these key parts together to form a class definition of biodiversity. *(Biodiversity is the variety and complexity of all life on earth.)* Discuss similarities and differences between this definition and what students thought the meaning was before looking it up.

6. Tell students that they will now be learning about biodiversity in different ecosystems, and especially in Wisconsin's forests.

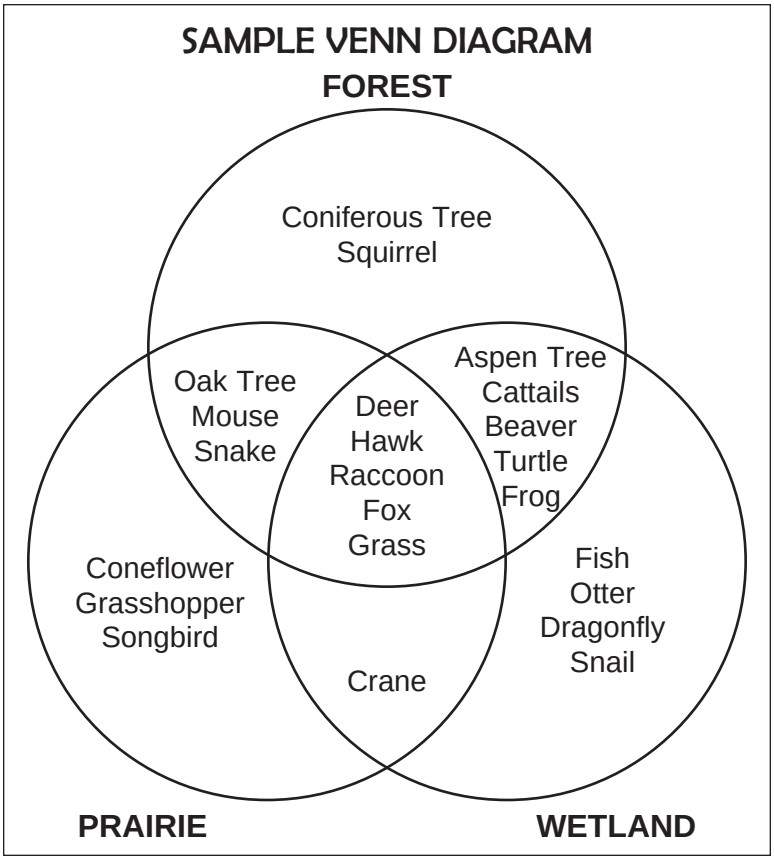
ACTIVITY 1 - VENN DIAGRAM

1. Divide the class into groups of three or four and assign each group an ecosystem type (forest, prairie, wetland). There should be at least one of each ecosystem.

2. Give each group a copy of Student Page **1**, *Forest Ecosystem*, OR Student Page **2**, *Prairie Ecosystem*, OR Student Page **3**, *Wetland Ecosystem*. (Ecosystem posters from other sources may be used in addition.)

3. Have each group study their picture, identifying all organisms they can see. They should fill in Student Page **4**, *Ecosystem Investigation*. To complete part two of the handout, students should draw on their past experiences to list species that they would expect to find in that ecosystem even if they are not shown in the picture. For example, humans do not appear in the pictures, but are part of ecosystems. If time and resources permit, the opportunity to go out and make field observations of an ecosystem is ideal. Reference materials and/or Internet research could also be used to learn about other organisms associated with the given ecosystem type.

4. Once all the groups have finished, draw a Venn diagram with three circles overlapping in the center on the board. (See example on next page.) Each circle should be labeled with one of the ecosystem types. You will use the diagram to determine the species overlap between these ecosystems. Have one group begin by telling the class one of the organisms found in their ecosystem. Ask students in the remaining two ecosystem groups if they also had this organism. If all three ecosystems have the organism, it should be listed in the very center of the diagram. If two of the ecosystems have the organism, it should be listed in the overlapping space between those two ecosystem circles. If only one ecosystem had the organism, it should be listed in the open space for that ecosystem.



