

# Puzzling Wisconsin's Biological Communities

Students identify different Wisconsin biological communities based on hearing a series of energy-related clues.

**Grade Level:** 9-12

**Subject Areas:** Agriculture Education, English Language Arts, Mathematics, Science, Social Studies

**Setting:** Classroom

**Time:**

**Preparation:** One to two hours

**Activity:** Four 50-minute periods

**Vocabulary:** Biodiversity, Biological community, Consumer, Decomposer, Diversity, Ecosystem, Eutrophication, Food web, Gross primary productivity (GPP), Net primary productivity (NPP), Producer, Tension zone

**Major Concept Area:**

- Energy flow in ecosystems, including human societies

**Getting Ready:**

Scatter or hide ten of the plastic eggs throughout one-half of the room. Place the others in a basket. Make two copies of the Lake, River, and Stream Communities clue card. Students fit the pieces together by laying them on top of each other. The map outline can be used to align the pieces correctly. Specific instructions are written on the master page. An alternative is to cut out the pieces to create a jigsaw where students place pieces into an outline of Wisconsin. You may need to outline the location of the pieces within the map to help students know where to place them. Another alternative is to project the completed *Puzzle Pieces of Wisconsin's Biological Communities* and have students color in their puzzle pieces.

**Objectives**

Students will be able to:

- identify food chains in Wisconsin biological communities;
- analyze the roles energy plays in the formation of Wisconsin biological communities; and
- provide examples to illustrate that the development and use of natural resources, including energy, affects plant and animal communities.

**Rationale**

Recognizing the role of energy in forming and sustaining biological communities helps students appreciate energy in their lives.

**Materials**

- 20 plastic eggs or some other small item
- A basket
- Copies of the following pages:
  - *Energy and Ecosystems Chart*
  - *Tension Zone Map* (optional)
  - *Lake, River, and Stream Communities* (two copies)
  - *Biological Community Clue Cards*
  - *Biological Community Update Cards*
  - *Puzzle Pieces of Wisconsin's Biological Communities*
- Road map of Wisconsin (optional)
- Map detailing types of vegetative cover in Wisconsin (optional) on [keepprogram.org](http://keepprogram.org) > Curriculum & Resources

**Background**

"Don't put all your eggs in one basket" is a familiar phrase used to caution people not to depend too much on one thing, such as a person, a resource, or a strategy. The same can be said for ecosystem management. In this case, the eggs represent energy and the basket symbolizes ecosystems (ecosystems are land areas characterized

by the interactions among living and nonliving components found there). There is concern among some environmentalists and land management planners that we are putting too much energy into one ecosystem at the expense of others.

Human ecosystems, primarily urban and agricultural settings, are taking large amounts of natural resources (including energy resources) from other ecosystems. In addition, to make room for growing human populations, land areas such as prairies are being plowed over to develop farms and cities. These activities can damage or destroy ecosystems. Reducing the number of ecosystems diminishes ecosystem diversity, which is one component of biodiversity. Maintaining biodiversity is a way of keeping eggs in many different types of baskets.

There are a variety of ecosystems in Wisconsin. Ecosystems can range in size from a few square feet (meters) to thousands of square miles (kilometers), and are characterized by their living (plants and animals) and nonliving (soil, temperature, moisture) components. Several factors cause the characteristics of one ecosystem to differ from another. Many of these factors relate to energy.

Climate greatly influences an ecosystem. Climate is determined by an area's average temperature and moisture, both of which are related to energy (see **Energy and Ecosystems** chart). The climate in the northeastern region of Wisconsin varies from the southwestern region. The transitional zone between the two climate types is called the Tension Zone. In Wisconsin, the region north of the tension zone is dominated by long, cold, dry winters. Climates south of the tension zone are more temperate and have four distinct seasons. Another element that contributes to the diversity of ecosystems is soil. The formation of soil in some areas of Wisconsin can also be attributed to energy because powerful glaciers scoured the land and transformed Wisconsin's landforms and vegetation. Fire and wind further define ecosystems and are also connected to energy.

The climate and soil conditions of an ecosystem influence what type of organisms will live there. For example, certain plant and animal species are more suited to the environmental conditions north of the tension zone, while others are more suited to the south.

Associated with ecosystems are biological communities. A community consists of the plant and animal

populations that live there and interact with each other. Biological communities are classified by the dominant plant type. There are many ways to classify Wisconsin biological communities. Following is one approach.

- Northern forest communities
- Southern forest communities
- Grasslands communities (including prairies)
- Oak savanna communities (blend of forest and grasslands)
- Aquatic communities (lakes, rivers, and streams)
- Wetlands (blend of aquatic and terrestrial communities)

These communities are aggregations of several different types of communities with similar qualities (based on *Wisconsin's Biological Diversity as a Management Issue*, Department of Natural Resources, 1995). See the **Biological Community Clue Cards** for descriptions of these biological communities.

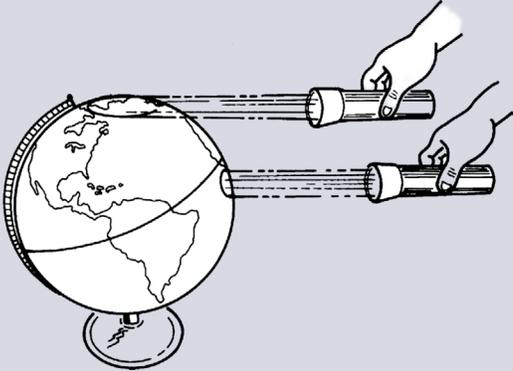
Energy flows and nutrients cycle through each of these communities. There are producers, consumers, and decomposers interconnected through complex food webs. Food webs are pathways through which energy, in the form of nutrients, flows from one organism to another (see the activity "Food Chain Game" for more information on food chains and webs).

Varying patterns and rates of energy flow and nutrient cycling contribute to the unique qualities of different biological communities. A major factor that characterizes a community is how efficiently the producers convert solar energy into chemical energy (food). All the energy that producers convert to chemical energy is called gross primary productivity (GPP). However, because plants use energy, not all the solar energy they convert is available to consumers. The net primary productivity (NPP) is what is left of the GPP after producers have used some of the energy for their growth, movement, and other life functions.

The NPP varies for different communities. Communities with high NPP, such as wetlands and forests, may have large amounts of stored energy. Energy that is stored in the producers can eventually make its way to consumers, including humans.

Biological communities are changing all the time. Humans have contributed to these changes by logging, mining, farming, and developing land. These activities alter natural habitats, making them more or less suitable

