ALLIANCE *for the* GREAT LAKES

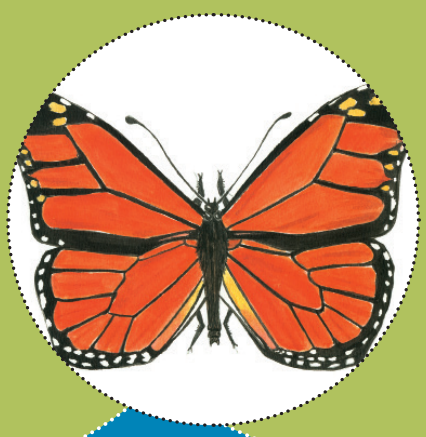
Great Lakes in My World

9–12

CONNECT | EXPLORE | INVESTIGATE | SYNTHESIZE





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ALLIANCE FOR THE GREAT LAKES

WWW.GREATLAKES.ORG

Formed in 1970, the Alliance for the Great Lakes (formerly the Lake Michigan Federation) is the oldest independent citizens' organization in North America. Our mission is to conserve and restore the world's largest freshwater resource using policy, education and local efforts, ensuring a healthy Great Lakes and clean water for generations of people and wildlife.

Great Lakes in My World 9-12

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Introduction

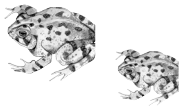
When we think of the Great Lakes, a lot of us think of home. Indeed, the first thing many of us learned in school about the Great Lakes was that we could remember the names of these vast, magnificent natural treasures by their mnemonic: Huron, Ontario, Michigan, Erie, Superior.

For those of us who work, play and live in the region, the Great Lakes are HOME. They provide a place for family getaways to local beaches and parks. They provide jobs. They provide drinking water. And, often overlooked for education purposes, they provide an example of how natural systems can both thrive and struggle depending on human decisions and actions.

Today's high school students are the next generation of scientists, engineers, educators, advocates, professionals, parents, problem-solvers . . . and more. This curriculum uses the Great Lakes as the starting point for teaching and learning while emphasizing hands-on, inquiry-based, real-world experiences. The intent of the *Great Lakes in My World 9-12* curriculum is to give students a meaningful way to learn scientific, geographic and research skills while learning about the Great Lakes – a rich, living ecosystem in its own right, and a cherished resource that defines our lives and, yes, our home.

We hope that the *Great Lakes in My World 9-12* curriculum will motivate you and your students to engage in meaningful learning about the natural world in a way that makes it personally relevant and exciting, and that lays the groundwork for a lifetime of learning about this wonderful corner of the world we inhabit.

Happy teaching,



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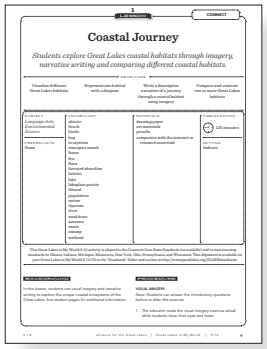
This Kit Includes:



1

Educator Instructions
guidelines for 17 activities

How to Get the Most from this curriculum

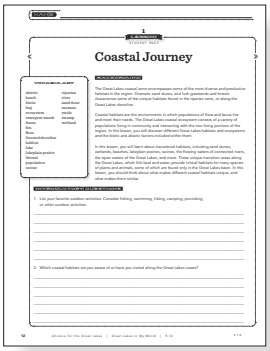
Begin with activities that CONNECT. Progress to those that EXPLORE. Allow students to finish with activities that INVESTIGATE and culminate in projects or plans that SYNTHESIZE.

CONNECT activities help students build a personal bond with the natural areas they're about to study. By appreciating and caring about these natural treasures, students will see the relevancy of their studies.

EXPLORE activities contain the unit's essential content. This is where concepts and vocabulary are shared, allowing mysteries to unfold and secrets to be revealed.

INVESTIGATE activities confront current issues facing the Great Lakes. Students analyze data and articles, weigh solutions and consider viewpoints of opposing positions.

SYNTHESIZE activities teach students to draw conclusions, integrate their learning and develop real-world solutions to protect the Great Lakes.

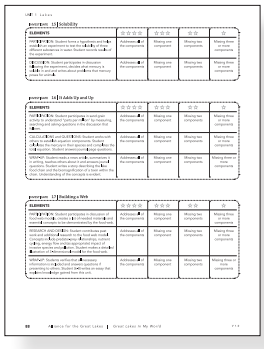


2

Student Pages
student worksheets designed in a journal format

Have students keep PORTFOLIOS, using the originals provided. Copy and distribute these pages for each student to place in a binder or folder. We recommend binders, as they provide a hard surface to write on during field trips.

The student pages provide questions and data sheets for the activities, along with space for required diagrams, sketches, essays and stories. By allowing creativity and frequent sharing, students will be excited and proud to maintain a portfolio of what they are learning. As lessons build upon each other, students will be able to refer to earlier notes. Teachers and students will both find the journals useful in reviewing the student's learning.



3

Assessment Rubrics
specific evaluation criteria for each activity

☆☆☆☆

Check student progress with the ASSESSMENT RUBRICS provided for each activity. We recommend giving each student a copy of the rubric as they begin each new activity so they understand expectations for grading. Feel free, of course, to modify them as you see fit, and perhaps even involve students as a way to increase their commitment.

4

USB Flash Drive Supplement
additional resources to supplement the activities

What you'll find on the USB Flash Drive

+ **Images of the Great Lakes** - These provide visual context for activities when a field trip is not possible
+ **Glossary** - Share this list of vocabulary terms and definitions with the students before or during the activities. Students can make flashcards, create their own vocabulary journal or learn the words using any number of study techniques.
+ **Media Articles** - You'll need these for certain activities.
+ **Learning Standards Chart** - Use the chart to identify the standards that each activity addresses.
+ **Activity Matrix** - Use this list to identify, at a glance, the activities designed for each grade level, from kindergarten through eighth grade.
+ **Student Pages** - In addition to the printed set in the curriculum book
+ **Assessment Rubrics** - Use the benchmarks provided for each activity to help you evaluate students' progress.
+ **Set of Creature Cards** - A set at these 66 Great Lakes creature cards that can be printed out
+ **Resource List** - For additional background and support materials, this is a great collection of helpful websites, agencies, books, etc.


Great Lakes In My World
Resource List

Books (K-5) (alphabetical by title)

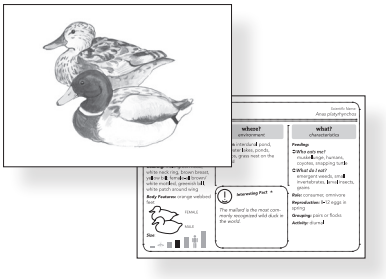
Books (6-8 and Educators)

5

Resource List
additional resources to supplement the activities

What you'll find on the Resource List

For additional background and support materials, this is a great collection of helpful websites, organizations, agencies, books, etc. Use this list to find resources for students' research or additional background for units and activities.



6

Creature Cards (optional)
illustrations and information on 66 notable plants and animals

How to use the Creature Cards

These 66 cards of plants and animals can be used to supplement a variety of the activities. See the list provided with the Creature Cards for specifics. You may also use them as flashcards, for background information, for research, as a tool for charades or have students sort them into various groups (by type, kingdom, class, habitat, role in food web, etc.). With two sets, students can play a variety of card games such as Memory, Go-Fish, Old Maid or Rummy.

We value your thoughts and feedback on Great Lakes in My World 9-12. Please let us know about any oversights, errors or omissions you find, or if there are things you or your students particularly like.

Send your comments to: education@greatlakes.org

Some Notes on Our Philosophy

Every educator has his or her own style of teaching, and we've designed this program with that in mind. Likewise, every student has his or her own style of learning, and we've given great consideration to that, too. Here is some brief background on the key teaching theories employed in this curriculum. We hope you find it helpful.

➜ A SENSE OF PLACE

At the root of a flourishing relationship between a young person and the Great Lakes ecosystem is the ability to acknowledge and build upon connections with places. "If you don't know where you are, you don't know who you are," says author Wendell Berry. We encourage students to explore their personal connection to the landscape. Ecosystems evoke feelings. Acknowledging that a place holds meaning, and inquiring about its special characteristics, gives new definition and importance to the word "home."

Through these activities, students ask questions that explore the science, history, beauty and mystery of the Great Lakes watershed. This moves students toward developing a greater sense of place—a connection to the lake through new awareness, reflection and experience. As students build relationships with the ecosystem, they gain a new understanding that can inspire a lifetime of learning and care.

➜ INQUIRY-BASED ACTIVITIES

This curriculum encourages students to learn through asking questions and finding answers. Students are challenged to formulate their own questions and find ways to answer them. In order to answer their questions, students must come to understand the concepts and material involved. They develop essential problem-solving skills.

Inquiry-based learning can be challenging to plan, as questions and solutions are driven by the students. This curriculum supports teachers in their planning by constructing an inquiry-driven learning process and by suggesting projects and models students are likely to come up with.

➜ A POSITIVE FOCUS

Environmental issues can be daunting to students of all ages. According to educator David Sobel, author of "Beyond Ecophobia: Reclaiming the Heart in Nature Education," when students are confronted by environmental issues, they may become overwhelmed and turned off. An ethic of care is more likely to develop if students are allowed to first find joy in the natural world, especially if it is in a local context. As their world view expands, from local to regional to global, students will have an easier time making connections.

NOTE: In presenting an issue to students, it is important that they understand both the concepts and their own ability to make positive changes.

➜ A PROBLEM-SOLVING APPROACH

For older students, a problem-solving approach to learning about environmental issues can turn negative topics into positive experiences.

In these activities, students learn what they can do to keep their local ecosystem healthy. They become both researcher and problem-solver, and by doing so they become empowered to take action that can impact the future of their own community. This is known as "authentic learning." Unlike simulated problems, real issues provide truly meaningful experiences for students. Student involvement in local issues can lead to mutually beneficial partnerships with the community, and can even lead to revitalization projects.

NOTE: When presenting issues to students, endeavor to provide balanced and complete information. Informed decisions take effort, and here is an opportunity for students to discover the difference between a superficial review and a deep exploration.

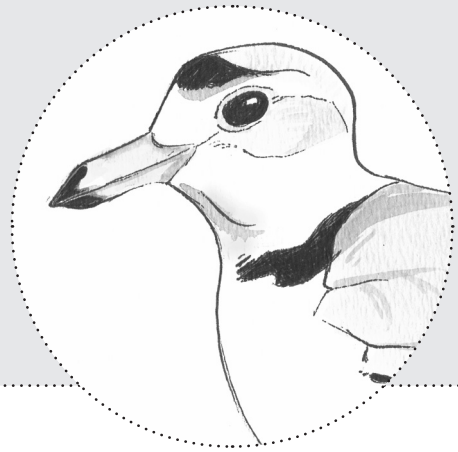
➜ SERVICE LEARNING

Several activities in this curriculum use service learning—a method by which students develop new skills through participating in a community service project that is integrated into the curriculum. These are thoughtfully organized activities that support an academic curriculum while meeting actual community needs.

➜ LEARNING FOR UNDERSTANDING

Though these activities teach material specific to the Great Lakes, their broader aim is for students to understand core principles that they can apply to other ecosystems. Assessments reflect this emphasis on understanding the big-picture concepts.

Great Lakes in My World 9-12



essential questions

- **How was the Great Lakes watershed formed and how have the coastal habitats changed over time?**
- **How do human communities and the Great Lakes coastal habitats affect each other?**
- **Why should humans work to restore and enhance Great Lakes coastal habitats?**
- **How can humans have a positive influence on the region?**
- **What are the regional benefits of a healthy Great Lakes system?**

curriculum overview

Students experience and discuss their connections to the Great Lakes. Concepts are explored first through the understanding of place, followed by the role humans play in the Great Lakes watershed and then to an understanding of the coastal ecosystems. Students reflect on and examine how human relationships with the environment affect Great Lakes' communities. Through mapping, technology and research, students study how human and wildlife needs are met within the Great Lakes region. Students learn about the interplay and balance essential in maintaining a healthy relationship with the Great Lakes. A field trip to a coastal habitat allows students to collect and analyze data through observations of plants and animals in the native habitat. Students explore the biodiversity and the abiotic components of an ecosystem and explore how urban ecosystems are dependent on water resources. Through data analysis and synthesis, students investigate issues that face the Great Lakes and the human role in creating, perpetuating and helping to solve these problems. Students study careers related to the Great Lakes region and plan and implement service-learning action projects related to coastal habitat restoration.

concepts

- The Great Lakes serve the region in many ways. To fully appreciate this ecosystem, it is important to understand the ways in which plants, animals, people and their communities depend on the lakes.

- Coastal habitats contain tremendous biodiversity and are essential for the healthy functioning of the Great Lakes ecosystem. They are made up of connected, yet diverse, microecosystems formed by sunlight, wind and waves, and change over time.

- Humans can both create and solve problems for the Great Lakes. In order to conserve, restore and have a healthy relationship with our Great Lakes, we need to understand the impact our actions have on them and develop skills to restore this vital ecosystem.

- Great Lakes stewardship is essential for the long-term health of the ecosystem. Fostering a connection to the ecosystem and taking action, whether through restoration, education, speaking out or a career choice can help achieve healthy Great Lakes.

Great Lakes in My World 9-12

A high school curriculum focused on understanding and stewarding Great Lakes coastal habitats

CONNECT

EXPLORE

INVESTIGATE

SYNTHESIZE

Coastal Journey

Students explore Great Lakes coastal habitats through imagery, narrative writing and comparing different coastal habitats.

OBJECTIVES

Visualize different Great Lakes habitats	Represent one habitat with a diagram	Write a descriptive narrative of a journey through a coastal habitat using imagery	Compare and contrast two or more Great Lakes habitats

SUBJECT
Language Arts, Environmental Science

PREREQUISITE
None

VOCABULARY
abiotic
beach
biotic
bog
ecosystem
emergent marsh
fauna
fen
flora
foredune
forested shoreline
habitat
lake
lakeplain prairie
littoral
population
ravine
riparian
river
sand dune
savanna
swale
swamp
wetland

MATERIALS
drawing paper
art materials
pencils
computers with the internet or research materials

TIME/DURATION
120 minutes

SETTING
Indoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

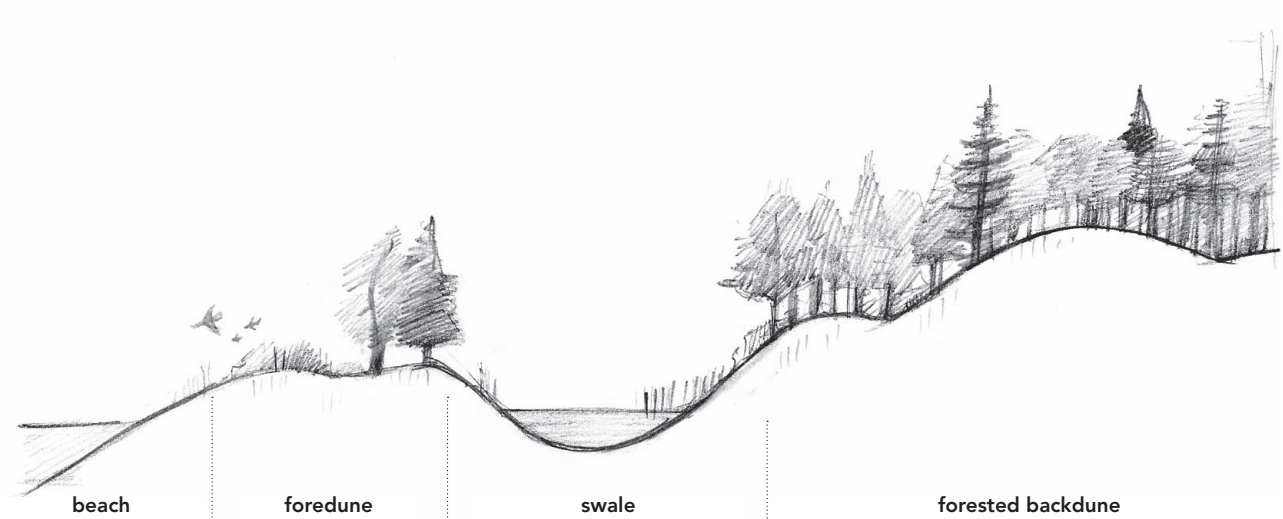
In this lesson, students use visual imagery and narrative writing to explore the unique coastal ecosystems of the Great Lakes. *See student pages for additional information.*

PROCEDURE

VISUAL IMAGERY
Note: Students can answer the introductory questions before or after this exercise.