5. Lead a discussion about biodiversity based on this diagram.

   - Which organisms were found in all three types of ecosystems? *(Deer, hawk, fox, raccoon, grass.)*
   - Are there some found in two ecosystems, but not all three? *(In the Forest and Prairie: oak tree, mouse, snake. In the Forest and Wetland: aspen tree, cattails, frog, turtle, beaver. In the Wetland and Prairie: crane.)*
   - Name some organisms unique to each ecosystem. *(Forest: Coniferous tree, squirrel. Prairie: grasshopper, songbird, coneflower. Wetland: dragonfly, fish, otter, snail.)* Suggest reasons that they are only found there. *(Possibilities might be that they need a critical resource such as water or that their food or shelter can only be found there.)*
   - Tell students there are three major categories of biodiversity. (Species, genetic, ecosystem.)
   - Explain that having a variety of types of organisms is called "species diversity," the first category of biodiversity.
   - Ask what advantage there is in having this type of diversity. *(Various species fill different roles or niches in the ecosystem.)*
   - Ask students to give examples of diversity they have seen among the trees in a forest or in their town. *(Examples could include a mixed coniferous/deciduous forest or a variety of tree species in the same forest, such as oak and maple.)*
   - Are all organisms of the same species exactly the same? For example, are all sugar maple trees exactly the same? *(No; there are differences in shape, size, coloration, and many unseen things.)*
   - Tell students this is an example of the second type of diversity, "genetic diversity." Why is genetic diversity important? *(It is necessary for maintaining healthy populations. If a particular population of a species becomes diseased and dies, other members of the same species may have a genetic variation that prevents them from getting the disease.)*
   - Ask students to give examples of how species might depend on one another. *(Any food chain/food web answer is good. For example, an insect might be food for a fish, which is then eaten by a raccoon. Other possibilities include trees and other plants providing shelter for some animals, insects pollinating plants, etc.)*
   - What would happen if there were more or fewer of any one species? *(Eventually it would affect all the other organisms.)*

- Ask students to give examples of how some species might depend on more than one ecosystem. *(Hawks nest in forest trees but hunt over open fields and prairies. Beavers live in ponds and wetland areas but need the trees in forests to build their dams.)* This illustrates how species and ecosystems are interconnected.
- Ask students which ecosystems are found around their school. If your school lacks any natural area, use another example, such as a park, that most of your students are familiar with. *(Answers will vary from forests to prairies to wetlands, but accept other ecosystem types as well.)*
- Now have them expand their thinking to ecosystems around their community. Explain that this is an example of the third category of diversity, "ecosystem diversity."

ACTIVITY 2 - BIODIVERSITY PUZZLE

1. Give each group a container of puzzle pieces and ask them not to look at any other group's pieces. Have groups take their puzzle pieces out of the container and try to figure out what the puzzle picture is. Ask groups to put together any pieces that fit and also to identify what parts of the picture some of their pieces might be (e.g., blue pieces might be part of the sky or of a body of water; parts that seem to have fur or fins might be some type of mammal or fish).

2. After a few minutes, have each group first write down and then report their ideas to the rest of the class. Discuss the similarities and differences in their ideas.

3. Next, have each group join another group (if group numbers are uneven, there can be one set of three groups) and look at the combined group's puzzle pieces. Does this alter their thinking? Can any more sections be completed? *(Probably yes.)*

4. Ask one student to **walk** around the room and pick up as many pieces of a certain color as possible in 30 seconds (you may want to adjust the time). How many did the student get? Now give those pieces back to the groups in **roughly** the same numbers as they were taken. Ask the groups to gather all of the pieces of that color together in one place where they are working. Now have the same student **walk** around again and pick up as many pieces of that color as possible in 30 seconds. How many did he or she get this time? *(It should be more.)*