## Energy and Ecosystems

<b>Glaciers</b>	Changes in global temperature, among other conditions, allow for the formation of glaciers. Glaciers contain large amounts of potential energy which is converted to kinetic energy through pressure and gravity. The motion of glaciers carves and reshapes landscapes. The melting of glaciers (caused by an increase of heat energy) further defines the landscape by forming lakes, rivers, and wetlands. Glaciers plowed through all except the southwestern region of Wisconsin. A rolling plain covered by a layer of glacial till was what remained after the glaciers receded. Soil conditions in northern and southern parts of the state (generally above and below the tension zone) vary greatly because of glacial activity.
<b>Soil types</b>	Soil is formed by the erosion (mechanical energy) of rocks and the addition of organic matter (decomposition). The types of rocks in an area are determined by geologic processes. Soil can also be transported from one place to another by glaciers, rivers, and wind.
<b>Temperature</b>	The air is heated by energy radiating from Earth's surface. Earth's surface is heated by the sun. Variations in temperature are determined primarily by the angle at which sunlight strikes Earth's surface (see Latitude). Temperature is also affected by other conditions, including wind and moisture.
<b>Moisture</b>	The amount of moisture in an ecosystem is indirectly related to energy. Oceans, lakes, and groundwater systems supply the water, but how water cycles through the ecosystem (evaporation, precipitation, global winds) is determined by energy. Heat energy causes evaporation and precipitation. Many of Wisconsin's lakes, rivers, and wetlands were formed by glaciers (see Glaciers). The water cycle is powered by solar energy. Winds carry moisture from one location to another.
<b>Fire</b>	Burning is the release of energy stored in organic matter. Fire keeps certain plants from growing and promotes reproduction in other plants, thus keeping the dominant species constant and maintaining a community.
<b>Wind</b>	Earth's rotation and uneven heating of Earth's surface by the sun cause variation in ambient air temperatures. When hot air rises, cold air comes in to take its place, creating wind. Cold air also pushes away hot air. Winds enhance evaporation and contribute to drier soil conditions, which some species tolerate better.
<b>Climate Change</b>	Long-term global or regional shift in climate patterns based on the statistical distribution of weather patterns.
<b>Latitude</b>	<p>The sun's rays strike Earth's surface at different angles at different locations, creating variations in temperature. At the equator the planet is facing the sun and receives direct sunlight (rays meet the surface at a 90° angle) and thus heats up quickly. At the poles the Earth's surface faces the sun at an inclined angle; the sun's rays strike the poles at an oblique angle and the heating is less intense.</p> <div style="text-align: right;">  </div> <p style="font-size: small; margin-top: 10px;">Diagram from The Watercourse and Western Regional Environmental Education Council (WREEC). <i>Project WET: Curriculum and Activity Guide</i>. Bozeman, Mon. The Watercourse and Western Regional Environmental Education Council (WREEC), 1995. Used with permission. All rights reserved.</p>

for certain species to survive. In this way, food chains are disrupted or rearranged, changing the way energy flows through a community.

Following are a few ways biological communities have changed in Wisconsin.

- Grasslands and oak savannas have been largely replaced by agricultural and urban communities. Energy flows through human-built communities differently than it does through natural systems.
- The energy flow of lake communities is altered through eutrophication. Eutrophication is a natural aging process of lakes, where nutrients (stored energy) from surrounding land areas are added to the lake over time. Events such as runoff that carry lawn fertilizers and sediments from construction sites add nutrients to lake systems and increase the rate at which lakes age. Increasing the amount of nutrients in a lake increases its NPP and influences what types of plants and animals will live there.
- Communities in the northern forests have been altered by logging and regrowth and are no longer characterized by the presence of conifers. This alteration means that food chains and webs that included the conifers were affected. Other energy-related aspects of the community, such as temperature and moisture, could be affected by the presence or absence of conifers or other dominant plant species as well.
- Climate change impacts on Wisconsin's wildlife

will alter the behavior, distribution, development, reproduction, and survival of wildlife populations including a northern shift in Wisconsin's tension zone. Conditions predicted to change include an advance in spring conditions, a spatial shift in climate niche, high temperature extremes, altered snow cover and cold exposure, drought and heavy rainfall/flooding events.

Humans use about 40 percent of Earth's potential NPP for human agricultural and urban communities. Urban communities do not have a dominant plant species. The agricultural community provides food and energy to maintain lifestyles that come primarily from burning fossil fuels. With agriculture, humans have created communities that have large populations of very few species (corn, hay, cows) and simple food chains.

Creating urban and agricultural communities has enabled humans to lead safer, healthier, and more productive lives. However, because these communities are made up of simpler food chains, some scientists and resource managers are concerned that we may be "putting all our eggs in one basket" as far as biological diversity is concerned.

A diversity of producers and consumers allows multiple pathways through which energy can flow; this diversity contributes to the stability of an ecosystem. For example, if one species of producer is reduced, other producers

NOTE: Depending on student background knowledge, you may wish to review the following concepts (see **Background** and **Related KEEP Activities** for ideas)

- Food Chains and Food Webs
- Energy related qualities of an ecosystem.
- The Tension Zone that marks the transition between two different climate types.
  - The **Tension Zone** map shows the transition area between different climates in Wisconsin.
  - Certain species of trees, such as conifers, endure colder climates of northern Wisconsin better than many deciduous trees that are generally more common in southern Wisconsin.
- Plants influence what other types of organisms live in the ecosystem.
  - How much energy plants are able to convert into and store as food determines how much energy is available to other organisms in the ecosystem.
  - Communities with higher Net Primary Productivity have more stored energy.
  - Size and density of plant species influence which animals will live there; for example, certain species of bison are more suited to live in grasslands than in dense forests.

still exist that can convert energy. Maintaining these different communities ensures that a diversity of resources will be preserved. These resources benefit humans and other organisms by providing us with food, shelter, water supplies, and energy sources.

Fortunately, various steps are being taken to preserve Wisconsin communities. Projects strive to restore the variety of plant and animal communities that once lived in these areas. The Nature Conservancy, a private conservation organization, along with UW–Madison, the U.S. Forest Service, UW–Stevens Point, and others, initiated a project to analyze the biological diversity of communities in the Baraboo Hills. A master plan has been developed to restore oak savanna communities in the Kettle Moraine State Forest. Individuals can also contribute to maintaining community diversity. In addition to participating in restoration projects, we can use materials and resources, including energy, wisely and efficiently. Doing so can reduce the amount of energy and other resources needed from other communities.

## Procedure

### Orientation

Explain to students that each half of the classroom represents different ways natural resources are distributed. In one half, the “resources” (plastic eggs) are scattered and hidden throughout the room, and in the other half, they are all kept within one basket in the center of the room. Have students list advantages and disadvantages of each method of distribution. Mention “putting all your eggs in one basket” and see if students can relate it to these different distributions. Inform students that they will be investigating how the presence or absence of ecosystems and biological communities influence where natural resources, including energy sources, are distributed and used in Wisconsin.

### Steps

1. Ask students to identify environmental conditions that characterize an ecosystem. Project the blank **Energy and Ecosystems Chart**. Write students’ responses in the left column.
2. Challenge students to connect each of the identified environmental conditions to energy (see **Background**). Write their responses on the right side of the chart. These can be common sense descriptions (anything that moves uses energy), or students can research relevant facts (see the activity “Energy Use in an Ecosystem”). The chart can also be filled in throughout the activity as students acquire more information.
3. Review the definition of biological community (plant and animal populations living in a specific area). Explain that they are often identified by which type of plant is dominant.
4. Write the titles of the communities listed on the **Biological Community Clue Cards** on the board. Tell students that they will use what they know about energy’s role in forming ecosystems while playing a guessing game. They will hear a series of clues about one of several Wisconsin communities and will try to match the description to the correct title. Most of the clues have connections to energy.
5. Divide the class into seven groups. Randomly select one of the first seven **Biological Community Clue Cards**. Read the clues aloud in order. Give students a few seconds after each clue to identify which community is being described before all the clues are read (the clues for each community are arranged from general to specific; you may need to define certain terms). Students should be able to use their common sense and the process of elimination to match the description to the community.
6. If a group knows the answer, one group member should raise her or his hand and be called upon. It may help to have an assistant who watches to see who raises a hand first.
7. The group that identifies the correct community gets a puzzle piece for that community and the **Biological Community Clue Card**. Repeat the procedure for the other communities. Make sure that each group gets a puzzle piece (this may entail not allowing a group who already has a puzzle piece to guess again, or passing out the puzzle pieces to each group after all the communities have been identified). NOTE: Do not give the Wetlands group a puzzle piece. Instead give them a dry erase marker.
8. Inform students that the puzzle pieces represent the location of their biological community in Wisconsin. Explain that these are general approximations of the locations.
9. Have students read the instructions on the **Biological Community Clue Card**. Students should use information provided by the clues and, if time allows, do additional

research to follow the instructions. Below is the basic information that each group should provide.