1. The educator reads the visual imagery exercise aloud while students close their eyes and listen.

COASTAL HABITATS DIAGRAM



beach	foredune	swale	forested backdune
bronze tiger beetle	antlion	Canada goose	American beech
herring gull	beach pea	dragonfly	bald eagle
ladybug	beach wormwood	eastern box turtle	black oak
piping plover	common milkweed	great blue heron	gray squirrel
sea rocket	eastern hognose	mallard duck	pileated woodpecker
spotted sandpiper	Fowler's toad	mosquito	poison ivy
	hairy puccoon	water strider	red fox
	Lake Huron locust		song sparrow
	little black ant		white tailed deer
	marram grass		
	monarch		
	Pitcher's thistle		
	riverbank grape		
	sand cherry		
	snake		
	wolf spider		

DUNE HIKE

Imagine you are at the beach. Even if you have never been to a beach, think about what it would be like. Your bare feet push into the cool, wet sand, which feels soft under your toes. You hear waves crashing into the shore. As you walk away from the water, you see hills of sand, called sand dunes. They are beautiful and mysterious, and they beckon to you, inviting you to explore them. You wonder how far you might be able to see if you climbed to the top.

There are long green and brown grasses growing on these massive sand dunes. These grasses seem to draw you towards them. There is a path leading up the side of one of these hills. You decide to follow it. The sand is very warm and dry on your feet. The sound of the waves grows dim. It becomes very quiet. You feel the wind in your hair. Notice that your hair is not the only thing affected by the wind. The sand is, too. You watch some sand grains skipping along, until they are all captured by the tall marram grass on the hill. This first dune, nearest the lake, is called the foredune.

As you walk along the path, you see that the dunes create a series of hills that lead away from the beach. You wonder where all of this sand came from. As you continue to walk, the sun shines warmly on your skin. The only sound you hear is that of a gull calling in the distance. Notice that the dune now dips down into a low area, called a swale, which has water in it. It has a low area called a trough that is filled with water and plants. You cool your feet in the water and wonder what sorts of animals might live in the dunes or might be living in this pond in the trough.

Your heart begins to pound as you climb the second hill of sand, and when you reach the top you turn and look toward the lake. The spot on the beach where you once stood seems so small and you can see far over the lake.

You feel as if you have the vision of a bird high in the sky. You turn to continue your journey across the dunes. Hike up and down the hills until you enter a shady forest. Sit down under a black oak tree in the backdune forest and take a rest from your hike. As you listen to song sparrows singing from their nest in a nearby shrub, you notice that even here, in the woods, it is sandy.

2. On a separate piece of paper, students draw part of, or the whole, journey they made in their imaginations. Have them write one or two words that describe how the journey made them feel.

3. After students finish drawing, the educator draws a side view of the "journey" (lake, beach, foredune, trough, and backdune) on the board, or uses a projector to share the image from this lesson with the students. Explain to students that some areas around the Great Lakes have the same type of sand dune ecosystem that they just "hiked" through. Ask students to identify which area(s) they illustrated (according to the diagram) and what type of flora/fauna they would expect to find in that habitat. Students are to label their drawings with these areas.

OBSERVATIONAL WRITING

4. Students select one Great Lakes habitat (from the vocabulary list or from a list you create as a class) and write a narrative essay that details their observations during a "Habitat Hike." This could be a walk through another ecosystem, such as a lakeplain prairie, emergent marsh or forested shoreline, or they could swim through the lake ecosystem.

5. Students complete the pre-writing graphic organizer (see student page). Students use imagery to detail the observations they would make while exploring a particular coastal habitat. Students focus on their observations, using the five senses, as they "walk" or "swim" through a coastal habitat. They can use books or the internet (see resource list) for research, searching for the information they need to complete the graphic organizer.

6. Each student writes a "Habitat Hike" narrative essay that answers the following questions: What native plants and animals do they see? What is the temperature? How do the animals they see and the students themselves move through the ecosystem?

WRAP-UP

7. Each student shares his/her "Habitat Hike" narrative with a peer. When sharing, students will note the similarities and differences between the different ecosystems. As a class, discuss what makes the different coastal habitats unique and similar. How are they dependent on one another? How might a positive or negative influence impact the habitat? If time permits, several students can share their narratives with the class.

8. While students present their "Habitat Hike" stories, the other students complete the Venn diagram (see student page). Each student selects one other coastal habitat which with to compare and contrast their coastal habitat. Their comparison should focus on characteristics such as location, climate, geographic features and native species. Students also select at least one additional characteristic to compare and contrast.

9. Most of the sand dunes in the Great Lakes basin occur along the east side of Lake Michigan in Michigan and on the south side of Lake Michigan in Indiana. Show students a map that includes this area, or use the internet to look at maps online (see resource list for more information). Have them locate Lake Michigan and the area where the dunes are found. Additional dunes are found in Wisconsin, on the northern portion of the Illinois shoreline, and throughout Northern Ohio along the lake. Also, there is a smaller complex of dunes from Maumee Bay to Pennsylvania, which is largely paved over but can still be identified by the road names (i.e. Ridge Road). Students can locate these spots, as well as emergent marshes, ravines, lakeplain prairies, forested shorelines, wetlands or other coastal ecosystems along the Great Lakes coast or in their local community. Discuss what makes each of these coastal habitats unique, and what makes them similar. What plants and animals might students find in each of these habitats?

EXTENSION

A. Students create a book, either written and illustrated for children or illustrated as a scientific magazine, detailing their observational hike through a coastal ecosystem.

B. Students create a poster or collage for their particular habitat with quick facts to post on classroom walls for later reference.

C. Use GIS or Google Maps to research different habitat landscapes and provide a report or presentation on the visual aspects and features.

ASSESSMENT

See rubric on page 15.

RESOURCES

Please see Resource List for additional information related to organizations, sand dunes, wetlands and more.

NAME: _____

1
LESSON
STUDENT PAGE

Coastal Journey

VOCABULARY

abiotic
beach
biotic
bog
ecosystem
emergent marsh
fauna
fen
flora
foredune
forested shoreline
habitat
lake
lakeplain prairie
littoral
population
ravine
riparian
river
sand dune
savanna
swale
swamp
wetland

BACKGROUND

The Great Lakes coastal zone encompasses some of the most diverse and productive habitats in the region. Dramatic sand dunes, and lush grasslands and forests characterize some of the unique habitats found in the riparian zone, or along the Great Lakes shoreline.

Coastal habitats are the environments in which populations of flora and fauna live and meet their needs. The Great Lakes coastal ecosystem consists of a variety of populations living in community and interacting with the non-living portions of the region. In this lesson, you will discover different Great Lakes habitats and ecosystems and the biotic and abiotic factors included within them.

In this lesson, you will learn about transitional habitats, including sand dunes, wetlands, beaches, lakeplain prairies, ravines, the flowing waters of connected rivers, the open waters of the Great Lakes, and more. These unique transition areas along the Great Lakes, which link land and water, provide critical habitats for many species of plants and animals, some of which are found only in the Great Lakes basin. In this lesson, you should think about what makes different coastal habitats unique, and what makes them similar.

INTRODUCTORY QUESTIONS

1. List your favorite outdoor activities. Consider fishing, swimming, hiking, camping, picnicking, or other outdoor activities.

2. Which coastal habitats are you aware of or have you visited along the Great Lakes coasts?

GRAPHIC ORGANIZER

Coastal Habitat:_____

SIGHT What do you see? What plants or animals do you see? What is on the ground? Are there water sources? How much light do you see?

_____

_____

_____

_____

_____

SOUND What do you hear? What animal noises do you hear? What sounds do your feet make as you walk or swim through the habitat? Do you hear the wind or waves? What sounds are made by leaves or grasses moving in the wind?

_____

_____

_____

_____

_____

TOUCH What are you able to touch? What is the temperature? Is there humidity in the air? What do your hands feel as you walk through the habitat? What do your feet feel? Is the habitat wet or dry?

_____

_____

_____

_____

_____

SMELL What do you smell? Do you notice any fragrant, flowering plants?

_____

_____

_____

_____

_____

TASTE What (if anything) do you taste? Did you find any edible plants along your "hike"?

_____

_____

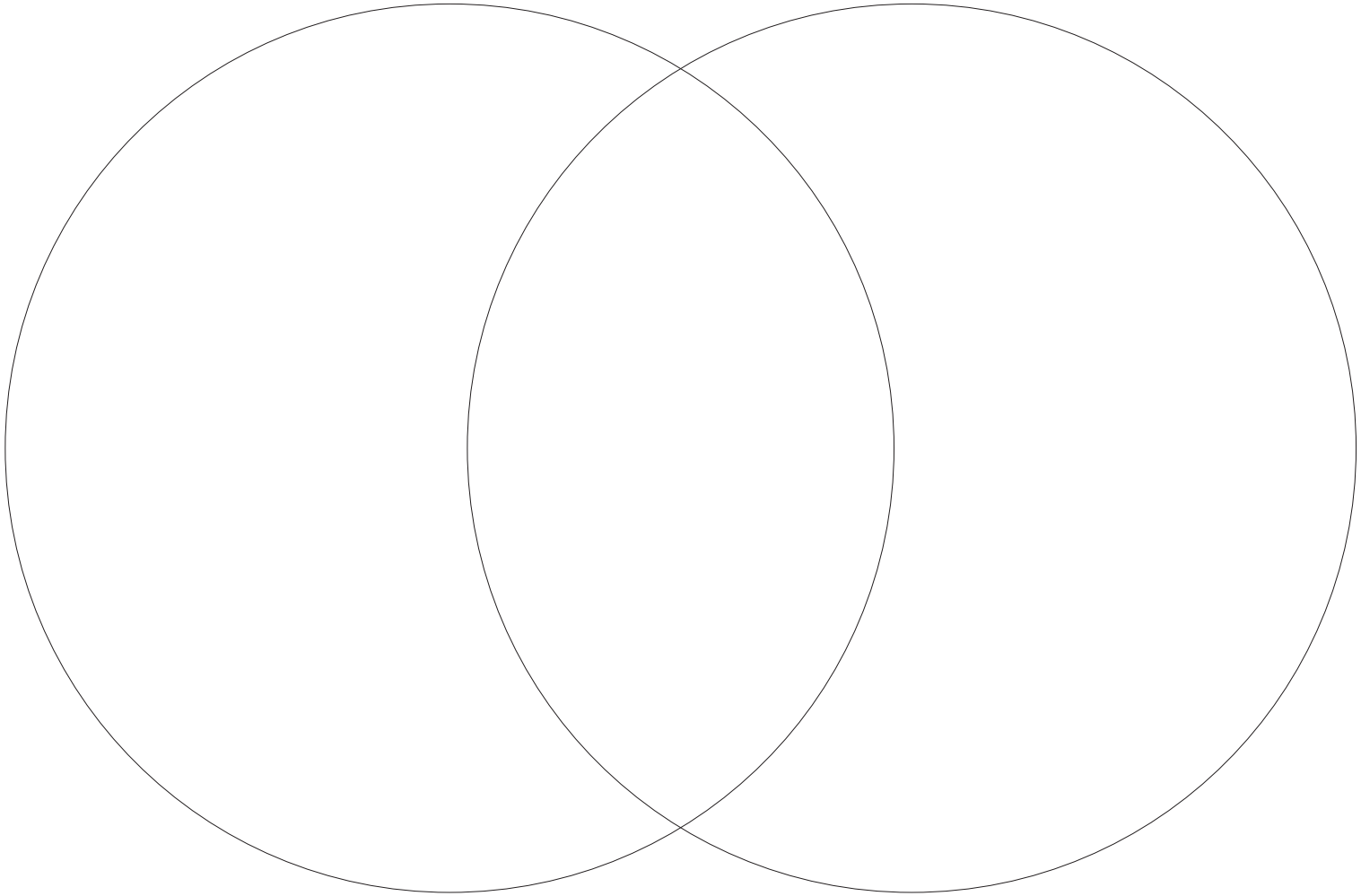
_____

_____

_____

My Coastal Habitat: _____ Another Coastal Habitat: _____

Compare and contract these two habitats according to these characteristics: Plants (flora), animals (fauna), location, climate, other features



NARRATIVE WRITING ASSIGNMENT

3. Write a narrative essay of your observations as you "explore" your coastal habitat. Compose this essay on a separate page, or on a computer.

WRAP-UP QUESTIONS

4. What makes different coastal habitats unique and similar?

_____

_____

_____

5. How are coastal habitats dependent on one another? How are plants, animals and humans dependent on these habitats?

_____

_____

_____

_____

6. What are two new things you learned about the Great Lakes coastal habitats? What additional questions do you have about Great Lakes coastal habitats?

_____

_____

_____

_____

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
DISCUSSION: Student contributes any prior knowledge of coastal habitats to the discussion. Student uses active listening skills (eye-contact, confirming or referencing others' comments, affirmative gestures or comments).	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
LISTENING: Student attentively listens to the description of the coastal journey without distracting others. Personal investment is obvious.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
DRAWING: Student draws a representation of her/his imagined dune journey and reflects on which part of the dunes s/he drew. Students share drawing with a partner.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
ESSAY: Student completes the pre-writing graphic organizer and then writes a narrative essay. Essay has a central theme developed throughout. Student explains and illustrates the unique characteristics of the coastal habitat. This includes sensory or observational details related to all five senses. Essay has minimal spelling and grammatical errors. Sources are cited.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
COMPARE AND CONTRAST: Student completes the graphic organizer to compare and contrast two coastal habitats on all five characteristics.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
WRAP-UP: Student demonstrates an overall understanding of coastal ecosystems of the Great Lakes by answering the wrap-up questions and reflecting on their own learning.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

A Sense of Place

Students draw maps of their local area, weaving in the importance of the Great Lakes.

OBJECTIVES

Develop a personal map relating students' location to the nearest Great Lake

Explore students' local area and the Great Lakes Basin using a variety of maps

Draw a map of the school grounds that includes elements, such as a title, legend, scale, cardinal directions and labels

SUBJECT
Geography, Math

PREREQUISITE
None

VOCABULARY
cartography
Geographic Information System
map
mental map
physical map
political map
topography

MATERIALS
paper
a variety of maps (see procedure and resources list)
8.5" x 11" tracing paper
ruler for each student
tape measurer for the class (if needed)
colored pencils or markers

TIME/DURATION
120 minutes

SETTING
Indoors/Outdoors, Classroom, Computer lab

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

As the poet and bioregionalist Wendell Berry says, "If you don't know where you are, you don't know who you are." This activity focuses on using a variety of maps to understand and identify your location within the Great Lakes Basin. Students will be able to create their own map or visual representation of their local area. Mapmaking is a skill used in many school subjects, including language arts (story mapping), social studies (geography), and science (topography). It is also a skill needed by community planners, engineers, surveyors and those traveling to new places.