5. Finally, take all the pieces from one group. Will the puzzle ever be completed with these pieces missing? *(No.)*

6. Now lead a discussion relating the puzzle pieces to biodiversity.

   - Tell students that the individual pieces represent organisms. Those that were similar in color or pattern might represent one species while those of a different color or pattern might represent another. Did all groups have a diversity of species? *(If pieces were well mixed, they probably did.)*
   - Do students think this mix of pieces (species) gave them a better idea of what the picture was than if they had all of one type? *(Most will say yes.)*
   - Pieces that fit together show how species can depend on one another. Think of the groups as separate ecosystems or separate locations. Was there a connection between them? *(Yes; most groups have a better idea of the "big picture" when they can see more of the parts. They were probably able to make more connections, as well.)*
   - How are the puzzle pieces similar to real species? *(Different species are interconnected like puzzle pieces. It takes a variety of species to make a whole ecosystem "fit together.")*

- When the student picked up all the pieces of one color, this was similar to a disease or human-caused disturbance affecting one species. Give some examples of this. (Dutch elm or oak wilt disease or increased demand for a certain species like white pine for lumber.) It was easier for the student to take more pieces when they were already gathered together by each group. What is this similar to? *(When species are all planted together, such as a pine plantation, or the same species planted along a street for shade.)*
- What does this illustrate about the value of biodiversity? *(More diversity makes it less likely that any one species will be destroyed. If one species is especially affected, having more of that kind in a different location provides a source for replacement.)*
- Taking all the pieces from one group would be like losing the biodiversity of one large location. What would happen if all the species in Wisconsin disappeared? *(More species may replace them from other areas. Species in other areas may be affected by a loss of food or shelter. Many natural interconnections between species would be destroyed because Wisconsin species migrate to other areas and species from other areas migrate to Wisconsin.)* This shows how one place (like Wisconsin) is interconnected with the biodiversity and ecosystem function of the United States or even the world.

CONCLUSION - REVIEW DISCUSSION

Write the following questions on the board. Have students (in the groups used for Activities 1 and 2) discuss the questions and record their answers. Then have groups report their ideas to the rest of the class. After one group has reported, have the other groups tell how their answer was similar or different. Rotate which group answers the question first.

1. What is biodiversity and why is it important? *(Biodiversity refers to the variety of living things on Earth or in a given system [e.g., biome, ecosystem, forest]. It is important to human beings because we depend on this variety for clean air and water, food, shelter, raw materials, beauty, and recreational opportunities. We have also derived medicinal products from plants and learned a great deal by studying plants and animals. Biodiversity allows for the interactions among living things that are crucial to survival [e.g., food chains and webs].)*

2. What are the problems of having limited diversity? *(With limited biodiversity there is a greater chance that a disturbance [e.g., fire, disease] will lead to catastrophic losses, as has happened with Dutch elm disease. It also limits the potential for us to learn from or use species we may not even know exist [or may not realize the potential of].)*

3. What is species interdependence? What are some examples? *(Interdependence has to do with species relying on one another for certain critical needs such as food or shelter. For example, bacteria in our digestive systems help us break down food while obtaining nutrition for themselves, an apple blossom provides nectar for a bee and in the process is pollinated.)*

4. How do interconnections between forests and other ecosystems contribute to biodiversity? *(Some species that live in forests depend on other ecosystems for food or water and vice versa. Where ecosystems meet, as at the edge between a forest and a wetland, the characteristic conditions and species of both ecosystems can exist. This means that there is a greater diversity than there would be in either ecosystem by itself. Without a variety of ecosystems interconnected with one another, these species could not survive and biodiversity would be reduced.)*