- Describe how energy helped develop this community (include work done by winds, fire, gravity, and glaciers).
- Describe how energy flows through this community (describe or draw one or more food chains and webs).
- Indicate where this community is located in Wisconsin by placing the puzzle piece on the map of Wisconsin.

**10.** Have groups representing communities numbered one through seven come to the front of the class, report the energy-related information about their community, and place their puzzle piece appropriately on the map. After all of the presentations, there should be a complete biological communities map for Wisconsin. You can show the **Completed Puzzle of Wisconsin's Biological Communities (mid 1800s)** to show students how their map should have turned out. If available, show students a road map of Wisconsin or one that details the different vegetative types available on [keepprogram.org](http://keepprogram.org) > Curriculum & Resources.

**11.** Explain that the map made of all the compiled clue cards represents biological communities prior to European settlement. Read **Biological Community Clue Cards** 8 and 9 and ask the class to guess which communities they represent. Have students suggest ways human development has affected each of the biological communities.

**12.** Hand out the **Biological Community Update Cards** and revised puzzle pieces for groups that get them. Have each group report how human development has affected their communities and create a new map using the revised puzzle pieces. These reports can be based on information from the **Biological Community Update Cards**. Explain that not receiving a puzzle piece means that the community is nearly absent from the state; more detailed maps would show where they are actually located. You can show the **Completed Puzzle of Wisconsin's Biological Communities (1971-1981)** to show students how their map should have turned out.

### Closure

Review the distribution of “resources” (plastic eggs) around the two halves of the room. Which one is more like the Wisconsin environment prior to European settlement and which is more like the present day? Have students discuss reasons why loss of biological

communities may have undesirable effects. Students may mention the loss of resources, ecosystem instability, decline in aesthetic appeal, etc. Challenge students to relate their responses to energy (for example, simple food chains versus complex food webs).

Share what is being done to maintain biological community diversity in Wisconsin. Depending on time and interest, students can describe activities they can do to preserve communities and reduce energy and resource consumption.

## Assessment

### Formative

- How reasonably did students attribute to energy the conditions that formed ecosystems
- Did students listen to clues and use the information to correctly identify communities?
- Did student reports accurately describe energy flow through food chains in Wisconsin communities?
- Were students able to describe how development of urban and agricultural communities affects Wisconsin's biological communities?

### Summative

- Conduct a mini-debate on the pros and cons of using government money to restore biological communities. Arguments should include information about energy flow and use in communities.
- Have students create three vegetation/land use cover maps for Wisconsin. They should develop one for 100 years ago, one for the present (both of these two cover maps will look similar to the ones in this activity), and one for 100 years from now. Each map should have a legend and a key. Students should describe changes from past to present, and for the future map, they should explain why they think the vegetation will appear as they project it will.

## Extension

A variation of the game is to award points for correctly guessing the community. The point system for identifying the community can be simple (each correct guess gets one point) or weighted. For example, if there are six clues, guessing the community correctly after the first clue is worth six points. The number of points awarded is reduced by one point for each additional clue that is read.

## Related KEEP Activities

Prepare students for this activity by having them participate in “Energy Use in an Ecosystem.” The activity “Food Chain Game” will help students understand energy flow in food chains and webs. “Puzzling Wisconsin Biological Communities” can be adapted to coincide with the activity “Energy Use Then and Now” where students compare energy use in the past and present. Environmental effects of human settlements, particularly with energy resource development, are introduced in “Dirty Half Dozen.” Investigation Ideas: “Energy and the Environment” in the Energy Sparks section describes different research possibilities. Energy-related topics dealing with planting in human-built ecosystems are provided in the Energy Sparks section, Action Ideas: “Energy Efficiency Measures.”

## Credits

Background information, tension zone map and descriptions within **Biological Community Clue Cards** from Addis, James T., Ronald Eckstein, Anne Forbes, DuWayne Gebken, Richard Henderson, John Kotar, Betty Les, Paul Matthias, Wendy McCown, Steven Miller, Bruce Moss, David Sample, Michael Staggs, and Kristin Visser. *Wisconsin’s Biodiversity as a Management Issue: A Report to Department of Natural Resources Managers*. Madison, WI: Wisconsin Department of Natural Resources, 1995. Used by permission. All rights reserved.

LeDee, O., Hagell, S., Martin, K. et.al. *Climate Change Impacts on Wisconsin’s Wildlife: A Preliminary Assessment*. Technical Bulletin No 197. Department of Natural Resources, Madison, WI.

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# Biological Community Clue Cards

## Community 1

### Clues

1. The soil and landscape of this community was formed by the action of glaciers.
2. The net primary productivity is about 3,500 kcal/m<sup>2</sup>/year. The sun is the primary source of energy. The conversion of the sun's energy to chemical energy (food) mostly takes place many meters above ground level. Sunlight often does not reach the ground level.
3. Much of the energy in this community is stored in the bodies of the producers. Humans can use typical producers as an energy source and for home construction.
4. Consumers include many types of insects, such as beetles and moths, birds such as woodcock and owls, and mammals such as white-tailed deer, snowshoe hares, and black bears. Before European settlement, moose, pine martens, and timber wolves lived here as well.
5. The major producers include trees such as sugar maple, basswood, and American beech. Before European settlement, white pine was also common.
6. It is located north of the tension zone.

### Answer: Northern Forest Communities

### Instructions

- Describe how energy helped develop this community.
- Describe how energy flows through this community.
- Indicate where this community is located in Wisconsin by placing the puzzle piece on a map of the state.

### Description

The term "northern forest" refers primarily to location rather than to any specific species composition. Northern forests contain mixed deciduous and coniferous forests found in a distinct climatic zone that occurs north of a roughly S-shaped transition belt known as the tension zone that runs from northwest to southeast Wisconsin. Early forest surveys indicated that northern forest consisted of a mosaic of young, mature, and old growth forests composed of pines, maples, oaks, birch, hemlock, and other hardwood and conifer species. Old growth is defined as a community in which the dominant trees are at or near biological maturity.

# Biological Community Clue Cards

## Community 2

### Clues

1. The soil and landscape of parts of this community were formed by runoff from melting glaciers. Other areas of this community are covered by silt carried in by winds during the glacial period.
2. The net primary productivity is about 5,600 kcal/m<sup>2</sup>/year. The sun is the primary source of energy. The conversion of the sun's energy to chemical energy in food mostly takes place many meters above ground level. Sunlight often does not reach the ground level.
3. Much of the energy in this community is stored in the bodies of the producers. Over the years, large amounts of energy is stored in decaying matter in the soil. Humans burn the producers for energy and cut them down to build homes.
4. Consumers include many types of insects, white-tailed deer, coyotes, blue jays, and beavers. The community used to support many large herbivores and carnivores such as bison, bobcats, and black bears.
5. The major producers include trees such as oak, sugar maple, basswood, hickory, and box elder. Not many conifers (such as pine trees) are found in this community.
6. It is located south of the tension zone.