Educator David Sobel says, "Mapmaking, in the broad sense of the word, is as important to making us human as language, music, art and mathematics. Just as young children have an innate tendency to speak, sing, draw and count, they also tend to make maps. … The stories of their lives are folded into the niches of their neighborhoods; their maps are the weaving together of inner emotion and external forays." *(Mapmaking with Children: Sense of Place Education for the Elementary Years,* David Sobel, Heinneman 1998).

In this lesson, students will use mental mapping and look at local maps to develop their spatial reasoning abilities, their mapping skills and a greater sense of place – a connection to the Great Lakes – through new awareness, reflection and experience. Mental maps (or "sense of place" maps) show a location's shape and the mapmaker's context in relation to his/her surroundings. Not only is this type of map geographically accurate, but it also tells the story of a place from the point of view of the mapmaker(s). Kevin Lynch says, "A common exercise in urban design and urban planning courses is to ask students to draw a map of their neighborhood or city (or of a common geographical area such as the university campus) in order to develop a better understanding of the differences between the physical map and layout of an area and how people actually perceive the same area." (*The Image of the City*. Boston: The M.I.T. Press. http://dels-old.nas.edu/dels/rpt_briefs/learning_to_think_spatially_final3.pdf, 1960)

These maps are an introduction to community planning and to the Great Lakes region. Students will learn (or review) the key components of maps and create their own maps of their local area. These community-based maps will build a link between students and their physical surroundings and help them make sense of their world. The basic premise is that the better we know our communities and experience our connection to them, the more willing we are to act to ensure that they are socially- and environmentally-healthy places to live. Students begin to learn how to translate spatial reasoning in the form of cognitive maps into standardized maps. Students will learn to appreciate the differences and similarities between their perspectives and those of their classmates. They start to grasp spatial concepts, including location, distance, relationships and networks, and they learn which key components are included in a wide variety of maps.

PROCEDURE

INTRODUCTION

Students read background information and answer introductory questions on the student pages which ask them to name three or more different types of maps and describe what elements most maps include.

PART ONE: MENTAL MAPS

1. Ask students to picture their neighborhoods. Have them think about where the following things are located in relation to each other: their school, home and the nearest Great Lake. Also, have them think about what they like and don't like about their neighborhood. What features make their neighborhood unique? What helps them feel good about their community?

2. Students follow the directions and answer the questions on the student pages. Each student will draw a mental map of his/her neighborhood, which includes his/her school, home and the nearest Great Lake. They should each think of their map as a personal recollection of a space, or as a mental map, rather than as a geographical map. Students draw these maps from memory, rather than with physical measurements.

Please see example below.

a. Students first brainstorm a list of 10 to 15 important landmarks in their neighborhood and/or near their school. Students should include several of these landmarks on their maps. They may also include natural objects, plants and animals and their habitats.

b. In the center of their mental maps, students draw their school or home. Note: If all students choose to place the school in the center, all of the maps will have a common starting point, which can lead to a discussion of what makes each person's mental map unique and similar. See Kevin Lynch's *The Image of the City (1960)* for research on the common features of students' mental maps.

c. After drawing the places on their maps, students then make connections between features of the map, by identifying what makes these places important and how they are interconnected. For example, a student may draw an arrow from their school to the park and from the park back to the school. The student would then write "place to play, socialize, explore" and/or "nature, family" to explain the connection and the importance.

d. There is no right or wrong way to make these mental maps. Things that are more important to students may naturally be more prominent in their maps. They may go into as much detail as they like and as time allows.

3. Discussion:

a. Allow each student to present his/her mental map to large or small groups. Ask students about the prominent features in their maps. Why are these features important?

b. Students answer wrap-up questions on their student pages: Ask them where the lake is, and how far they think it is from their school and homes. Ask students if they have visited the lake. Ask if they consider the lake to be a part of their neighborhoods. Why or why not?

PART TWO: LOOKING AT LOCAL MAPS

4. As a class, review some basic map-reading skills, including how to use the key, the scale and the cardinal directions.

5. Break students into groups of four. Distribute one map of the local area to each group. If possible, distribute different types of maps to each group (e.g. transportation map, topographical map, zoning map, land-use map, natural resources map, navigation map, bathymetric map, utilities map). You can also distribute maps from different years to show that maps are dynamic, not static.

6. Discussion: Ask students to think about why we have so many different types of maps. Why doesn't one map include roads, land use, zoning, natural resources, topography and utilities? *The answer is that maps have various purposes. They model the world in order to be useful, and if there is too much information on one map, it is no longer useful.*

7. In their groups, have students circle the following things on their local map: their school, their homes, their local Great Lake and any local coastal habitats (i.e. sand dunes, coastal wetlands) and/or shoreline (cliffs, beach).

8. Students should also circle or discuss the common elements of these maps, including the title, key/ legend, cardinal directions or north arrow, scale and labels.

9. Discussion:

a. Describe the route from your school to the nearest Great Lakes beach or shoreline. Note: If the school or the students' homes are far from a Great Lake, this discussion will be more difficult, but still possible.

b. What method of transportation do you use to get to the lake from school or home? In which county do you live? In which aldermanic ward or senatorial district?

c. What makes living near a Great Lake interesting? If you don't live near a Great Lake, choose the lake that your state borders and discuss why you would want to visit it (identify natural, cultural and geographic features).

d. Students answer questions on the student pages: What different types of maps did you see in class? What common elements did these maps have?

PART THREE: MAPPING THE SCHOOL

10. Each student maps out the school grounds, either on-site or from memory. Each student will have one 8.5" x 11" piece of paper (plain white or graphing paper) on which to draw their map and can use drawing/art materials.

11. These maps should display the unique aspects of the school and the school grounds. To integrate mathematics, students should include the ruler measurements and the scale.

12. After creating these maps, the teacher can bring up an aerial map of the local place on a projector or interactive whiteboard. Students should compare their maps of the school grounds to the aerial image of the area.

13. Discussion: Ask students to think about the features shown on the aerial map and those they included in their maps of the school grounds. Did they include any habitats for animals? Do animals live on their school grounds? What other features were included in these maps? Do these maps show elevation, heights or depths? *No.* Why not? *They are one-dimensional.* Have students think about why it could be important to have two-dimensional or even three-dimensional maps.

14. Use Google Earth to print an aerial map or image of the school grounds. How does this bird's eye view compare to the mental maps that students have drawn of the school grounds? Have they forgotten to include any of the features of the school grounds?

WRAP-UP

15. As a class, look at a large map of North America. Use the map to identify important features of the local area, the distance from the school to the nearest Great Lake and other features.

16. Discussion: What states or provinces does your Great Lake border? How many states or provinces border the Great Lakes? The Great Lakes have approximately 10,900 miles of coastal shoreline. How does this compare to the Atlantic Ocean coastline on the eastern edge of our country? *The Atlantic coastline is 2,165 miles long, which is less than 1/5 the length of the Great Lakes coastal shoreline.*

17. Point out the Great Lakes watershed or the Great Lakes Basin using a map of the region, or using the "The Great Lakes Watershed" map on the USB. Point out that the entire coastal shoreline is part of the watershed, but that some cities and states are only partially included in the watershed. What else do the students notice about the watershed?

18. Select a city in the United States. Use road maps, a Web-based mapping program or Google Earth to calculate its distance from the Great Lakes. Compare this with the distance from the lake to your school.

19. Look again at the mental maps. Were students' perceptions of their proximity to the lake correct? How does the location of the lake influence experiences with it? If some of their maps include plants, animals or their habitats, discuss why they are not included in the local maps that you looked at.

20. Discussion: What makes a good map? How does the purpose of the map influence its design?

21. Students answer wrap-up questions on the student pages: Which Great Lake is nearest to you? Which state(s) or province(s) does your nearest Great Lake border? How does the location of the lake influence your experiences with it? Include your ideas on how a location's proximity to the Great Lakes could influence recreation, municipalities, transportation, tourism, industry and more. What habitats are found along the Great Lakes coastline? What types of organisms live in and around the Great Lakes?

EXTENSION

22. Students can visit the website: http://maps.google.com, and then type in any location to see what that land looks like on satellite photo images. Have the students discuss the similarities and differences among the lakes. Ask them to write these down in their own notebooks, or on a classroom chart. Develop a table with "differences and similarities" forming the top of the table and comparisons lining the vertical edge.

23. Have a group of students, or the entire class visit: http://cfpub.epa.gov/surf/locate/index.cfm to learn the name of the nearest watershed or any other watershed they would like to learn about. Type the name of that creek, stream, river, or lake into Google Maps to see a satellite photo of that particular watershed. Have students observe the land and topography of that area, and do research online to learn about the natural history and formation of that watershed. Have students create a report, presentation, diagram, model or other project on their watershed to educate the class on the area's various watersheds.

24. As a class, use a Geographic Information System (GIS) (see resource list) to find out the quantities of particular vegetation, types of water, or animal species in a chosen Great Lakes habitat and provide a report for the class (PowerPoint or another type).

ASSESSMENT

See rubric on page 23.

RESOURCES

Please see Resource List for additional information related to mapping, geographic information systems (GIS) and more.

NAME _____

2
LESSON
STUDENT PAGE

A Sense of Place

VOCABULARY

cartography
Geographic Information System
map
mental map
physical map
political map
topography

BACKGROUND

Learning about where we live helps us to understand who we are. The Great Lakes are bordered by eight United States and two Canadian provinces: Michigan, Wisconsin, Minnesota, Illinois, Indiana, Ohio, New York, Pennsylvania, Quebec and Ontario.

Maps are tools that help us orient ourselves on streets, in cities, in states, in counties, on the planet and more. If you have a current map, you can always find where you are, if you know how to use it. Every day we make decisions based on geography: where to go, how we will get there and what we will do when we get there. We think geographically when planning simple events, such as going to school in the morning, or when planning major events, such as a diving trip in one of the Great Lakes. In this activity, you will map your local area or "place." You will also review various maps to learn how maps are useful to many different people. By understanding our places in this world, we can make better decisions about the ways we choose to live on our planet.

INTRODUCTORY QUESTIONS

1. Name and describe three or more types of maps.

_____

_____

_____

_____

2. What elements do most maps include?

_____

_____

_____

ACTIVITY

PART 1: MENTAL MAPS

3. List 10 to 15 important features of your neighborhood, including your home, your school and the nearest Great Lake.

_____

_____

_____

_____

4. What makes these features (or places) important?

5. On a separate sheet of paper, draw a "sense of place" map or a mental map of your home, school, the nearest Great Lake and the local features that you listed above.

6. After drawing your mental map, draw arrows to show how different features of your local place are connected and what makes them important. For example, you may draw an arrow from the school to the park and/or from the park to the school. You would then write "place to play, socialize, explore" and/or "nature, family" to explain the connection and the importance of each feature.

7. Where is the nearest Great Lake in relation to your school and home? Do you consider the lake to be a part of your neighborhood? Why or why not?

PART TWO: LOOKING AT LOCAL MAPS

You will explore some common (and not-so-common) types of maps. No map can depict all of the physical, biological and cultural (or political) features in even the smallest area. Most maps of the world are therefore either categorized as "physical" or "political".

8. What different types of maps did you see in class? What common elements did these maps have?

PART THREE: MAPPING THE SCHOOL GROUNDS

Now, draw a map of the school grounds on a separate sheet of paper. You can either go outside to do this, or you can map the school grounds from memory. If you are going outside, you can take measurements of the features of the school grounds using tools and mathematics. If you are mapping from memory, try your best to be accurate in drawing things to scale.

9. Think about what features you will include on this map. Make a list of what you will include here:

10. Was the map you drew one-, two- or three-dimensional? What features could be shown on a two-dimensional map that could not be shown on a one-dimensional map? What features could be shown on a three-dimensional map?

11. Compare the map you drew of the school grounds to the aerial image your teacher printed. How were the two maps similar? How were they different?

WRAP-UP QUESTIONS

12. Which Great Lake is nearest to you? Which state(s) or province(s) does your nearest Great Lake border?

13. How does the location of the lake influence your experiences with it? Include your ideas on how a location's proximity to the Great Lakes could influence recreation, municipalities, transportation, tourism, industry and more.

14. What habitats are found along the Great Lakes coastlines? What types of organisms live in and around the Great Lakes?

15. What habitats are found on your school grounds, or in your neighborhood? What types of organisms live in your neighborhood?

16. Choose one type of map, and list all of the components of that type of map.

17. What determines whether a map is a good map? How does the purpose of a map influence its design?

18. Summarize the discussion you and your classmates had on the topic of maps. Overall, what did you learn from this lesson? How does this new knowledge change the way you think about maps and your location?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
MENTAL MAPPING: Student imagines their school, neighborhood and nearest Great Lakes and list 10 to 15 important features of their local area. Student draws a mental map of their local "place". Student explains the importance of and connection between the features they included in their maps. Students share maps in small groups and answer wrap-up questions together.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
MAPS: Student recognizes there are many different types of maps, how to use all the features included in a map, and the differences and similarities between different types of maps.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
MAP: Student creates a map of the school grounds including important features. Student recognizes the difference between 2-D and 3-D maps and which features are characteristic to each.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
WRAP-UP: Student is able to get a "sense of place" of where they are in relation to the Great Lakes by looking at a map of North America. Student is able to distinguish the different types of environments that surround the Great Lakes and their homes as well.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Great Lakes Coastal Update

Students role-play an interview with a representative from Great Lakes history, discuss the "State of the Great Lakes Coast" and present to the class

OBJECTIVES

Describe the impact that humans have had on the Great Lakes

Role-play an interview with a representative from Great Lakes history that describes the conditions of the coasts, their habitats and ecosystems at a key point in time

SUBJECT
Social Studies

PREREQUISITE
None

VOCABULARY
mammoth
nomad
pelt
subsistence
voyageur

MATERIALS
Great Lakes role-playing cards
computers with internet access or research materials
large timeline (piece of paper or rope)

TIME/DURATION
2-3 hours

SETTING
Indoors, Computer Lab

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

The humans who have lived in the Great Lakes watershed have shaped the eventful history of the five lakes. The Great Lakes region has played host to many different groups that have lived in the area over time, all drawn here by the powerful lure of fresh water. The Great Lakes are direct sources of drinking water, and also provide food, support wildlife and have provided means of livelihood for many through industry, shipping, canal building and farming. The Great Lakes contain nearly 20 percent of the world's fresh surface water and have a coastline longer than the East Coast of the United States. Most of North America's fresh surface water (95 percent) is in the Great Lakes. From Native Americans to explorers, voyageurs, miners, immigrants and settlers, the region has provided for many groups, and interacted differently with each of them. There are similarities and differences among the ways we use the Great Lakes now and the ways the lakes were used in earlier times.

This activity serves as a means for students to begin thinking about the different ways peoples throughout history have interacted with and influenced the Great Lakes, and how we affect these bodies of water today. Encourage students to think about how the Great Lakes are and have been assets to the watershed's people, and how people and nature have brought about changes to these lakes and their coasts.

In this activity, each student develops a presentation from the point of view of one of the many historical or cultural figures of the Great Lakes. Students will present the "State of the Great Lakes Coast" and coastal habitats as they were at an important time in the history of the Great Lakes.