5. Using organisms and resources common in Wisconsin as examples, explain Wisconsin's role in world biodiversity. (If there were more or less of a Wisconsin organism, how would that affect the diversity of organisms worldwide?) *(One example is migratory birds. If a bird that spends part of its life in Wisconsin, such as the sandhill crane, is protected, its numbers go up. That means it has greater food and space needs as a species and will not only affect its food [e.g., corn and prairie plants] here, but also in Texas or Florida when it migrates. Conversely, if a migrant is hunted, if its habitat is reduced, or if it is affected by disease or a natural disaster in one location, its numbers will go down and affect the food chain/web of which it is a part in all places where it lives. If we choose not to harvest certain species here [such as large white pines], but still have a demand for the products made from that resource, it often means that that species, or one that can provide similar resources, will be harvested more heavily elsewhere and potentially reduce biodiversity.)*

CAREERS

The career profile in this lesson features Robert Howe, Director of the Cofrin Center for Biodiversity. The Career Profile is found on page 53. A careers lesson that uses this information begins on page 170.

SUMMATIVE ASSESSMENT

1. Describe how Wisconsin contributes to the world's biodiversity and give examples of how changes in Wisconsin's forests affect forests worldwide.

2. Observe and illustrate (with pictures or words) biodiversity around your school. Explain how this biodiversity contributes to the overall biodiversity in your community.

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RECOMMENDED RESOURCES

●●● ON-LINE POSTER ●●●

EEK! (Environmental Education for Kids), Wisconsin Department of Natural Resources http://dnr.wi.gov/eek/

The Wisconsin DNR has a series of interactive forest, prairie, and wetland posters on-line. You can click on an item in the picture and read more about it. Visit "Habitats" in the "Nature Notes" section of the EEK website.

CAREER PROFILE

Robert studies birds and teaches courses in ornithology at the university.

ROBERT, DIRECTOR, COFRIN CENTER FOR BIODIVERSITY

Meet Robert Howe. He is the director of the Cofrin Center for Biodiversity. The center was established to promote the appreciation and study of plants and animals of the Northern Lake States region. Robert's work connects him with students, community members, and government agencies. The center is located at the University of Wisconsin-Green Bay. In addition to directing the center, Robert also teaches ecology and biology courses at the university and conducts scientific research on the animals in Wisconsin forests.