### Answer: Southern Forest Communities

### Instructions

- Describe how energy helped develop this community.
- Describe how energy flows through this community.
- Indicate where this community is located in Wisconsin by placing the puzzle piece on a map of the state.

### Description

Early European observers recognized southern forests (those south of the tension zone) as distinct from the northern types because of the predominance of oaks and general absence of conifers. They also noted the relative openness or park-like appearance, created by the lack of small trees and shrubs. There is evidence that these southern forests were shaped by fire in the previous 5,000 to 6,000 years.

# Biological Community Clue Cards

## Community 3

### Clues

1. Fire helps maintain this community by preventing certain plants from growing and by promoting reproduction in others.
2. The net primary productivity is about 3,200 kcal/m<sup>2</sup>/year. The sun is the primary source of energy. The conversion of the sun's energy to chemical energy (food) takes place many meters above ground level as well as near ground level.
3. Over the years, large amounts of energy have been stored in decaying matter in the soil. Humans found this soil very fertile for growing crops.
4. It is located primarily south of the tension zone.
5. Consumers include cottontail rabbits, red foxes, American goldfinches, and white-tailed deer. Before European settlement, bison, northern flickers, bobwhite quails, and timber wolves lived here.
6. Producers from both deciduous forest and grassland communities live here. Forest plants include oaks, and grassland species include purple milkweed and wild hyacinth.

**Answer: Oak Savanna (Grassland-Forest Complex) Communities**

### Instructions

- Describe how energy helped develop this community.
- Describe how energy flows through this community.
- Indicate where this community is located in Wisconsin by placing the puzzle piece on a map of the state.

### Description

Oak savanna are characterized by open grassland areas interspersed with trees, especially oaks. Savanna, historically found in southern and western Wisconsin, were the gradation between the great prairies and the eastern deciduous forests. The savanna were perpetuated by fire. In the early 1800s, Wisconsin had perhaps 5.5 million acres (2.2 million hectares) of oak savanna.

# Biological Community Clue Cards

## Community 4

### Clues

1. Fire helps maintain this community by preventing certain plants from growing and by promoting reproduction in others.
2. The wind blows most of the year here, promoting quick water evaporation.
3. The net primary productivity is about 2,400 kcal/m<sup>2</sup>/year. The sun is the primary source of energy. The conversion of the sun's energy to chemical energy (food) takes place near ground level.
4. It is located primarily south of the tension zone.
5. Over the years, large amounts of energy have been stored in decaying matter in the soil. Humans found this soil very fertile for growing crops.
6. Consumers include thirteen-lined ground squirrels, sharp-tailed grouse, and red-winged blackbirds. Before European settlement, other consumers such as bison lived here.
7. The major producers in this community are grasses and sedges. Very few or no trees exist here.

**Answer: Grassland Communities (including prairies)**

### Instructions

- Describe how energy helped develop this community.
- Describe how energy flows through this community.
- Indicate where this community is located in Wisconsin by placing the puzzle piece on a map of the state.

### Description

Wisconsin's grassland (prairie) communities are characterized by the absence of trees and large shrubs and by the dominance of grass species. These grasslands, which grew 5,000 to 6,000 years ago after the glaciers retreated, were maintained by fire and probably by large grazing animals such as buffalo. Prior to European settlement, Wisconsin had about 3.1 million acres (1.24 million hectares) of prairies, of which almost one million acres (400,000 hectares) were a wet prairie type known as sedge meadow.

# Biological Community Clue Cards

## Community 5

### Clues

1. This community is located both north and south of the tension zone. In the north its location is influenced by past glacial activity.
2. Net productivity is around 8,800 kcal/m<sup>2</sup>/year. A wide diversity of plants and animals live here.
3. The sun is the primary source of energy. The base of some food chains in this community is detritus, or decaying plant matter, rather than living green plants. Therefore, the primary consumers are detritus eaters rather than plant eaters. Food webs are complex.
4. Producers include both terrestrial and aquatic organisms such as birch trees, spruce trees, cattails, floating marsh marigolds, and pitcher plants.
5. Consumers include both terrestrial and aquatic organisms such as sandhill cranes, painted turtles, northern pike, and muskrats.

### Answer: Wetland Communities

### Instructions

- Describe how energy helped develop this community.
- Describe how energy flows through this community.
- Indicate where this community is located in Wisconsin by using the marker to make dots all over the map.

### Description

Wetlands are lands on which soils or substrate is periodically saturated with or covered by water. Wetlands occupied an estimated ten million acres (4 million hectares)(nearly one-third of Wisconsin's land area) in the early 1800s.

# Biological Community Clue Cards

## Community 6

### Clues

1. This community is found predominantly in northern Wisconsin. Its location was influenced by glacial activity.
2. Net productivity is around 2,400 kcal/m<sup>2</sup>/year. The sun is the primary source of energy. The conversion of the sun's energy to chemical energy (food) takes place many meters above the bottom of this community.
3. Temperature differences vary greatly from the top to the ground level of this community, especially in summer. Sunlight may not reach the bottom level in many parts of this community.
4. Consumers include ospreys, largemouth bass, and ducks.
5. Producers include many types of algae, cattails, and phytoplankton.

### Answer: Lake Communities

### Instructions

- Describe how energy helped develop this community.
- Describe how energy flows through this community.
- Indicate where this community is located in Wisconsin by placing the puzzle piece on a map of the state.  
NOTE: Your puzzle piece is the same as the River and Stream puzzle piece and overlays the whole map. Point out several lakes.

### Description

When the glaciers receded, they left behind a variety of aquatic communities, including springs, ponds, lakes, streams, and rivers. Within this grouping is a wide variety of systems, differing in size, fertility, and geographic area. Wisconsin has 620 miles (992 km) of Great Lakes shoreline and more than 14,000 lakes covering a total of a million acres (400,000 hectares).

# Biological Community Clue Cards

## Community 7

### Clues

1. This community is found throughout Wisconsin. Its location was influenced by glacial activity.
2. The temperature in this community depends on its location within the state, its kinetic energy, and its size.
3. Net primary productivity is around 2,400 kcal/m<sup>2</sup>/year. The sun is the primary source of energy. The conversion of the sun's energy to chemical energy (food) takes place near the surface of this community.
4. The potential energy of the abiotic component of this ecosystem is continually being converted to kinetic energy. In some places where the amount of energy converted in this way is large, humans harness the kinetic energy to do work and to generate electricity.
5. Consumers include snapping turtles, trout, and great blue herons.
6. Producers include cattails, grasses, willows, and phytoplankton.

### Answer: River and Stream Communities

### Instructions

- Describe how energy helped develop this community.
- Describe how energy flows through this community.
- Indicate where this community is located in Wisconsin by placing the puzzle piece on a map of the state. NOTE: Your puzzle piece is the same as the Lakes puzzle piece and overlays the whole map. Point out the major rivers.

### Description

When the glaciers receded, they left behind a variety of aquatic communities, including springs, ponds, lakes, streams, and rivers. Within this grouping is a wide variety of systems, differing in size, water temperature, and geographic area. Wisconsin has more than 33,000 miles (52,800 km) of rivers and streams.

# Biological Community Clue Cards

## Community 8

### Clues

1. This community is located throughout Wisconsin, but is predominantly found in central and southern portions of the state.
2. Net productivity is around 3,000 kcal/m<sup>2</sup>/year. The primary source of energy is the sun; however, it is supplemented with fossil fuels, which can be traced back to the sun. The conversion of the sun's energy to chemical energy (food) takes place at ground level.
3. Food chains in this community are very simple.
4. Consumers include a variety of insects, cows, and humans.
5. Producers include corn, wheat, and cucumbers.