PROCEDURE

1. Before class, hang a long piece of paper or rope to create a timeline of the past 12,000 years.

2. Introduction: Students read the background information and answer the questions on the student pages: How have the Great Lakes been assets to the region's peoples? How have people and nature brought about changes to the Great Lakes and their coastlines?

3. As a class, create a list of the roles that the Great Lakes play in their lives. Explore this by asking them what experiences they have had with the lakes. *Responses might include recreation, drinking water, irrigation for crops, shipping imports and exports and access to world markets, and/or industry (using water in the manufacturing of various products).*

4. Ask students what types or groups of peoples they think have lived in the region over time. *Answers might include: Native Americans, French and British explorers, voyageurs, fur trappers, European settlers and/or scientists.*

5. Tell students that humans have been living near the Great Lakes for thousands of years, beginning with Native Americans, and continuing with European explorers and settlers. Ask students in what ways these groups of people may have depended on the Great Lakes.

6. Each student is given a role card, either for a group of people or for an individual. Students should organize themselves along the timeline according to their places in Great Lakes history. Have students read through the description of their group or individual. While standing in the timeline, students "introduce" themselves to the class by stating their name (if their character doesn't have a name they can select one), their place in time and their place in the Great Lakes region. These statements should be brief and should each serve as an introduction to the unique history of the Great Lakes region and the various individuals and groups of people who have depended upon the Great Lakes.

7. Students then work individually (or in pairs or small groups, depending on what the teacher prefers) to research their individual or group from Great Lakes history. Then, students will develop a presentation. They will present the "State of the Great Lakes Coast" from the point of view of the person described on their role card. Each student explains their location, time period, any significant events from that time period and the status of the Great Lakes at that time. This is an "update" from a specific point of time in Great Lakes history that describes how the Great Lakes were viewed by the individual or group adopted by the students. Later, students present these "State of the Great Lakes Coast" updates to the class.

8. To aid with their research, students develop a list of at least five research questions. Students write these on the student pages before conducting research at the school library or online (see Resource List for suggested websites). Research questions might include: How did this event or person influence the Great Lakes coast? What difficulties did this person or group of people face when caring for the Great Lakes? How was the Great Lakes region different then than it is now? What plants or animals lived in the Great Lakes region at that point in time?

9. Their "State of the Great Lakes Coast" address should explain why they depend on a Great Lake and what impact they had on the region. As part of their preparation, students can look at maps of the Great Lakes region from different points in time: http://gis.glin.net/maps/, or conduct research on a time period in Great Lakes history at: http://www.great-lakes.net/teach/history/.

10. Note: If working in groups, students should divide up their tasks so that each group member participates in the preparation and the presentation. For example: one person asks the questions or acts as an eyewitness or character witness while the other person takes on the role of the key person. This work can be done in class, or as homework.

WRAP-UP

11. Once the groups have completed their "State of the Great Lakes Coast," each group presents their projects or interviews to the entire class, another class or the community, either in person or through video (and/or audio) recordings.

12. Students provide feedback to each other on their projects using a rubric. This can be the rubric created for this assignment, or as create a rubric for the presentations.

13. Discuss the following before students answer the wrap-up questions on their student pages: How do peoples today use the lakes and their surrounding watersheds differently than they did in the past? How might people feel differently or similarly about the lakes now than they did in the past? How were the lakes different in the past than they are today?

EXTENSION

A. As a class, create a detailed timeline of the history of the Great Lakes using the information gathered through the research. Display this timeline in the classroom, hallway or library of the school.

ASSESSMENT

See rubric on page 31.

RESOURCES

Please see Resource List for additional information related to organizations, Department of Natural Resources and more.

Paleo-Indian

10,000 B.C.-8,000 B.C. – NORTHEAST WOODLANDS

Paleo-Indians, the earliest inhabitants of the Great Lakes region, built great mounds of earth as burial chambers and monuments to their gods. About 1600 years ago (400 A.D. or C.E.), the mound-building culture gave way to the Mississippian culture. Within a few thousand years, the Paleo-Indians divided into hundreds of groups, speaking many different languages. They hunted mammoths and lived a nomadic lifestyle. About 3,000 years ago, they began raising squash, corn, sunflowers and tobacco.

Iroquois Farmer

400 A.D. – LAKE ONTARIO

The Six Nations of the Iroquois (IR-uh-kwoy) lived around Lake Ontario in the northeastern part of what is now the United States and Canada. They were sedentary and built longhouses where multiple families lived. Their culture was, and continues to be, rich in religion, self-government and history. It is frequently said that Native Americans knew how to live comfortably with nature, while preserving its resources for future generations. Iroquois farmers grew beans, squash and corn. They called these crops, "The Three Sisters." The women tended the crops, while the men hunted and fished

Algonquian – Hunter

400 A.D.–WESTERN REGION AROUND THE GREAT LAKES

Algonquians were nomadic or seminomadic, and they moved as a group, depending on the season, to meet their needs. They lived in simple, portable wigwams, although some lived in summer homes similar to the Iroquois longhouses. Each clan had its own lodge. Their culture was, and continues to be, rich in religion, self-government and history. It is frequently said that Native Americans knew how to live comfortably with nature, while preserving its resources for future generations. They hunted, fished, and developed extensive civilizations throughout the region. The Algonquian hunted the forests surrounding the Great Lakes. Algonquian hunters used bows and arrows, spears, and knives, or built traps to catch large animals.

Iroquois – Politician

400 A.D. – LAKE ONTARIO

The Six Nations of the Iroquois (IR-uh-kwoy) lived around Lake Ontario in the northeastern part of what is now the United States and Canada. Their culture was, and continues to be, rich in religion, self-government and history. It is frequently said that Native Americans knew how to live comfortably with nature, while preserving its resources for future generations. They hunted, fished, grew crops and developed extensive civilizations throughout the region. As early as 1570, the Iroquois tribes were organized into the Iroquois League. They created 13 laws in order to live in peace and unity. Leaders of the League (Grand Council) were men, selected by each tribe's women. The Iroquois had one of the first participatory and representative democracies in history. They believed that, "in all of your … acts, self-interest shall be cast away. … Look and listen for the welfare of the whole people, and have always in view not only the present, but also the coming generations … the unborn of the future nation."

Iroquois – Artisan

400 A.D. – LAKE ONTARIO

The Six Nations of the Iroquois (IR-uh-kwoy) lived around Lake Ontario in the northeastern part of what is now the United States and Canada. Their culture was, and continues to be, rich in religion, self-government and history. It is frequently said that Native Americans knew how to live comfortably with nature, while preserving its resources for future generations. They hunted, fished, grew crops and developed extensive civilizations throughout the region. The Iroquois were known for their mask-making and basket weaving. Kitchen utensils and wooden bowls were also made and carved for decoration. Women embroidered and wove.

Iroquois – Warrior

400 A.D. – LAKE ONTARIO

The Six Nations of the Iroquois (IR-uh-kwoy) lived around Lake Ontario in the northeastern part of what is now the United States and Canada. Their culture was, and continues to be, rich in religion, self-government and history. It is frequently said that Native Americans knew how to live comfortably with nature, while preserving its resources for future generations. Iroquois men could be warriors, if they needed to protect their land. Iroquois warriors used bows and arrows, clubs, spears and shields as weapons.

René-Robert Cavelier, Sieur de La Salle

1643-1687 – LAKES MICHIGAN, HURON, ERIE AND ONTARIO

Cavelier was a French explorer sent by King Louis XIV (14) to travel south from Canada and sail down the Mississippi River to the Gulf of Mexico. He explored Lakes Michigan, Huron, Erie and Ontario. Europeans brought objects made of iron, including needles, fishhooks, hatchets, traps and guns, items that the native peoples immediately saw could make their lives easier, and they began trading furs and skins for these tools. Many natives abandoned their traditional work and became dependent on trade. Such was the basis of the Indian trade over which wars were waged and the history of the Great Lakes region was shaped.

Voyageur

1580-1640 – CANADIAN NORTHWEST

The term "voyageur" comes from the French "voyager," meaning "to travel." Voyageurs were fur traders employed by fur companies to transport goods to and from remote stations, especially in the Canadian Northwest. These voyageurs introduced guns, iron, and the wheel and manufactured goods to the Native Americans. They also brought a host of deadly diseases to which the Native Americans had little resistance, including smallpox, measles and cholera. These outbreaks killed one-third to one-half or more of a native population, whenever they occurred. After a few decades, Native Americans grew increasingly dependent on Europeans for their survival.

First European Settler

1600-1800 – GREAT LAKES BASIN

The first European settlers grew specialty crops, such as fruits, vegetables and tobaccofor their expanding urban population. These settlers claimed an increasingly important share of the lands suitable for them. Canals allowed farmers to export their crops, which meant that the farmers were able to expand their operations beyond a subsistence level. The rapid, large-scale clearing of land for agriculture brought rapid changes to the ecosystem. Soils stripped of vegetation washed away into the lakes. As a result, fish habitats and spawning areas were destroyed.

Early Industrialist – Logger

MID-1800S – UPPER CANADA, MICHIGAN, MINNESOTA AND WISCONSIN

Loggers harvested trees and cleared the land for agriculture, in addition to providing lumber for the settlers. With the harvest wood, settlers were able to build houses and barns. By the 1830s, commercial logging had begun in Upper Canada, Michigan, Minnesota and Wisconsin. The trees that were logged were hundreds of years old and so were not soon replaced. Clearcutting was the usual practice. Without proper rehabilitation of the forest, soil eroded from barren landscapes and was lost to local streams, rivers and lakes. In some areas of the Great Lakes watershed, reforestation has not been adequate. Today, as a result, forests may be a diminishing resource.

Early Industrialist – Paper Industry

MID-1800S – CANADA

Papermaking from pulpwood developed slowly. The first paper mill was built on the Welland Canal in the 1860s. Eventually Canada and the United States became the world's leading producers of pulp and paper products. The pulp and paper industry contributed to mercury pollution and added other chemicals to the water.

Early Industrialist – Canal Builder

MID-1800S – GREAT LAKES REGION

Some early industrialists helped build canals such as the Erie Canal, the Lachine Canal and the Welland Canal. Once built, canals enabled people and goods to be carried to and from the region. Canals carried settlers west and freight east. Canals caused the Great Lakes to become the transportation hub of eastern North America.

Algonquian – Warrior

400 A.D. - WESTERN REGION AROUND THE GREAT LAKES

Algonquians were nomadic or semi-nomadic, and they moved as a group, depending on the season, to meet their needs. They lived in simple, portable wigwams, although some lived in summer homes similar to the Iroquois longhouses. Each clan had its own lodge. Their culture was, and continues to be, rich in religion, self-government and history. It is frequently said that Native Americans knew how to live comfortably with nature, while preserving its resources for future generations. They hunted, fished, grew crops and developed extensive civilizations throughout the region. Algonquian warriors policed the villages and protected their tribes. Algonquian warriors used bows and arrows, spears and knives.

Algonquian – Artisan

400 A.D. - WESTERN REGION AROUND THE GREAT LAKES

Algonquians were nomadic or semi-nomadic, and they moved as a group, depending on the season, to meet their needs. They lived in simple, portable wigwams, although some lived in summer homes similar to the Iroquois longhouses. Each clan had its own lodge. Their culture was, and continues to be, rich in religion, self-government and history. It is frequently said that Native Americans knew how to live comfortably with nature, while preserving its resources for future generations. They hunted, fished, grew crops and developed extensive civilizations throughout the region. Algonquian artisans were known for their beadwork and their basketry.

Samuel de Champlain

1567-1635 – QUEBEC AND NORTHEASTERN NORTH AMERICA

Champlain was a French explorer and navigator who mapped much of northeastern North America and started a settlement in Quebec. Europeans brought objects made of iron, including needles, fishhooks, hatchets, traps and guns, items that the native peoples immediately saw could make their lives easier, and they began trading furs and skins for these tools. Many natives abandoned their traditional work and became dependent on trade. Such was the basis of the Indian trade over which wars were waged and the history of the Great Lakes region was shaped.

Jean Nicolet

1598-1642 – GREAT LAKES AREA

Nicolet was a French explorer who lived among Native Americans. He was the first European to travel through the Great Lakes area, visiting Lake Michigan and possibly reaching the Mississippi River. Europeans brought objects made of iron, including needles, fishhooks, hatchets, traps and guns, items that the native peoples immediately saw could make their lives easier, and they began trading furs and skins for these tools. Many natives abandoned their traditional work and became dependent on trade. Such was the basis of the Indian trade over which wars were waged and the history of the Great Lakes region was shaped.

Father Jacques Marquette

1637-1675 – LAKE SUPERIOR

Marquette was a French Jesuit priest and explorer. He started an Ojibwe mission at the western end of Lake Superior. Europeans brought objects made of iron, including needles, fishhooks, hatchets, traps and guns, items that the native peoples immediately saw could make their lives easier, and they began trading furs and skins for these tools. Many natives abandoned their traditional work and became dependent on trade. Such was the basis of the Indian trade over which wars were waged and the history of the Great Lakes region was shaped.

Louis Joliet

1645-1700 – CANADIAN WILDERNESS

Joliet was born in Québec City and explored the Canadian wilderness, including the Great Lakes area. He expanded the fur trade westward and did extensive mapping. Europeans brought objects made of iron, including needles, fishhooks, hatchets, traps and guns, items that the native peoples immediately saw could make their lives easier, and they began trading furs and skins for these tools. Many natives abandoned their traditional work and became dependent on trade. Such was the basis of the Indian trade over which wars were waged and the history of the Great Lakes region was shaped.

NAME

3
LESSON
STUDENT PAGE

Great Lakes Coastal Update

BACKGROUND

The Great Lakes region has played host to many different groups over time. Native Americans, explorers, voyageurs, miners, immigrants and settlers were all drawn here by the powerful lure of fresh water. The Great Lakes are a direct source of drinking water and also provide food, support wildlife and have provided means of livelihood for many through industry, shipping, canal building and farming.

In this activity, you will begin thinking about the different ways that people throughout history, and those in the present day, have interacted with and influenced the Great Lakes. You will role-play one of the many Great Lakes historical or cultural figures in order to present the "State of the Great Lakes Coast" and coastal habitats at different periods in the history of the Great Lakes.

VOCABULARY

mammoth
nomad
pelt
subsistence
voyageur

INTRODUCTORY QUESTIONS

1. How have the Great Lakes been an asset to the people of the region? List your favorite outdoor activities. Consider fishing, swimming hiking, camping, picnicking, or other outdoor activities.

2. How have people and nature brought about changes to the Great Lakes and their coasts?

GREAT LAKES HISTORY

My "role" (individual or group of people from Great Lakes history): _____

_____

Write your research questions here:

a. _____

_____

_____

b. _____

_____

_____

c. _____

_____

_____

d. _____

_____

_____

e. _____

_____

_____

WRAP-UP QUESTIONS

3. How do people today use the lakes and their surrounding watersheds differently than they did in the past?

_____

_____

_____

_____

_____

_____

_____

4. How might people feel differently or similarly about the lakes now than they did in the past?

_____

_____

_____

_____

_____

_____

5. How were the lakes different in the past than they are today?

6. What are two new things you learned about the Great Lakes coastal habitats? What additional questions do you have about Great Lakes coastal habitats?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
BACKGROUND: Student reads background information about the different people that have influenced the Great Lakes over time and are able to answer questions relating the people to the Great Lakes.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
PREPARATION: Student introduces their role card knowing their place in time and in the Great Lakes region. Student develops research questions to research their person, place and time in Great Lakes history.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
PRESENTATION: Student presents a "State of the Great Lakes Coast" to the class from the point of view of the person described on their role card. Student explains their location, time period, any significant events at that time, and the state of the Great Lakes coast at that time. Students are well prepared and show eye-contact with the audience.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
WRAP-UP: Students engage in the presentations and discussions that follow and are able to compare and contrast the Great Lakes throughout different time periods.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Explore and Restore

Students research Great Lakes restoration issues and identify organizations and individuals working to alleviate them.