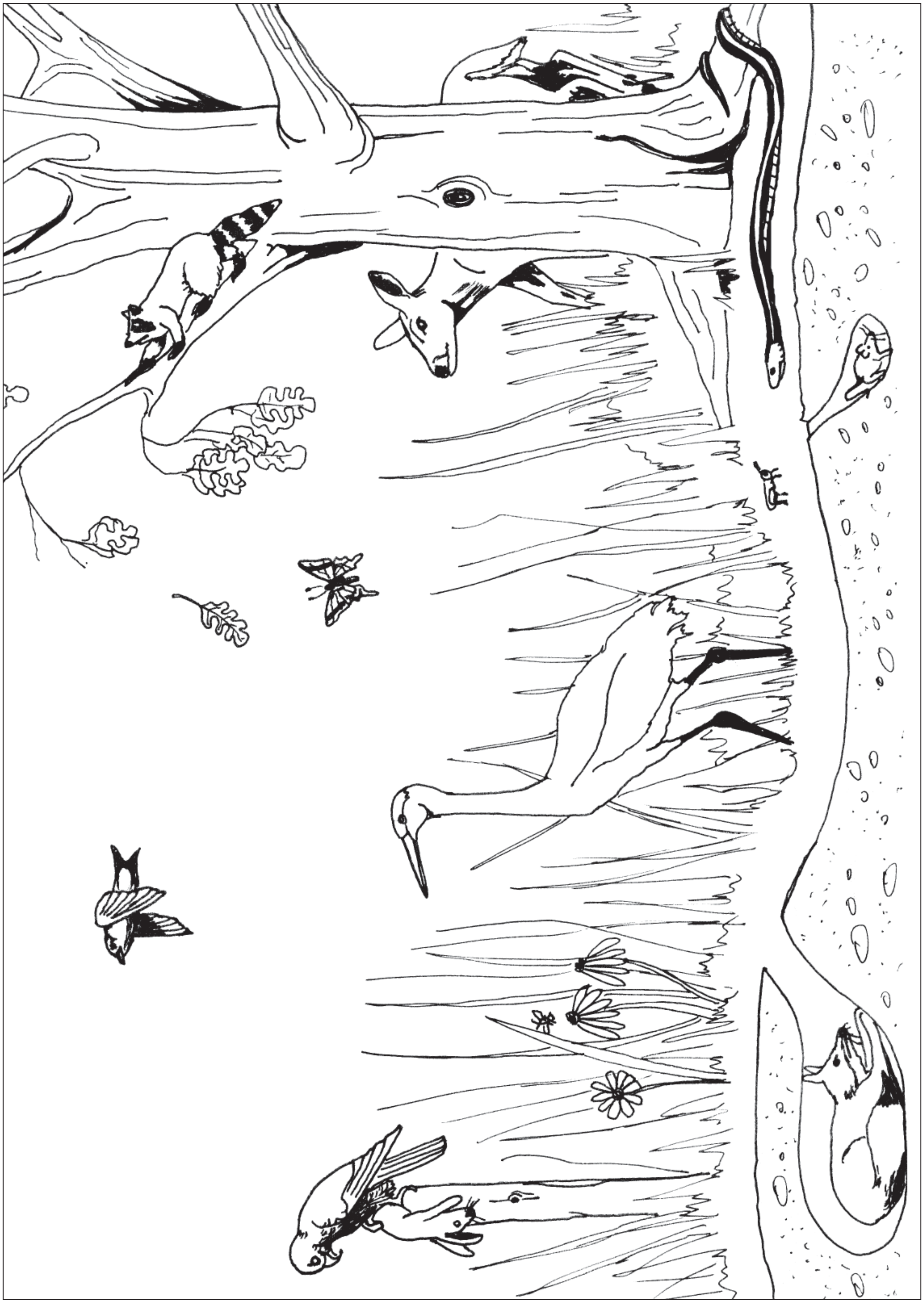
Robert's educational background includes a Bachelor's degree in Biology and a Master's degree and a PhD in Zoology. Robert worked previously as a Zoologist and Director of the Iowa Natural Areas Inventory. He also is a member of several professional organizations including the Wisconsin Society for Ornithology, the Society for Conservation Biology, and the Ecological Society of America.

Robert says that his favorite thing about his job is, "Learning about animals and plants, [having] opportunities to observe nature in the field, and trying to help people manage natural resources in the best way possible, including ways that are least harmful to native species."

If you are interested in a job like Robert's, he has some recommendations. He says not to neglect math and to take every opportunity to get outside and enjoy nature. He also suggests that you get some field guides and learn about plants and animals.

FOREST ECOSYSTEM

PRAIRIE ECOSYSTEM



WETLAND ECOSYSTEM

ECOSYSTEM INVESTIGATION

ECOSYSTEM TYPE: FOREST PRAIRIE WETLAND

In the table below, list the name of each species that you can see in your ecosystem picture. If you are unsure of a name, but know the category it belongs in, just describe it. Use Part 1 for those organisms you can see. Use Part 2 for those organisms not shown in the picture that you would expect to find in that type of ecosystem based on past experience or research.

Part 1: Organisms that can be seen in the picture.

Trees	Plants, Moss, Fungi, Flowers, Etc.	Amphibians	Reptiles	Birds	Mammals	Fish, Shellfish, Etc.	Insects, Spiders, Worms, Etc.

Part 2: Organisms that can't be seen in the picture but are typical of this type of ecosystem.

Trees	Plants, Moss, Fungi, Flowers, Etc.	Amphibians	Reptiles	Birds	Mammals	Fish, Shellfish, Etc.	Insects, Spiders, Worms, Etc.