### Answer: Agriculture Communities

### Description

Agricultural lands are designed by humans to grow large quantities of food within a set location. Native Americans in Wisconsin have been using agricultural practices for thousands of years. European settlers began farming on Wisconsin soils soon after their arrival. In 1850, around nine percent of Wisconsin was agricultural. This percentage increased steadily until the 1950s when over 60 percent of the state was used for farming. With increased urban populations and more efficient, technological farming practices, the amount of land used for farming has decreased. Currently, less than 45 percent of Wisconsin is farmland. Corn and hay are the major crops and the majority of farms in Wisconsin raise milk cows and beef cattle.

# Biological Community Clue Cards

## Community 9

### Clues

1. This community is located throughout Wisconsin, but mainly in eastern and southern portions of the state.
2. The primary source of energy is fossil fuels. However, these fuels can be traced back to the sun.
3. Net productivity is negligible. Food energy sources are imported from other communities. Food chains in this community are very simple.
4. The primary inhabitants are humans.

### Answer: Human Communities

### Description

Humans have lived in Wisconsin for thousands of years. The Native Americans who lived in Wisconsin belonged to primarily hunter-gatherer societies and were also skilled in certain agricultural practices. European explorers began arriving in small numbers in the sixteenth and seventeenth centuries. Wisconsin was a non-industrial agricultural society for many years. During the second half of the nineteenth century, Wisconsin made the transition from a nonindustrial agricultural society to an industrial society. A massive inflow of European immigrants increased the Wisconsin population from around 31,000 in 1840 to just over two million in 1900. The majority of people lived in rural settings until around 1930. Wisconsin's shift to an industrial society was completed by the middle of the twentieth century. Currently, Wisconsin has a population of over five million, with around 65 percent of these people living in urban environments.

# Biological Community Update Cards

## Northern Forest Communities

The late nineteenth- and early twentieth-century loggers cut down virtually the entire northern forest. Conditions after logging were more favorable to hardwoods than to pine, resulting in limited pine reproduction after logging ceased. Today, most areas that were formerly pine are now oak, maple, and aspen, and the age structure of the northern forest is considerably different than before logging. Likewise, distribution and abundance of animals in the northern forests have been altered dramatically, with some species declining in numbers, and others finding the current forest advantageous and increasing their populations. **This group gets a new puzzle piece.**

## Southern Forest Communities

Beginning in the early 1800s, the southern forests were cleared for farming or harvested for lumber, fuel, and railroad ties. Fire was also suppressed. As a result, the southern forests today are severely fragmented into small wood lots. Remaining forest cover is heaviest in the southwest coulee (a valley with hills on either side) region. The large herbivores and carnivores originally found in the southern forest, including buffalo, elk, and cougars, are gone. These species and others were unable to survive on increasingly smaller patches of appropriate habitat, and were also affected by land development practices and over-harvest by settlers. Some bird species (notably the passenger pigeon) have been lost, and others remain in reduced numbers. **This group gets a new puzzle piece.**

## Oak Savanna Communities

Wisconsin had perhaps 5.5 million acres (2.2 million hectares) of oak savanna, virtually all of which has been destroyed for farming and urban development or has succumbed to natural succession as fire has been suppressed. Oak savanna is now virtually nonexistent in Wisconsin, with only a few remnant areas remaining. Many animal species associated with savannas have managed to find surrogate habitats such as wooded pastures, lawns, and small wood lots. Savanna vegetation has not fared as well. Many savanna plant species are now uncommon and found only on the fringes of oak woods, brushy areas, and lightly grazed pastures. Fortunately, oak savanna restoration is possible, through the use of fire and perhaps light grazing. **This group does not get a new puzzle piece (the land space covered by this community is nearly absent).**

## Grassland Communities

The grassland biological community has been degraded throughout its range, generally from farming and grazing, but also from urban development. Some prairie areas also grew up into trees and shrubs as fire was controlled. Thus, the prairie community has been severely fragmented, with only a few remnant areas left. Prairies along with oak savanna are the most endangered biological communities in Wisconsin. As a result, an estimated 15 to 20 percent of the state's original grassland flora is now considered rare. Some grassland mammals and birds fared better, using "surrogate" grasslands such as pastures for their survival needs. **This group does not get a new puzzle piece (the land space covered by this community is nearly absent).**

# Biological Community Update Cards

## Wetland Communities

Wetlands have been subject to intense modification, mainly through draining and filling for agricultural and urban development. Today, about 5.3 million acres (2.12 million hectares) of wetlands remain (less than half of what early European settlers found). Nearly all the remaining wetlands have suffered from the effects of fragmentation and simplification. **Use your marking pen to put half as many dots as before, placing most of them in the northern part of the state.**