OBJECTIVES

Research organizations and individuals who have positively impacted the Great Lakes region

Identify current restoration efforts by Great Lakes organizations

SUBJECT
Social studies, Current events

PREREQUISITE
None

VOCABULARY
career
conservation
preservation
profession
restoration
sedimentation

MATERIALS
computers with internet access

TIME/DURATION
90 minutes

SETTING
Indoors
Computer Lab

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

Habitats within the Great Lakes Basin were significantly altered following the arrival of European settlers, especially during the last 150 years. Nearly all of the existing forests have been cleared at least once and the forest and the prairie soils suited to agriculture have been plowed or intensively grazed. This, together with the construction of dams and urbanization, has created vast changes in the plant and animal populations. Streams have been changed not only by direct physical disturbances, but by sedimentation and changes in runoff rates due to changing land use, and by increases in temperature caused by the removal of shading vegetation. Although the Great Lakes are large, they are finite and their resources are limited.

In this lesson, students will research Great Lakes issues and those who have worked and continue to work to alleviate them. In addition, they will identify careers around the Great Lakes and the qualifications needed to work in these careers. Finally, students will be introduced to organizations working to keep the Great Lakes great.

PROCEDURE

1. Discussion: As a class, review the background information to prepare for a discussion about the importance and the fragility of the Great Lakes. Students will answer the introductory questions on the student pages: Why are the Great Lakes important? Why should people work to conserve, preserve and restore the Great Lakes?

2. Divide the class into small groups of students, or individual students may opt to work independently. In small groups (or individually), students will select an issue facing the Great Lakes. They will then research this issue, such as non-native species, the disappearance of wetlands, or another issue identified during the research process.

a. To aid with research, allow the students to reference the vocabulary list, background information, Web addresses for a few resources, the list of "Caretakers of the Great Lakes" and give them access to additional print or online resources as identified by the teacher (see resource list).

b. Using the list of individual "Caretakers of the Great Lakes" from this activity, students will explore how humans have significantly and historically impacted Great Lakes environmental issues. During their research, students should also identify the careers of these individuals.

Note: Some individuals may have more than one career. Students should compile a class list of the careers of these Great Lakes caretakers.

3. Each student completes the graphic organizer with the information that they acquired during their research.

4. Students share their graphic organizer with another student, a small group or the entire class to summarize the knowledge they have gained and to receive feedback or additional ideas for how to more thoroughly complete their graphic organizer.

5. As a class, make a list of related professions. Then, compile a list of all of the issues facing the Great Lakes. This can be done on the board or using a projector.

6. Discussion: How long have the Great Lakes faced each of these issues? What initially caused these issues? Which organizations are working to address these issues and restore Great Lakes coastal habitats? How could individuals in the listed professions work to address these issues? How can individuals or citizens help to alleviate these issues?

WRAP-UP

7. Discuss the following questions. Students then answer these questions on their student pages: What are the major issues facing the Great Lakes currently? What organizations are working to alleviate those problems and restore Great Lakes coastal habitats? How can individuals help to alleviate those problems through their professional work or through volunteerism? What additional restoration project would benefit the Great Lakes coast? What local restoration efforts could benefit your community and the Great Lakes region as a whole?

EXTENSION

A. Each student researches one career from the list in order to identify the qualifications needed to do that job. Students visit Web sites of the Great Lakes Restoration Initiative (GLRI) and the Great Lakes Information Network (GLIN) to identify organizations working to preserve, conserve, and/or restore coastal habitats throughout the Great Lakes Basin. Students should find at least two organizations working on each of the GLRI focus issues. Students research the goal or the mission of these organizations and at what level the organizations operate (i.e. federal, state, city, private).

ASSESSMENT

See rubric on page 37.

RESOURCES

Please see Resource List for additional information related to organizations, careers and more.

NAME _____

4
LESSON
STUDENT PAGE

Explore and Restore

VOCABULARY

career
conservation
preservation
profession
restoration
sedimentation

BACKGROUND

Habitats and coastlines within the Great Lakes Basin have been significantly altered since the arrival of European settlers, especially during the past 150 years. Nearly all of the existing forests have been cleared at least once and the forest and prairie soils suited to agriculture have been plowed or intensively grazed. This, together with the construction of dams and urbanization, has created vast changes in the plant and animal populations. Streams have been changed not only by direct physical disturbances, but by sedimentation and changes in runoff rates due to changing land use, and by increases in temperature caused by the removal of shading vegetation.

As many forms of pollution have been controlled and reduced, the importance of habitat is being recognized as critically important to the health of the Great Lakes ecosystems. As the physical, chemical and biological interactions of the ecosystems are becoming better understood, it has become apparent that no one component can be viewed in isolation. To protect any living component, its habitat and place within the system must be protected. Throughout this lesson, you will research Great Lakes restoration issues and identify organizations and individuals working to alleviate them.

INTRODUCTORY QUESTIONS

1. Why are the Great Lakes important?

2. Why should people work to conserve, preserve and restore the Great Lakes?

GREAT LAKES RESTORATION INITIATIVE

In 2010, President Obama made restoring the Great Lakes a national priority when he allocated $475 million to the nation's largest fresh surface water ecosystem. The initiative, led by the Environmental Protection Agency, seeks to stop invasive species from entering the lakes, to clean up beaches, remove toxic pollution and restore fish and wildlife habitats.

Focus areas for Great Lakes Restoration Initiative (GLRI) projects include:

- Habitat and Wildlife Protection and Restoration
- Invasive Species
- Nearshore Health and Nonpoint Source
- Toxic Substances and Areas of Concern
- Accountability, Monitoring, Evaluation, Communication and Partnerships

Visit http://www.epa.gov/glnpo/glri/2010GLRIProgramsProjects.pdf to learn more about the organizations that are currently involved in GLRI projects.

CARETAKERS OF THE GREAT LAKES

Some environmental heroes in the Great Lakes region are:

Dr. Henry Cowles (1869-1939) - Indiana
Professor and scientist in the Indiana Dunes whose studies included "succession."

Dorothy Buell (1886-1977) - Indiana
An English teacher. After she graduated from college, she became a professional reader of current plays and organized book review groups. Helped form the Save the Dunes Council in 1952 and mobilized citizens to push for the creation of the Indiana Dunes National Lakeshore.

Lee Botts (born in 1928) - Indiana
Environmentalist, founder of the Lake Michigan Federation (now the Alliance for the Great Lakes) and the Indiana Dunes Environmental Learning Center.

Marian Byrnes (1925-2010) - Illinois
Educator and environmentalist, preserved natural ecosystems and land in the Calumet area.

Rachel Carson (1907-1964) - Pennsylvania
Environmental writer, author of Silent Spring.

Sigurd Olsen (1899-1992) - Minnesota
Environmental activist and writer, author of Singing Wilderness.

Aldo Leopold (1887-1948) - Wisconsin
Environmental writer and science professor, author of A Sand County Almanac.

Josephine Mandamin (born in 1942) - Thunder Bay, Ontario
Anishinabe elder and environmentalist, founder of Mother Earth Water Walk.

Gaylord Nelson (1916-2005) - Wisconsin
Former U.S. senator, founder of Earth Day, sponsored federal legislation establishing the Apostle Islands National Lakeshore in Lake Superior.

Lorrie Otto (1919-2010) Wisconsin
Naturalist and Milwaukee native who pioneered natural landscaping in the 1970s, spearheaded the successful movement to ban DDT, and founded The Wild Ones.

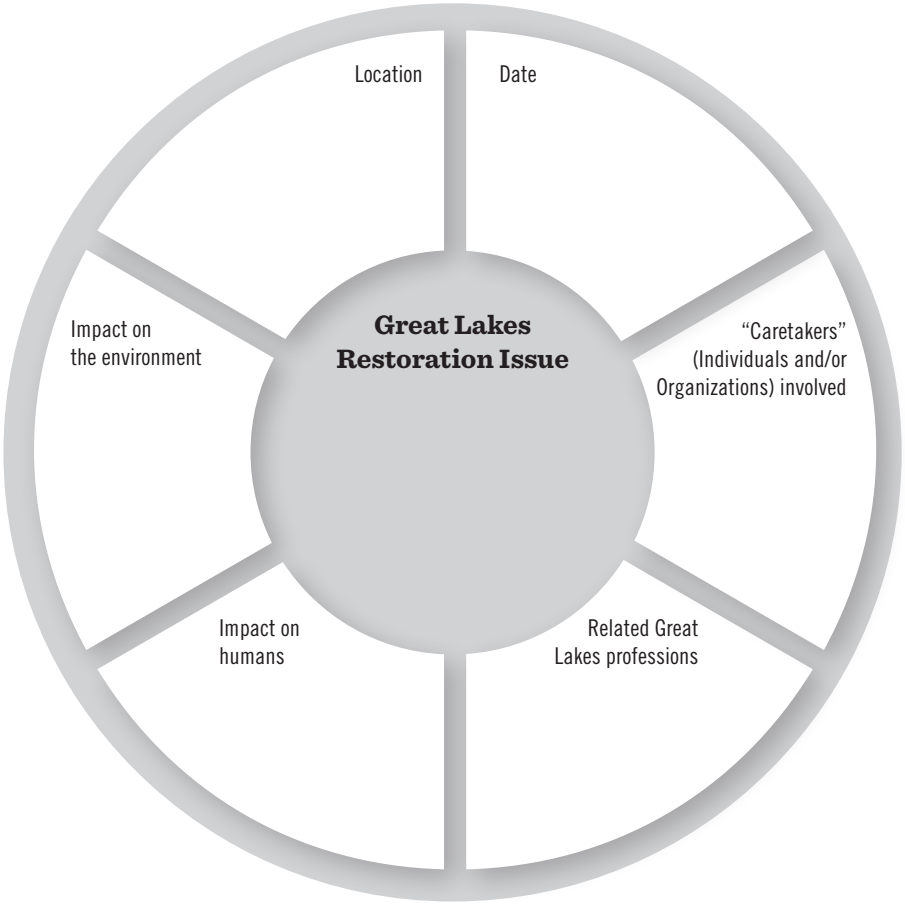
Sam Speck (born in 1937) - Ohio
Commissioner on the International Joint Commission, former director of Ohio's Department of Natural Resources, helped develop the Great Lakes-St. Lawrence River Basin Water Resources Compact and Agreement.

Gene Stratton-Porter (1863-1924) - Indiana
Environmental writer and photographer.

OTHER GREAT LAKES RESTORATION AND ADVOCACY WORK:

A list of organizations engaged in Great Lakes restoration and advocacy work can be found at: http://www.great-lakes.net/links/envt/.

GREAT LAKES RESTORATION AND CAREER EXPLORATION:
With your group, conduct research to complete this graphic organizer for one Great Lakes restoration issue.



Making connections between Great Lakes restoration issues and professions:
Draw two columns. Write a list of five professions in the left column. Then, write a list of five of the issues facing the Great Lakes today in the right column. Draw lines to connect each of those professions to an issue that could be addressed by someone within that profession.

PROFESSIONS	GREAT LAKES ISSUES

WRAP-UP QUESTIONS

3. What are some of the major issues currently facing the Great Lakes?

_____

_____

_____

_____

4. What organizations are working to alleviate these problems and restore Great Lakes coastal habitats?

5. How can individuals help to alleviate these problems through professional work or through volunteerism?

6. What additional restoration project would benefit the Great Lakes coast?

7. What local restoration efforts could benefit your community and the Great Lakes region as a whole?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
DISCUSSION: Student participates in class discussion about the importance and fragility of the Great Lakes including the issues that the Great Lakes face and what types of organizations are involved in working to address these issues.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
RESEARCH: Student references vocabulary list, background information, web resources, and the "Caretakers of the Great Lakes" list to gain information Great Lakes restoration work. Students locate and summarize information including: location, date, "caretakers" involved, related Great Lakes profession, impacts on humans and the environment. Student completes the graphic organizer with the information they acquired during their research.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
CAREER CONNECTIONS: Student shares the information they found with their peers. During class discussion, student participates in organizing list of professions associated with the Great Lakes and connects them to appropriate issues that that the Great Lakes face.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
WRAP-UP: Student recognizes the issues that the Great Lakes face and the professions and organizations that work towards the goal of restoring these habitats. Student suggests any efforts that could be made in their community that would benefit the coastal habitats.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Getting to the Bottom of the Lakes

Students create bathymetric and other layered maps of the Great Lakes watershed.

OBJECTIVES

Students learn about the glacial formation of the Great Lakes

Students understand the difference between topographic and bathymetric maps

Students create a bathymetric map of a lake

SUBJECT
Geography

PREREQUISITE
#2: A Sense of Place

VOCABULARY
bathymetric map
bathymetry
contour lines
contour map
Geographic Information System (GIS)
Global Positioning System (GPS)
impervious surface
lake bottom
plumb bob
topographic map
topography

MATERIALS
maps of the local area
modeling clay
dental floss
paper
pencil
fish tank
food coloring (red and blue)
plumb bob, weights attached to strings, or rulers for measuring depth
graph paper
a contour map
a strip of paper of overhead transparency
clear tape
metric ruler

TIME/DURATION
90 minutes

SETTING
Indoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

In this activity, you and your students will study the Great Lakes land and water features through mapping. In order to understand the features that you study, it is important to understand that the Great Lakes and the Great Lakes coast are a result of glacial formation.

Glaciers are made of ice, snow and rocks and can be 3.2 km, or two miles: equal to seven Sears Towers (now the Willis Tower)! A glacier occurs when ice and snow build up over a long period in which precipitation is greater than melting, due to constant cold temperatures. Interglacial periods are times of climate warming between glaciers, when plants and animals return. We are currently living in an interglacial period.

During the Pleistocene Epoch, glaciers advanced and retreated from the north four times, forming the landscape we see today. River valleys from the previous era were deepened and widened by the glaciers, hills were scraped flat, large basins were scooped out, and piles of rocks were deposited in various formations. As the climate warmed, the glaciers melted, filling in a large basin and forming the Great Lakes.
See the student page for additional information.

PROCEDURE

BATHYMETRIC MAPS

BEFORE CLASS

1. In a fish tank, the teacher will create a lake bottom using modeling clay. This could be done in one fish tank as a demonstration lesson for the whole class, at lab tables or at stations in three to five different fish tanks.

2. The teacher also takes a photograph of the created lake bottom, to which students can compare their own bathymetric maps.

3. The teacher fills the fish tank with water and dyes it with red and blue food coloring, thus hiding the lake bottom beneath the water.