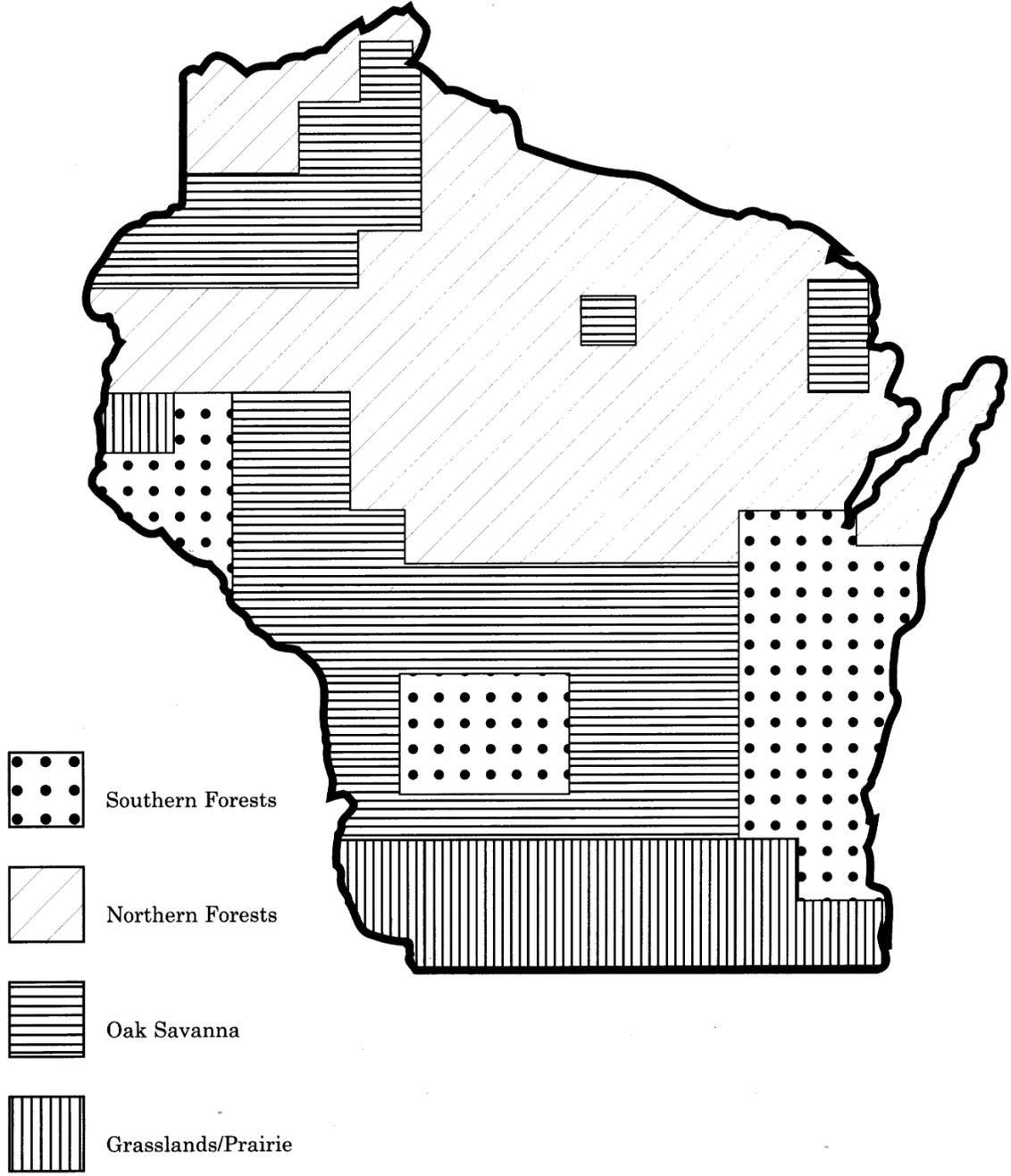
## Lake Communities

Lakes normally undergo a natural succession from oligotrophic (clear, lacking large amounts of nutrients) to eutrophic (filled with nutrients that reduce clarity of the water). This process can take thousands of years, but human activities can shorten this process to a few decades. For example, runoff containing agricultural and urban fertilizers dramatically increases the nutrient content of lake waters. **This group can use the same puzzle piece as before.**

## River and Stream Communities

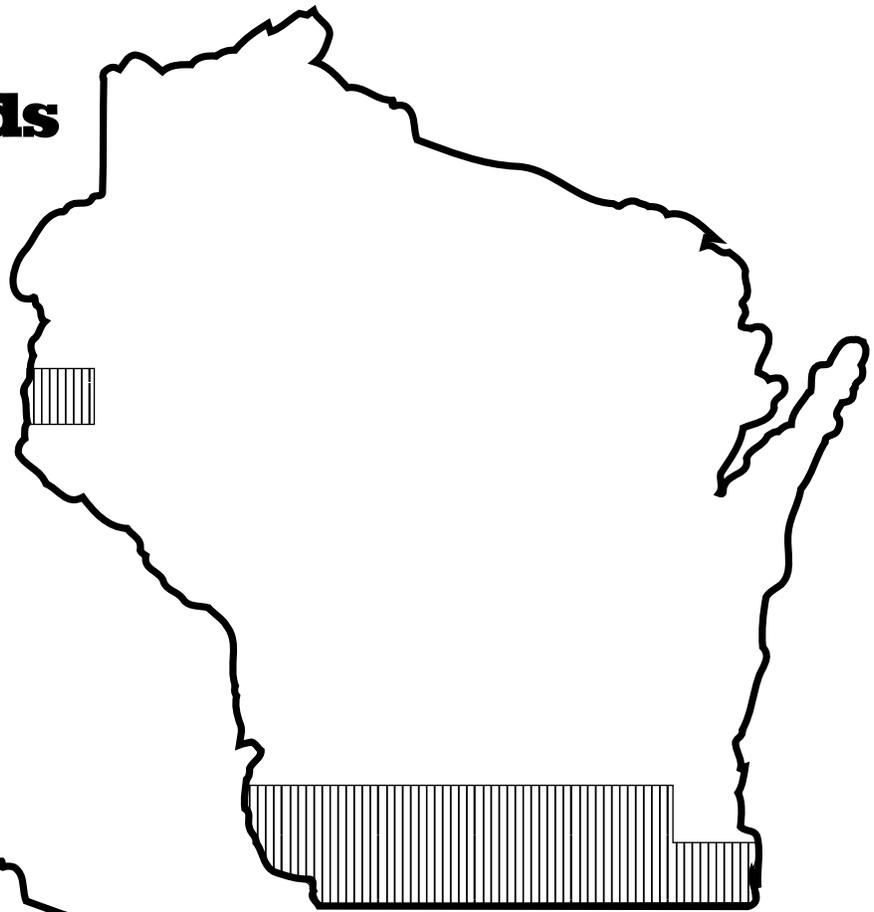
Fragmentation has been caused by dam construction. Dams block movement of fish and other aquatic organisms, isolating populations and sometimes resulting in loss of genetic diversity and eventual extirpation of species in a portion of the river. Dam construction also changes water flow and temperatures, resulting in changes in habitat that can lead to extirpation of species. Other activities that create pollution or cause simplification and fragmentation of aquatic systems include agricultural and urban development and resulting runoff, channelization of streams, shoreline development and resulting loss of habitat and spawning areas, and industrial and urban development and resulting effluent and runoff. **This group can use the same puzzle piece as before.**

# Completed Puzzle of Wisconsin's Biological Communities (mid 1800s)



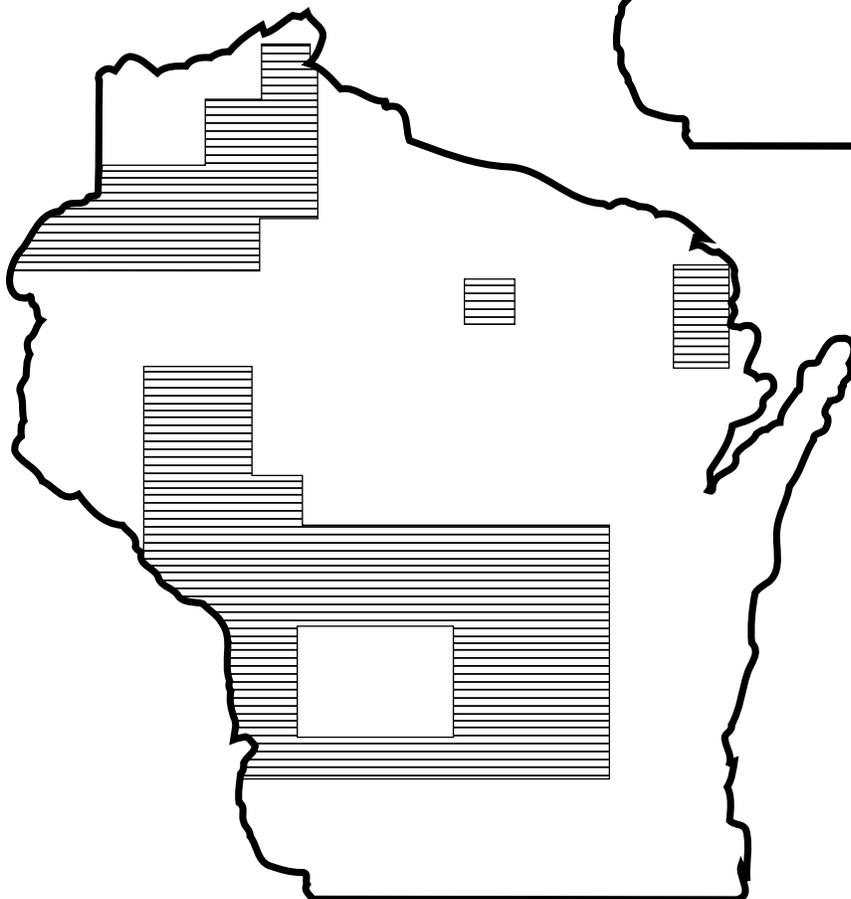
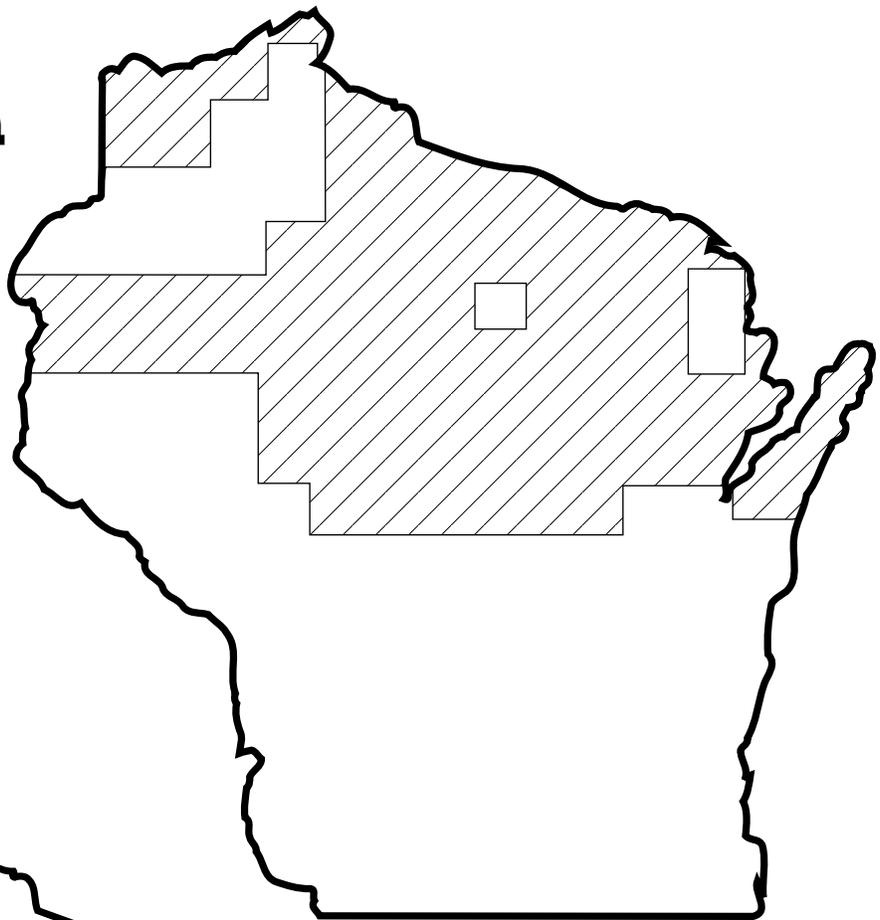
Based on: Wisconsin Department of Natural Resources. "Figure 10" pp. 46 *Wisconsin Biodiversity as a Management Issue: A Report of Natural Resource Managers*. Madison, Wisc. : Wisconsin Department of Natural Resources, 1995

## Grasslands (1800s)



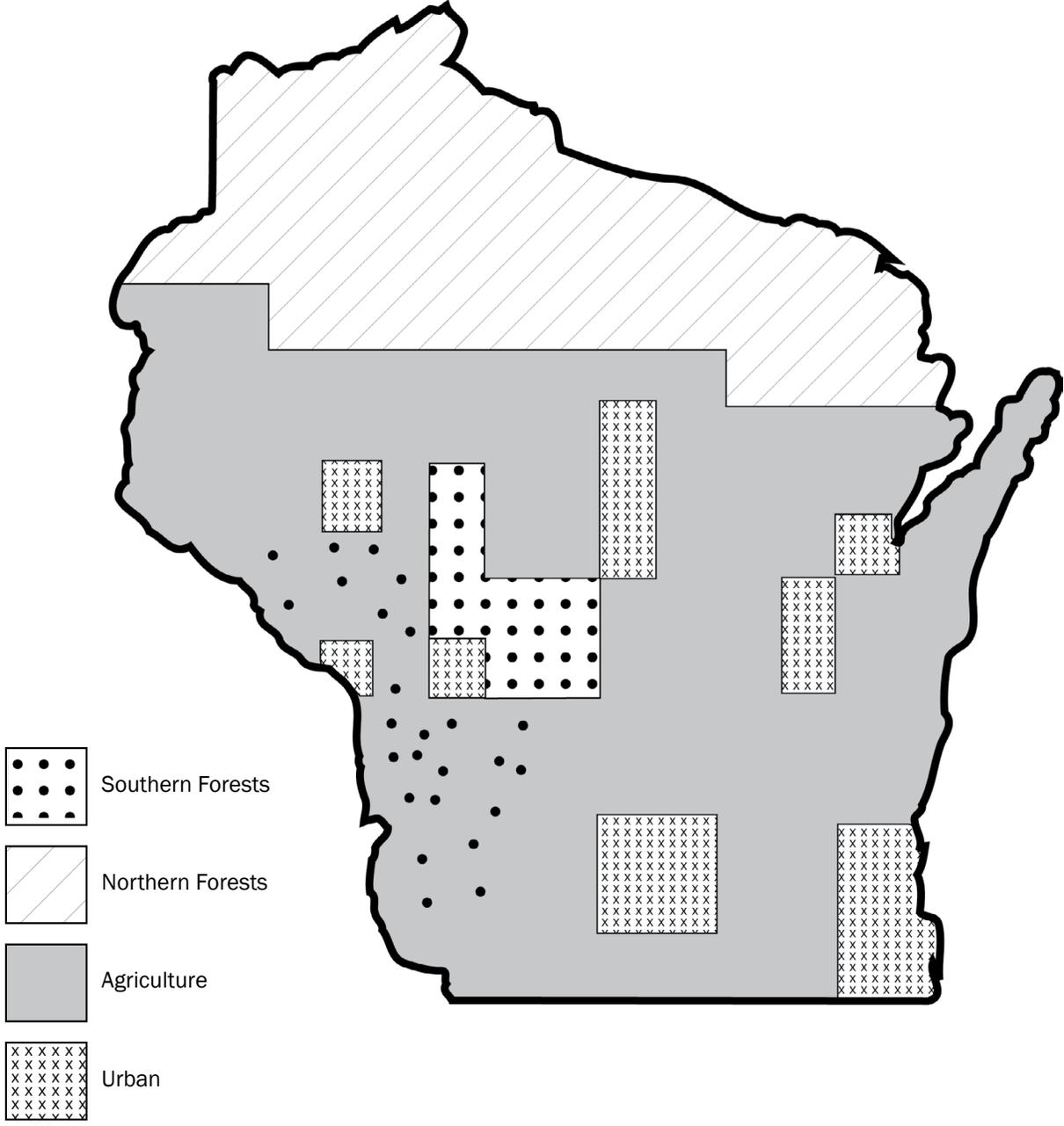
## Southern Forests (1800s)