DURING CLASS

4. Students read the introduction about the formation of the Great Lakes. Show the students the video by Environment Canada's Great Lakes Kids: http://www.msue.msu.edu/objects/content_revision/download.cfm/item_id.211898/workspace_id.26697/How%20The%20Great%20Lakes%20Were%20Formed%20(Video).swf/

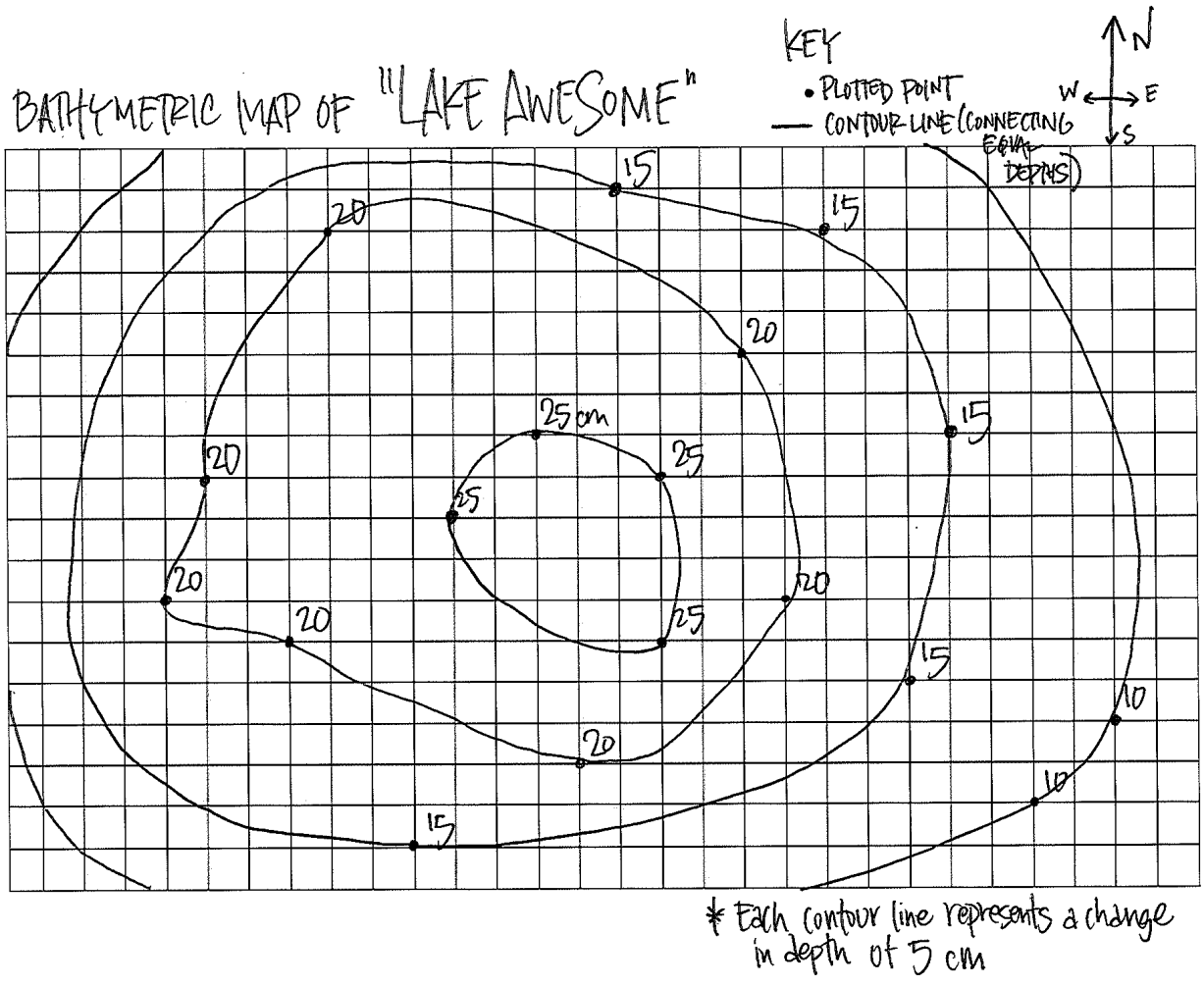
5. Engage the students in a discussion about what a lake bottom looks like, why we might want a map of a lake bottom and how the lake bottom would be measured. Then students answer the introductory questions: As you think about how the Great Lakes were formed, what do you think the bottoms of the Great Lakes look like? Why is it useful to know what the lake bottoms look like?

6. Show the students the video of the lake bottoms of Lake Superior and Lake Michigan: http://www.ngdc.noaa.gov/mgg/greatlakes/wildride.html

7. Discuss the following: Bathymetric data details the topography of the lake bottom or the "lake bottom." Bathymetry is used for navigational purposes and by coastal communities concerned with Great Lakes science, pollution, coastal erosion, response to climate changes, threats to lake ecosystems, and the health of the fishing industry.

8. Now, students create a bathymetric map of the fish tank "lake bottom." Students should not be able to see the bottom of the "lake" in the fish tank, so they will need to measure the depth of the "lake".

Please see example of a simple bathymetric map below



9. Students use a ruler or a lead plumb bob to measure the distance from the top of the water (sea level) to the bottom of the "lake" at different points. This can be done as a whole-class demonstration in which student volunteers measure the points and all students record these points, or this can be done individually by students during an independent work period.

10. Students use graph paper to plot the depths at different points. The more depth measurements that are taken, the more accurate the map will be. A minimum of 15 depths should be measured from the fish tank lake and then plotted on the graph paper.

11. After the students have plotted all of the points on the graph paper, they connect the points with equal depth using contour lines to create a bathymetric map. As students are drawing these contour lines, they should realize that the lake is deeper inside these lines and shallower outside these lines.

12. Discussion: What other elements of a map should be included? *The answers include a title, compass rose or north arrow, key, labels, scale.* If students have not already done so, ask them to add these elements to their bathymetric maps.

13. Students should hang their bathymetric maps for others to see, or they should share them in a group. Students should notice the differences between these maps, and the subtle inaccuracies. Because they only plotted 15 (or more) depths, they may have missed some features. Discussion: These are simple bathymetric maps. While they would probably not be adequate for navigation, what uses might these maps have? *Planning a fishing trip or developing aquatic plant management strategies.*

WRAP-UP

14. Discuss: How can bathymetric maps be used to understand, assess and problem-solve in relation to an ecosystem or an environmental issue (i.e. erosion, invasive species, land use, population growth)?

15. Students hang their maps around the room and view other students' maps. With the newly-made maps displayed in the classroom for reference, the class briefly discusses how both types of maps can be useful to scientists, conservationists, teachers, government leaders, and the community at-large.

16. Students answer questions on their student pages: Compare and contrast topographic and bathymetric maps.

    Why do you think bathymetric maps were used earlier in time than topographic maps?

    How can bathymetric maps be used to understand, assess, problem-solve in relation to an ecosystem or an environmental issue (i.e. erosion, invasive species, land use, population growth)?

    How has technology improved our understanding of the Great Lakes and the Great Lakes watershed?

    How do natural resource managers and other professionals solve environmental issues using these mapping systems?

    How do students and educators use mapping systems?

EXTENSION

A. Elevation is often measured in relation to sea level, but the United States Geological Survey (USGS) also measures elevation using a system of benchmarks. Visit http://benchmarks.scaredycatfilms.com/IL to locate benchmarks near you.

B. The teacher uses GIS and GPS mapping tools to show the class samples of changes over time in a particular habitat or area. Visit the websites from the "Resource List" and view the pages with the students.

C. Using the background information from above and the Web sites from the resource list, discuss how natural resource managers and other professionals solve environmental issues using these mapping systems.

ASSESSMENT

See rubric on page 45.

RESOURCES

Please see Resource List for additional information related to mapping, GIS and GPS.

NAME

5
LESSON
STUDENT PAGE

Getting to the Bottom of the Lakes

BACKGROUND

In this activity, you will study the features of the Great Lakes through mapping. In order to understand these features, it is important to understand how the Great Lakes were formed.

During the Precambrian Era, the geologic setting was established bedrock and mountains that later contributed to the formation of Lake Superior during the glacial advances of the Ice Age. At that time, there was a fracture in the Earth running from what would become Oklahoma to Lake Superior. Mountains were created that covered the future sites of Wisconsin and Minnesota, and the Laurentian Mountains appeared in what would later be eastern Canada. Molten magma below the area where Lake Superior would later form spewed out to the sides, causing the Earth to sink and form a large rock basin, which now holds the lake. Inland seas covered the area, depositing sand and silt that were compressed into a soft substrate of sandstone, shale and limestone. The seas retreated before the end of the Precambrian Era.

VOCABULARY

bathymetric map
bathymetry
contour lines
contour map
Geographic Information System (GIS)
Global Positioning System (GPS)
impervious surface
lake bottom
plumb bob
topographic map
topography

During the last million years, glaciers advanced and retreated over the Great Lakes area several times. The most recent glaciers occurred during the Pleistocene Epoch (2 million to 11,000 years ago). The ice leveled mountains and carved out shallow valleys. River valleys from the previous era widened and deepened. The hard bedrock in the north was not as heavily eroded as the softer sandstone and shale in the south. As the glaciers melted and retreated, the valleys filled with the freshwater that is now the Great Lakes. The lakes continued to change over time as the land rebounded from the release of the weight of the glaciers.

Glaciers are made of ice, snow and rocks and can be 3.2 km, or two miles: equal to seven Sears Towers (now the Willis Tower)! A glacier occurs when ice and snow build up over a long period in which precipitation is greater than melting, due to constant cold temperatures. Interglacial periods are times of climate warming between glaciers, when plants and animals return. We are currently living in an interglacial period.

During the Pleistocene Epoch, glaciers advanced and retreated from the north four times, forming the landscape we see today. River valleys from the previous era were deepened and widened by the glaciers, hills were scraped flat, large basins were scooped out and piles of rocks were deposited in various formations. As the climate warmed, the glaciers melted, filling in a large basin and forming the Great Lakes.

As early as the late-16th century, navigators began measuring lake and ocean bottoms. These early bathymetric maps confirmed that ocean and lake bottoms were not as flat as people had once thought. These navigators measured the depth at different points using plumbs in fathoms. Both bathymetric and topographic maps use contour lines to connect points of equal depth or altitude. These navigators in the late 1500s mapped the depth at points, but did not include contour lines. True bathymetric and topographic maps were not made until the 18th century, when contour lines were drawn.

Water causes most erosion, which leads to landforms. Topographic maps show changes in elevation and how water flows over and changes the landscape. Although most land surrounding the Great Lakes is flat, the glaciers did leave some moraines in the basin. The rolling lowland landscape of the Great Lakes basin and the vast collections of freshwater in the Great Lakes have brought many people to the region.

To see a flash video of the formation of the lakes, go to Environment Canada's Great Lakes Kids: http://www.msue.msu.edu/objects/content_revision/download.cfm/item_id.211898/workspace_id.26697/How%20The%20Great%20Lakes%20Were%20Formed%20(Video).swf/

To "take a wild ride" through the lake bottoms of Lake Superior and Lake Michigan, go to the National Oceanic and Atmospheric Administration's National Geophysical Data Center: http://www.ngdc.noaa.gov/mgg/greatlakes/wildride.html

MORE INFORMATION ON MAPS

Contour lines are imaginary lines connecting points at the same elevation level. A contour interval is the predetermined elevation difference between any two contour lines. A contour interval of 100 feet means that the slope of the land has risen or declined by 100 feet between two contour lines. A map that shows very close contour lines means that the land is very steep. A map that has wide spacing between contour lines has a gentle slope. The smaller the contour interval, the more capable a map is of depicting the finer features and details of the land. A contour interval of 100 feet will only pick up the details of features larger than 100 feet. It also means that a mountain top could be 99 feet higher in elevation than the map depicts.

Since water causes most erosion, which, in turn, leads to landforms, topographic maps can show the direction that water flows. Contour lines usually form "v"s that point uphill, while streams run in the opposite direction.

Advancements in computer applications and computer processing speed provide even more uses for topographic maps. Overlaying a computer-generated topographic map of a river watershed onto a computer-generated local county, city, and highway map allows emergency planners to create virtual flooding events to see which roads, bridges, and buildings would be most affected.

BATHYMETRY

Bathymetric maps or charts are topographic maps of the bottoms of rivers, lakes and oceans. Bathymetry and topography are quite similar, although bathymetry measures the distances below sea level while topography measures the distances above sea level. Although more people are probably familiar with topographic maps, bathymetric maps have a longer history than they do.

INTRODUCTORY QUESTIONS

1. As you think about how the Great Lakes were formed, what do you think the bottoms of the Great Lakes look like?

2. Why is it useful to know what a lake bottom looks like?

3. Sketch what you think a lake bottom looks like:

BATHYMETRIC MAPS

Your teacher created a lake in a fish tank, and you will measure the depth of this lake in order to create a bathymetric map.

4a. First, outline the fish tank on your graph paper, to represent the lake.

4b. Determine how you will measure the distance from the surface of the water to the bottom of the lake bottom. You can use a plumb bob attached to a string. You will need to mark the string after you reach every centimeter, but be sure to include the total length of the string with the plumb bob attached when listing your measurements on the map. Another method of measurement would be to use a ruler or a tape measure.

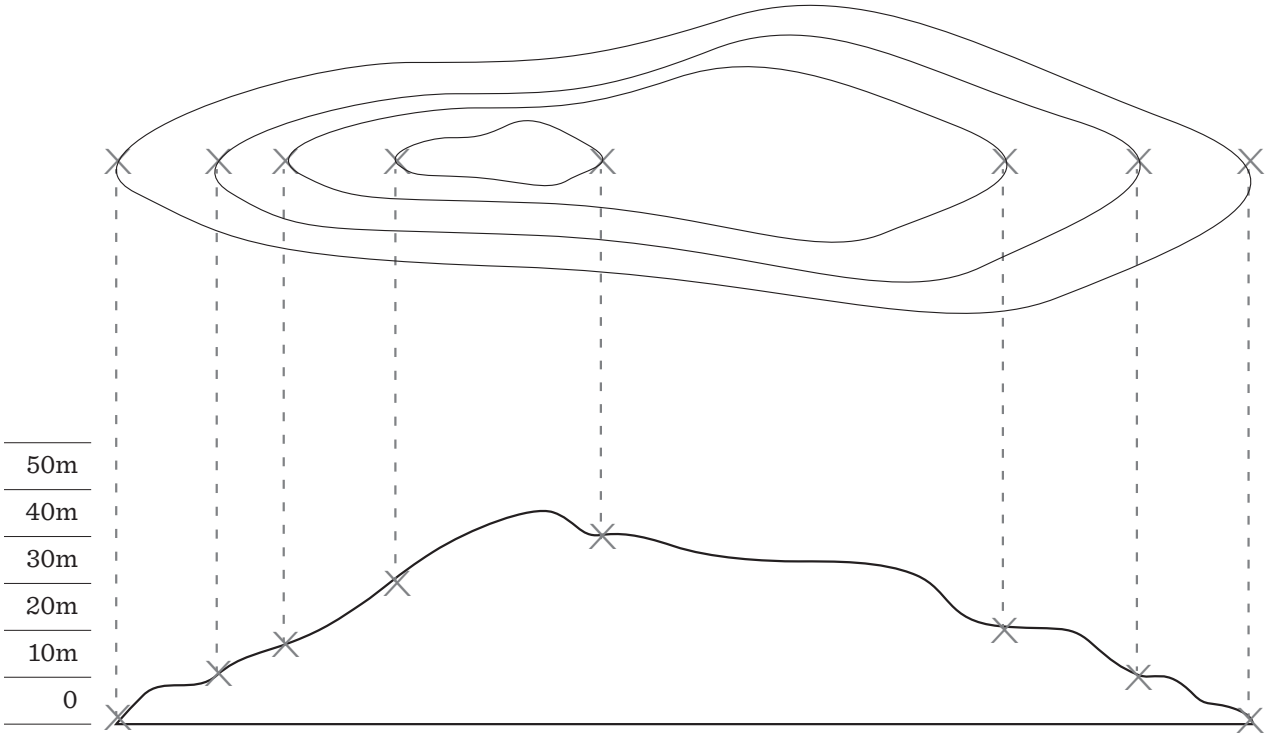
4c. Next, measure the distance from the top of the water (sea level) to the bottom of the "lake" at a minimum of 15 different points. Plot these depths on your graph paper. You will use contour lines to connect the places where the depths are the same. On a bathymetric map, all points inside of the contour lines are deeper, while all points outside of the contour lines are shallower. Draw all of the depths that you have measured to make a bathymetric map of the lake bottom. Scientists have used mapping to create a profile of the Great Lakes system. Search online for a profile image of the Great Lakes to compare the depths and positions of the different lakes.