**Northern  
Forests  
(1800s)**



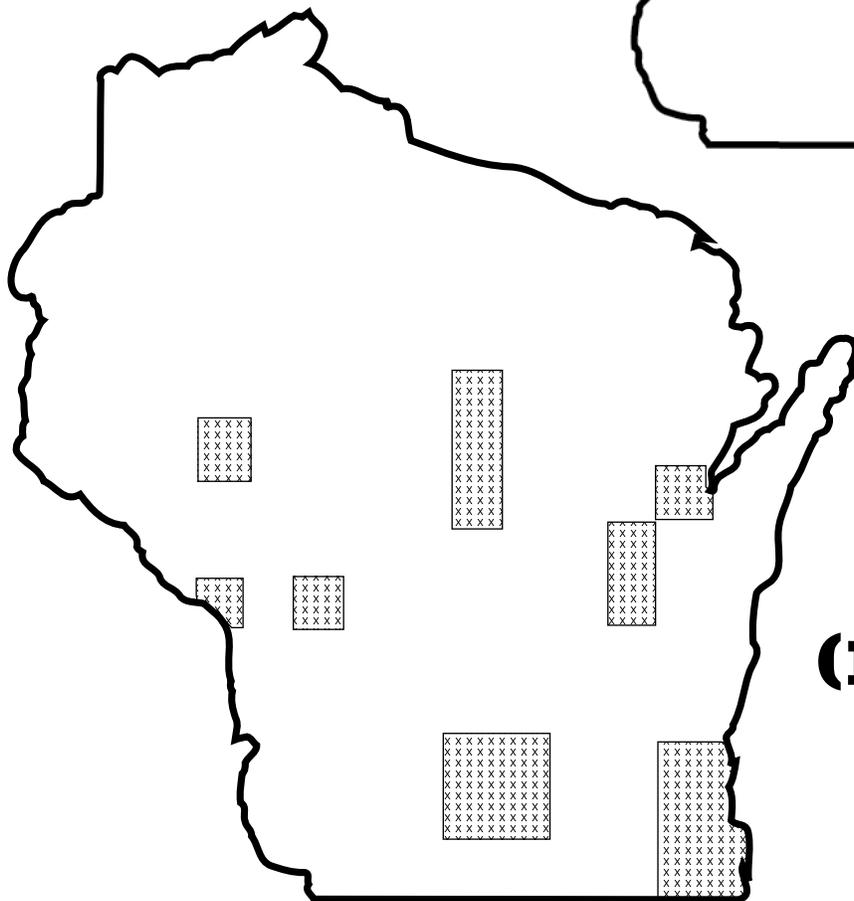
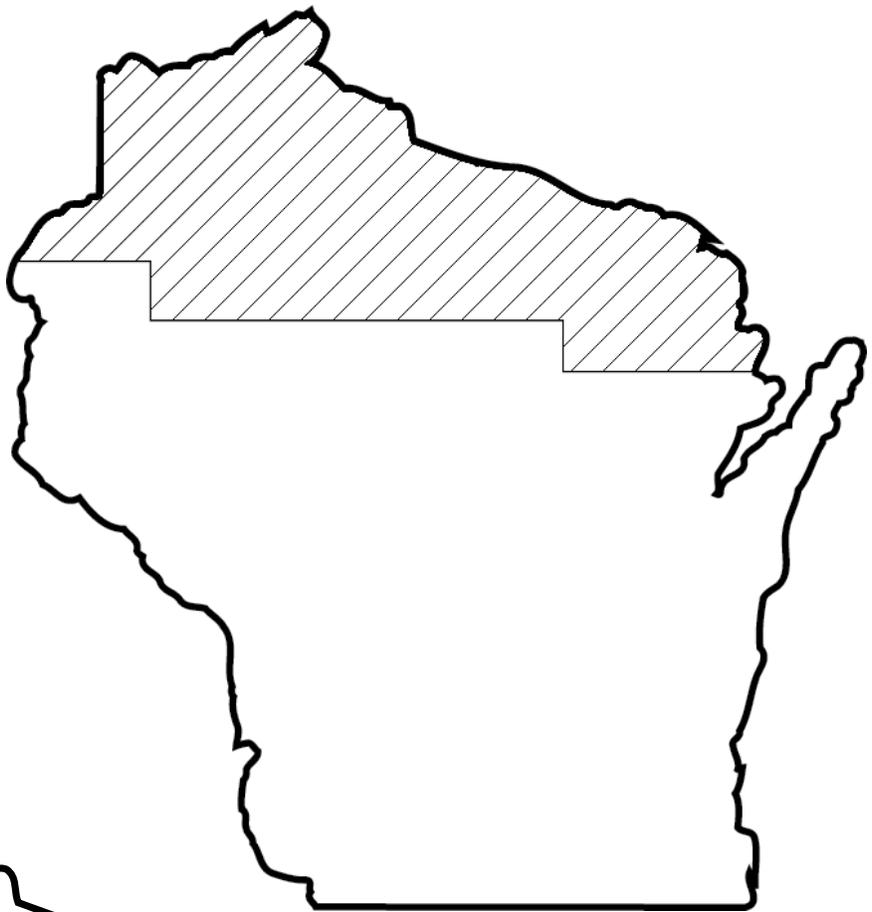
**Oak  
Savanna  
(1800s)**

# Completed Puzzle of Wisconsin's Biological Communities (1971-1981)



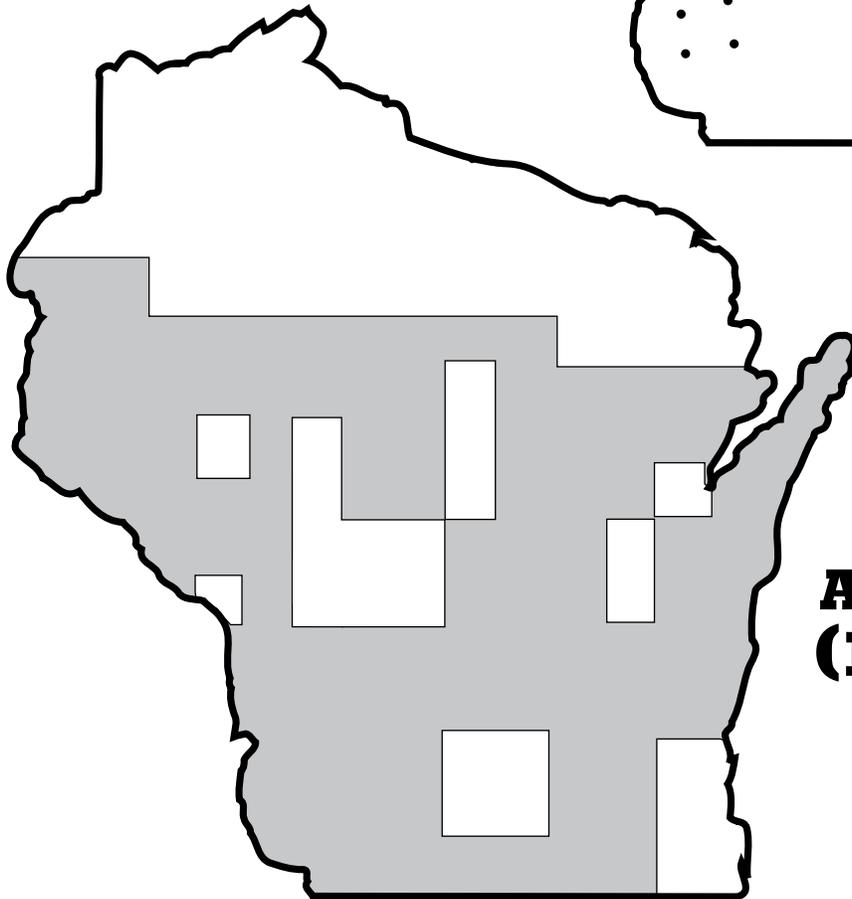
Based on Wisconsin Department of Natural Resources. "Figure 11" p. 47 Wisconsin Biodiversity as a Management Issue: A Report of Natural Resource Managers. Madison, Wisc.: Wisconsin Department of Natural Resources, 1995.

**Northern  
Forests  
(1971-1981)**



**Urban  
(1971-1981)**

**Southern  
Forests  
(1971-1981)**



**Agriculture  
(1971-1981)**