TOPOGRAPHIC MAPS

A topographic map is a two-dimensional map portraying a three-dimensional landform. Geologists, field biologists, geographers and hikers are just a few of the professionals who use topographic maps. While the use of a Global Positioning System (GPS) can give you their exact locations on Earth and even their directions from, and how far away they are, from other locations, it does not tell you if there are rivers, canyons and steep mountains along a suggested, direct route. A topographic map does.

Anyone who needs to know their position on Earth in relation to surrounding surface features may use a topographic map to understand this relationship. Visualization between two dimensions and three dimensions, a skill used in many other fields, can be a difficult process for some people. Interpreting topographic maps provides practice in this skill. In this part, you will use a topographic map to draw the profile (or a scaled side view) of a landform.

The map below shows how we can use topographic lines to create a profile, or cross-section, of a land feature. Use the bathymetric map you plotted to draw a profile of the lake bottom (of the fishtank).



WRAP-UP QUESTIONS

5. Compare and contrast topographic and bathymetric maps. For example, what they look like or how they are used.

6. Why do you think bathymetric maps were used earlier in time than topographic maps were?

7. How can bathymetric maps be used to understand, assess or solve problems in relation to an ecosystem or an environmental issue, such as erosion, invasive species, land use, population growth?

8. How has technology improved our understanding of the Great Lakes and the Great Lakes watershed?

9. How could you use a bathymetric or topographic map? How could a natural resource managers and other professionals solve environmental issues using these mapping systems?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
DISCUSSION: Student participates in class discussion about what a lake bottom may look like, why would we want to know that information, and how would that distance be measured. Student understands the difference between bathymetry and topography.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
MAPPING: Student logistically planned how to map the bottom of the fish tank by using a measuring tool. Student measured and recorded the depth at a minimum of 15 different points. Student plotted depth points on graph paper and connected them with contour lines. Students included the following elements on their final map: title, compass rose, key, labels, and scale.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
WRAP-UP: Student displays his/her bathymetric map for peers to view. Student recognizes the differences and similarities between their map and their classmates' maps. Student participates in class discussion about how maps are useful to scientists, conservationists, teachers, government leaders, and the community. Student relates discussion to wrap-up questions and completes.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Coastal Habitat Research

Students research the major Great Lakes coastal habitats and create a visual representation of one of these habitats. If possible, students visit at least one of these habitats.

OBJECTIVES

Identify the major habitats along the Great Lakes coast	Describe how humans depend on these Great Lakes habitats	Identify at least 10 native plants and animals in one habitat	Create a visual representation of one coastal habitat	Present information and a visual of a coastal habitat

SUBJECT
Ecology, Language arts, Environmental science

PREREQUISITE
#1: Coastal Journey

VOCABULARY
beach
bog
emergent marsh
fen
forested shoreline
lakeplain prairie
ravine
river
sand dune
savanna
swale
swamp
wetland

MATERIALS
enlarged printout or projection of the coastal habitats chart
research supplies, including computers with internet access
art supplies (i.e. colored pencils, markers, paints)

TIME/DURATION
3 hours

SETTING
Indoors, Computer lab, outdoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

The Great Lakes coastal zone encompasses some of the most diverse and productive ecosystems in the region. Dramatic sand dunes, lush grasslands, and forests characterize some of the unique coastal ecosystems found along the Great Lakes shorelines.

These unique transition areas along the Great Lakes—linking land and water—provide critical habitats for many species of plants and animals, some of which are found only in the Great Lakes watershed. The transitional ecosystems may include a sand dune, wetland (emergent marsh, bog, fen, swamp and/or swale), beach, lakeplain prairie, savanna, forested shoreline, island, the flowing waters of connected rivers and the open waters of the Great Lakes.

PROCEDURE

1. Introduce the activity by telling the class that they're going to build upon what they've learned about coastal habitats. You will need to project the coastal habitat chart onto a white board, or produce a large classroom copy of the chart. Each student should also have a copy of the chart from the student pages.

2. Students read the background information and answer the questions on their student pages: How do plants, animals and people depend on the habitats along the Great Lakes coastlines?

3. Next, on their individual charts, students should fill in the first (left) column with the names of the coastal habitats they've studied as a class. As the students fill in the left column on their individual charts, the teacher (or a student volunteer) should fill in the left column on the classroom chart.

4. Each student (or small group of students) selects one coastal habitat to research. Students research the habitat and use the information to fill in the rows on the chart. Students record the research in their journal or notebook, then enter concise responses on their own charts with information about the following:

   Location
   Climate
   Landscape Characteristics
   Native Flora (at least five)
   Native Fauna (at least five)
   How humans use or benefit from this habitat

5. Each student creates a visual representation (i.e. picture book, Web site, poster, video) of his/her selected coastal habitat. If students choose to make a book, consider one of the formats described on the Web site - Making Books: http://www.makingbooks.com/freeprojects.shtml. Visual representations should include the information from their charts, but students can also choose to include additional information (i.e. interesting facts, specific examples of these coastal habitats). These projects should include photographs and/or drawings of the habitats in addition to written or typed information.

6. Each student writes a one-page essay explaining the ecology, interrelationships and importance of the coastal habitats they have chosen. Essays should answer: What are the characteristics of this coastal habitat? What makes this coastal habitat unique? Why is it important to preserve or restore these coastal habitats?

7. Each student (or small group) should give a three- to five-minute presentation, which includes their visual representation and educates others about the coastal habitat that they researched. While students are presenting, other students will fill in the information on their own chart. To encourage other students to be attentive, the presenter should make their presentation interactive (i.e. with a quiz for the audience, discussion questions).

WRAP-UP

8. Discuss the following questions as a class: What characteristics are shared by these coastal habitats? What species are found in more than one of these ecosystems? How do humans depend on these coastal habitats? What problems might humans cause for plants and animals within these ecosystems? *(Global climate change and its effects, erosion, invasive species, habitat destruction, pollution)* What problems might nature cause for plants and animals within these ecosystems? *(Global climate change and its effects, erosion, weathering)* Why is it important to conserve or protect these ecosystems?

9. Students answer the wrap-up questions from above on their student pages.

EXTENSION

A. As a class, take a field trip to an off-campus coastal habitat, or visit a local habitat. Students can take photographs of the habitat and its flora and fauna. Another option would be to ask students to visit a local coastal habitat as a homework or extra-credit assignment to observe and take photographs.

B. Students share their coastal habitat projects with another class or the community (e.g. town/village hall, library, local business). Students can host a "Coastal Habitats Fair" or display their visual representations in the library or during a parent visit night.

ASSESSMENT

See rubric on page 52.

RESOURCES

Please see Resource List for additional information related to sand dunes, wetlands, native and invasive species and more.

NAME

6
LESSON
STUDENT PAGE

Coastal Habitat Research

VOCABULARY

beach
bog
dune
emergent marshes
fen
forested shoreline
lakeplain prairie
ravine
river
sand dunes
savanna
swale
swamp
wetlands

BACKGROUND

The Great Lakes coastal zone encompasses some of the most diverse and productive ecosystems in the region. Dramatic sand dunes, lush grasslands, and forests characterize some of the unique coastal ecosystems found along the Great Lakes shorelines.

These unique transition areas along the Great Lakes—linking land and water—provide critical habitats for many species of plants and animals, some of which are found only in the Great Lakes Basin. The transitional ecosystems include sand dune, wetland (emergent marsh, bog, fen, swamp and swale), beach, lakeplain prairie, savanna, forested shoreline, island, the flowing waters of connected rivers and the open waters of the Great Lakes. Keep in mind all of the different aspects of coastal habitats and how they impact your daily life.

INTRODUCTORY QUESTIONS

1. How do plants, animals and people depend on the habitats along the Great Lakes coastline?

COASTAL HABITATS: RESEARCH
On your own or in a small group, research one of the coastal ecosystems of the Great Lakes. Take notes on notecards or on a separate sheet of paper, then fill in one row of the information table with the facts that you learned while researching. Later, while your classmates present information about their ecosystems, fill in the other rows of the table.

COASTAL HABITATS: A VISUAL REPRESENTATION
It's time to be creative. Create a visual representation of the coastal habitat you researched. This could be a poster, picture book, Web page or other representation. Your visual representation should include the information from the chart above, but you can also choose to include additional information (i.e. interesting facts, specific examples of these coastal habitats). Your project should include photographs and/or drawings of the habitat.

COASTAL HABITATS: A WRITTEN REPRESENTATION
Using a computer or a separate sheet of paper, write a one-page essay explaining the ecology, interrelationships and importance of the coastal habitat that you researched. Your essay should answer the following questions: What are the characteristics of this coastal habitat? What makes this coastal habitat unique? Why is it important to preserve or restore coastal habitats?

NAME:

COASTAL HABITATS: RESEARCH

ECOSYSTEM	DESCRIPTION	LOCATION	PHYSICAL CHARACTERISTICS	CLIMATE

NAME

FLORA	FAUNA	HUMAN CONNECTION	BIODIVERSITY THREAT	INTERESTING FACTS

Use this space for research notes, to sketch ideas for your visual representation or to outline your essay.

WRAP-UP QUESTIONS

2. What characteristics are shared by these coastal habitats?

3. What organisms are found in more than one of these ecosystems?

4. How do humans depend on these coastal habitats?

5. What problems might nature cause for plants and animals within these ecosystems? What problems might humans cause?

6. Why is it important to conserve or protect these ecosystems?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
RESEARCH: Student recognizes the different types of coastal habitats and chooses one habitat to research. Student is able to report the location, climate, landscape characteristics, five native plants, five native animals and the human connection to this habitat.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
VISUAL REPRESENTATION: Student creates a visual representation of their selected coastal habitat. Visual representations include all information described in the table, any interesting facts, specific examples of coastal habitat, photographs and/or drawings.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
ESSAY: Student explains the ecology, interrelationships, and importance of the coastal habitat they have chosen in a one-page essay. Essay describes the characteristics of the habitat, any unique features, and why it is important to preserve and/or restore this habitat. The essay is well developed and thorough. All ideas are supported with evidence from research. Spelling and grammar are accurate. Sources are cited.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
PRESENTATION: Student educates the class about the coastal habitat they researched through giving a three- to five-minute presentation. Student uses the visual aid they created and interacts with classmates in group discussion.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
SYNTHESIS: While other students are presenting, student completes the remainder of the coastal habitat table with information presented by their peers. Student asks questions, if needed, to fully complete the table.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

The Great Race for Survival

Students practice classification skills to understand how plants are typically organized in a field guide. Students use the information collected to create a field guide about native coastal plants.

OBJECTIVES

Sort and classify plants by characteristics

Research native and non-native species found along the Great Lakes coasts

Create pages for a Great Lakes native coastal plant "field guide"

SUBJECT

Biology, Ecology, Botany

PREREQUISITE

A visit to a coastal habitat where students make observations about specific plants. If students did not visit a habitat, they may choose any Great Lakes habitat's plants to research or the teacher may bring plants, leaves, flowers and photos of plants to class.

VOCABULARY

alternate leaves
annual
basal leaves
biennial
compound leaf
dichotomous key
field guide
germination
invasive species
lobes
native species
node
opposite leaves
perennial
veins

MATERIALS

notecards with plant species written on them (for the great race for survival)
Creature Card plant cards
leaf/plant samples (a variety)
pencils
colored pencils (if students will create their field guides by hand)
research resources (books, field guides, Internet)
quart-sized sealable bags (to sort plants/leaves)
permanent markers
other field guides (Golden Books, Audubon, etc.)
hand lenses
computers (with printing access)

TIME/DURATION

120 minutes

SETTING

Indoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

This activity introduces students to the characteristics of plants, both native and invasive, and teaches them to identify plants by their characteristics using various systems. The lesson begins with a simulation of native and invasive plants competing for space in a habitat. In order to determine if a plant is native or invasive, it must first be identified. To begin, students develop and use their own system of classification to identify plants. They then use a dichotomous key to identify a group of plants. Finally, students create field guide pages for the plants that they studied in this lesson. *See the student page for additional background information.*

PROCEDURE

1. Introduction: Students read the background information on their student pages and answer the introductory questions: What invasive plants have you heard of? How did these plants arrive at a location where they are considered invasive? What are some ways to identify and classify plants?

PART ONE: SIMULATION - "The Great Race for Survival"

Note: Write the names of the native and invasive species listed below on notecards. If there are fewer than 20 students, you will not use all of the species. If there are more than 20 students, write the names of some species on more than one card.

PLANT SPECIES FOR RACE SIMULATION

Native – American beech, beach pea, beach wormwood, black oak, common milkweed, hairy puccoon, marram grass, pitcher's thistle, riverbank grape, sand cherry, sea rocket

Invasive – baby's breath, garlic mustard, Japanese barberry, Japanese honeysuckle, multiflora rose, oriental bittersweet, purple loosestrife, spotted knapweed, tree-of-heaven

MOVEMENT DIRECTIONS

2. Select an open area, such as a gym or playing field, in which to conduct a race. Use cones or a rope to designate a starting and finishing line. Position the finishing line about 50 feet from the starting line.

3. The teacher reads aloud the following information to students:

Each one of you has been magically transformed into a tiny plant seed. You are each a different kind of seed from a different kind of plant. Through the actions of wind, water, animals, and people, each one of you is now lying along the same stretch of road on a Great Lakes beach. You have been lying dormant in the soil all winter. When this road was rerouted last year, the construction caused a disturbance in the soil. Conditions are now ideal for weed species to establish themselves here. The events that I will describe represent one year in your life. Not all of you will survive the year. Listen carefully to the instructions. When I tell you to step forward or backward, take normal walking steps.

It is early spring. Rain, snowmelt, warm temperatures, and long days result in rapid plant growth. Perennials send up new shoots from the soil, and seeds that have lain dormant all winter start to sprout. **Everyone take five steps forward.**

The soil along this new road bed contains many more seeds from some types of plants than others. **Baby's breath, spotted knapweed, oriental bittersweet and purple loosestrife take two steps forward. Garlic mustard take six steps forward.**

Some plants are taller and grow in thick patches, preventing other plants from growing so that they have more resources for themselves. **Japanese honeysuckle and multiflora rose take three steps forward.**

The growing season continues to be favorable. **All plants take 10 steps forward.**

Garlic mustard completes its life cycle the fastest, and it produces seeds before the other species. **Garlic mustard take five steps forward.**

A few species are capable of producing chemicals that they release into the soil. These chemicals inhibit the growth of nearby plants. Spotted knapweed and Japanese barberry raise your hands. **Any plant within five steps of these plants move backwards three steps.**

As the growing season continues, drought hits this area, and plant growth slows. Deep-rooted plants do best. **Tree-of-heaven move two steps forward.**

Summer storms and slightly cooler temperatures improve growing conditions for all plants. **All plants move forward six steps.**

Oriental bittersweet, raise your hand. This plant sends out long, creeping vines that can form a dense mat of vegetation, which chokes out other species in a wide area. **All plants within four steps of oriental bittersweet, move backward three steps.**

Plants continue to grow, but shortened days slow growth. **All plants move four steps forward.**

Much plant energy is now devoted to food storage and seed production. **All plants move forward two steps.**

Some plants produce numerous amounts of seeds. They are able to ensure their success by having more seedlings than other species, along with the ability to spread to new locations. One plant of purple loosestrife can produce up to two million seeds per year. **Purple loosestrife take five steps forward.**

4. End the game after one or more students have crossed the finish line.

5. Discussion: Was the "winner" a native or invasive species? Why do you think that was? In what habitat would these plants thrive? What reproductive or growth habits did the Invasives display? What impact would invasive plants have on an ecosystem? Why is it important to identify and respond to invasive species in an ecosystem? Students should think about what new information they learned during this simulation.

PART TWO: CLASSIFYING LEAVES

6. Discussion: In order to determine if a plant is native or invasive, it must first be identified. Explain to students that scientists use a system of classification to identify and organize plants, animals and other natural objects. *Plants, for example, are sorted into groups with similar traits. Within "like" groups, the differences among plants help distinguish them from each other. Field guides are arranged using a classification system to make it easier for people to find or identify specific plants.*

7. The students now practice classifying plants using their own system of classification. Break students into small groups. Give each group a set of at least six different leaves. Have each of the groups divide their leaves into two categories, based on an easily observed difference. Then have students divide those two categories in half again, based-on characteristics. It does not matter which characteristics the students choose.

PART THREE: PLANT KEY

8. Students will use the dichotomous key included in the student pages to identify Great Lakes native plant species. Botanists, ecologists and other scientists or natural resource managers use dichotomous keys to identify uncommon native species or invasive species. Students will identify invasive species from Part One: Simulation - "The Great Race for Survival".

PART FOUR: FIELD GUIDE ACTIVITY

9. Each of these small groups will create a field guide for the 10 native plant species from Part One: Simulation, "The Great Race for Survival -- Alien Invasion: Plants on the Move." Students will work in groups, but each student will create his/her own field guide pages. Student journal pages include a template for creating a plant field guide page. Students should also take advantage of other resources to gain information about their plants (guide books, the internet). The Native Plant Field Guide will include information on the plant's history, description, leaves, stems, flowers, habitat, reproduction and additional comments. Each student should draw his/her plant and fill in the information for it.

10. When students have completed their pages, collect them and then pass them out randomly so that each student has another student's page. Students will assess each other's pages based-on the following questions, written on the board. Or, have students come up with the assessment criteria. They should answer these questions on a separate sheet of paper.

a. Are all of the questions answered completely? (One point for each answer - 10 points total) If you feel that there is missing information, indicate what is missing.

b. Is the drawing detailed? (1-3 points for very little detail, 4-6 points for some detail, 7-10 points for lots of detail) If students give fewer points, they should make suggestions for what details could be added.

11. Discussion: What systems do scientists, naturalists, gardeners and other people use to classify plants? What characteristics must you be familiar with to identify plants? Would you prefer to use a dichotomous key or a field guide to help with identifying native plants while out at the dunes? Why are there multiple classification systems?

WRAP-UP

11. To create a complete field guide that includes all of the plants studied, choose the most accurate and complete entry for each plant. Photocopy these pages to create a complete set of field guide pages. Distribute a copy of the field guide to each student.

12. Have the class come up with a classification system with which to organize the field guide. To do this, they first need to come up with one major difference between the plants to divide them into categories. From there, they should break each category down one step further until each plant has its own identity.

13. Discuss the following and have students respond to these questions in their student pages: What impacts do invasive plants have on an ecosystem? Why is it important to identify and respond to invasive species in ecosystems?

EXTENSION

A. Students research native plants from other coastal habitats and create a field guide of these native plants.

B. The plants that students observe will change through the seasons. If it's practical, have students observe their plants several other times during the year and take note of any changes. For example, has the plant grown, flowered, or gone to seed? To be sure that students find the same plant at each visit, mark each one with a stake on the first field trip. Students may add new information to their field guides after each seasonal observation.

C. Use a dichotomous key to identify Great Lakes fish, by visiting Michigan Sea Grant's Project Flow Web site: http://www.miseagrant.umich.edu/flow/pdf/U3/FLOW-U3-L1-MICHU-08-403.pdf

ASSESSMENT

See rubric on page 61.

RESOURCES

Please see Resource List for additional information related to Great Lakes field guides, native and invasive species and more.

SOURCES

"The Great Race for Survival - Alien Invasion: Plants on the Move", modified for the Indiana Dunes from "Invaders of the Forest" 2005, WEEB, WDNR, Park People of Milwaukee County

NAME _____

7
LESSON
STUDENT PAGE

The Great Race for Survival

VOCABULARY

alternate leaves
annual
basal leaves
biennial
compound leaf
dichotomous key
field guide
germination
invasive species
lobes
native species
node
opposite leaves
perennial
veins

BACKGROUND

Invasive species travel, often accidentally, from their native ecosystem to a new ecosystem. There are hundreds of examples of invasive species (also known as exotic or nonnative species) around the world. An "introduced species" is one that has been intentionally brought from its native ecosystem to a new one. When a new species is introduced into an ecosystem, the balance is altered and competition is high until a new balance is achieved. Many times invasive or introduced species cannot survive in these new ecosystems or become a non-threatening part of this ecosystem. However, if the new species is successful, one or more native species populations can suffer, altering the ecosystem. The Great Lakes ecosystem has been "invaded" by nonnative invasive plant species such as baby's breath (Gypsophila paniculata) and garlic mustard (Alliaria petiolata), which have spread rapidly and outcompeted native species for space and resources. Since they are not indigenous, they do not usually have any natural enemies present to control their populations, which allows them to grow rapidly and easily out-compete native species. According to the United Nations Convention on Biological Diversity, about $1.4 trillion a year is spent globally to control invasive species and to help repair the damage they cause.

Each native coastal plant has a role. They may provide food or shelter to birds, insects, or other animals; hold soil in place; filter water; or provide a home for important bacteria or fungi. In this activity, students will observe plants from a coastal habitat, such as a wetland, shoreline forest, or dune, and learn about their characteristics and specific habitat. In this activity, you will characterize plants, both native and invasive, and you will learn to identify plants by their characteristics using various systems. In order to determine if a plant is native or invasive, one must be able to identify it.

Organisms can be identified with the use of a dichotomous key. Dichotomous keys have a number of different steps each with two options (just as "mono" means one, "di" means two). The user must select the option that best describes the plant in question and then he/she will be directed to a new pair of options to choose from. Eventually, the choices made will lead the user to the correct name of a given item.

This lesson begins with a simulation of native and invasive plans competing for a place in a habitat, and then continues as you learn how plants are classified and identified.

INTRODUCTORY QUESTIONS

1. What are some invasive plants that you have heard of?

_____

_____

_____

_____

_____

2. How do these plants get to a location where they are considered invasive?

3. What are some ways that you know of that are used to identify and classify plants?

GREAT RACE FOR SURVIVAL

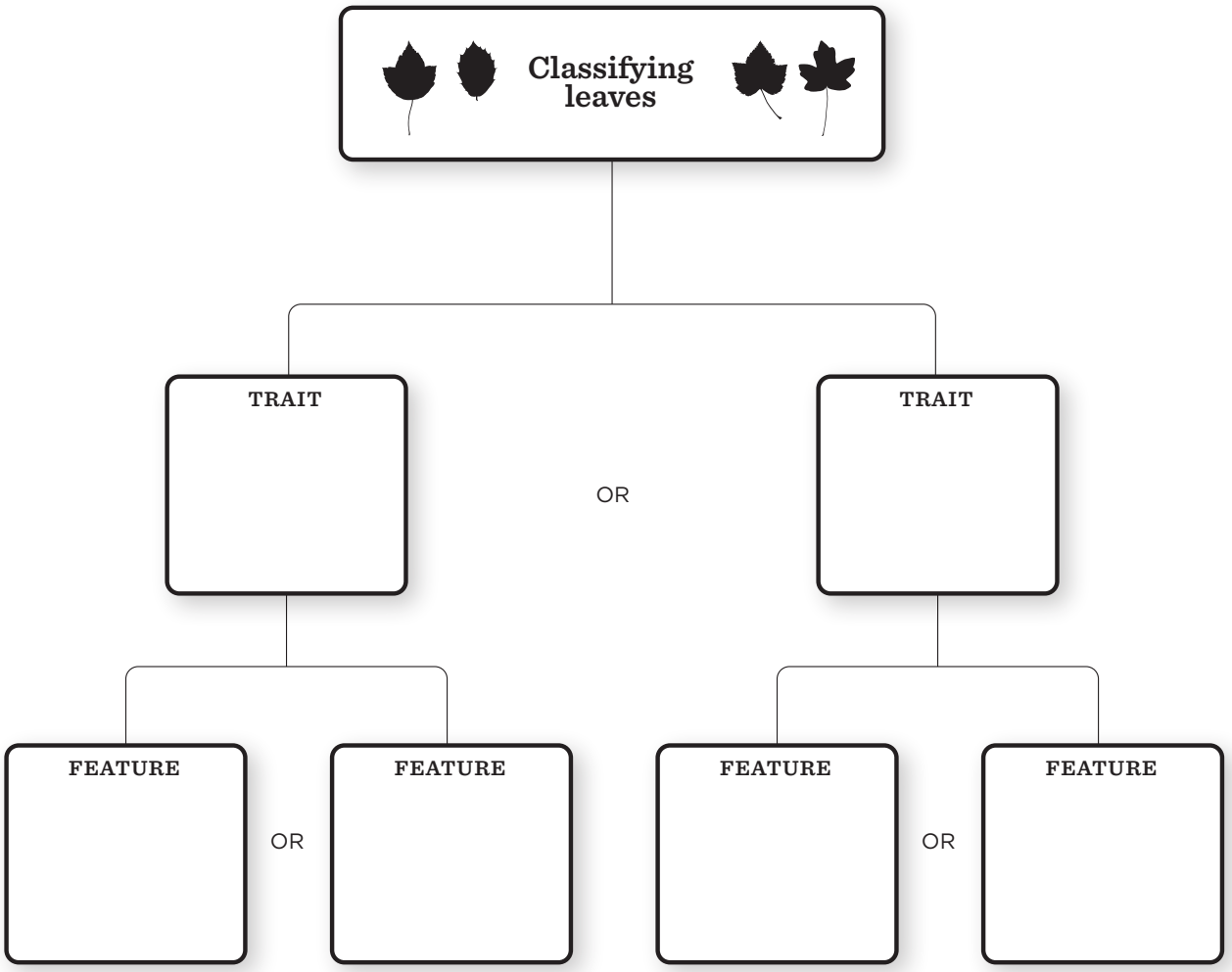
4. Your species:_____ Is it native or invasive? (circle one)

5. Was the "winner" a native or invasive plant? Why do you think that was?

6. What new information did you learn during this simulation?

CLASSIFYING LEAVES

Classify the leaves you were given based on their unique traits and features. First divide the leaves into two groups based on traits, then divide each of those groups by additional features.



FIELD GUIDE TEMPLATE

You will create a field guide page for a native plant. Draw the plant in the space provided and fill in the information below. Label any important traits on the drawing.

TYPE (CIRCLE ONE)
Woody • Herbaceous

BRANCHING
Opposite • Alternate

FLOWERS
Yes • No
Number of Petals _____
Color_____

SEEDS
Fruit • Nut • Parachute • Hitchhiker
Other

LEAVES
Color _____
Shape _____
Height _____

OTHER INFORMATION _____
_____
_____
_____
_____
_____
_____
_____
_____

SUNLIGHT
Sunny • Shady

SOIL
Wet • Medium • Dry • Clayey
Sandy • Mixed

LOCATION
Underwater • Emerging from the water
At the edge of the water • On land

ABUNDANCE
High Number • Medium • Very Few

DICHOTOMOUS KEY Identify the plant species on the left by making a selection in each step. You may also use the Creature Cards.

FIGURE	STEP	DIAGNOSTIC
	1 A	Plant has "woody" growth or parts ➥ GO TO 2
	1 B	Plant does not have "woody" growth or parts ➥ GO TO 5
	2 A	Plant has one erect perennial stem (trunk) that branches out with a crown of foliage ➥ GO TO 3
	2 B	Plant has several perennial stems that may be erect or close to the ground ➥ GO TO 4
	3 A	Plant has leaves that are deeply lobed and have tiny hairs on the underside ➥ BLACK OAK
	3 B	Plant has alternate leaves that are coarsely serrated with wavy edges ➥ AMERICAN BEECH
	4 A	Plant has white flowers and purple-black fruits ➥ SAND CHERRY
	4 B	Plant has grayish green leaves and yellow flowers ➥ BEACH WORMWOOD
	5 A	Plant is found on the foredune, beaches, and along lakes and oceans ➥ GO TO 6
	5 B	Plant is found on the forested backdune, forest floor, and climbing on trees ➥ POISON IVY
	6 A	Plant has flowers ➥ GO TO 7
	6 B	Plant has no flowers, but has narrow, spike-like leaves ➥ MARRAM GRASS
	7 A	Plant has fine hairs along the stems or leaves ➥ GO TO 8
	7 B	Plant does not have any hair along the stems or leaves ➥ GO TO 9
	8 A	Plant has pink/lavender flowers, and opposite oval shaped leaves ➥ COMMON MILKWEED
	8 B	Plant has orange/yellow flowers, and alternate narrow leaves ➥ HAIRY PUCCOON
	8 C	Plant has cream/pink flowers, and finely and deeply lobed leaves up to 1ft long ➥ PITCHER'S THISTLE
	9 A	Plant is less than 2 feet in height ➥ GO TO 10
	9B	Plant is greater than 2 feet in height with vines up to 50 feet long ➥ RIVERBANK GRAPE
	10 A	Plant has purple or pink flowers in clusters at the end of the stem ➥ BEACH PEA
	10 B	Plant has white/lavender flowers with thick, fleshy leaves ➥ SEA ROCKET

WRAP-UP QUESTIONS

7. What impacts do invasive plants have on an ecosystem?

8. Why is it important to identify and respond to invasive species in ecosystems?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
SIMULATION: Student participates in "The Great Race for Survival" and actively listens to instructions about his/her assigned plant species. Student recognizes the native and invasive plant species presented and the effects they have on coastal habitats.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
GROUP WORK: Student works with his/her group to classify leaves, based on their own set of characteristics. Student uses a dichotomous key to identify plants according to their features.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
FIELD GUIDE: Student creates a field guide for a native plant that includes the plant's history; a description of the plant and its leaves, stems, flowers; details about the plant's habitat; information about the plant's reproduction process; and any additional information. Visual representations of the plant are drawn using colored pencils.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
DISCUSSION: Student receives another student's field guide page and assesses the details of the information provided and the drawing. Student participates in group discussion and understands dichotomous keys and field guides and uses for each to classify native and invasive plants.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Food Web Invasion

Students develop a food web with ten native species and show the impact of two invasive species.

OBJECTIVES

List at least 10 connections between Great Lakes coastal organisms in a food web

Explain the impacts of changes on a Great Lakes coastal habitat food web

Diagram a food web that shows the interconnectedness of native species and two invasive species

SUBJECT
Ecology

PREREQUISITE
#7: The Great Race for Survival

VOCABULARY
autotroph
decomposer
food chain
food web
heterotroph
invasive species
primary producer
primary consumer
quaternary consumer
secondary consumer
tertiary consumer

MATERIALS
Great Lakes food chain and food web images
paper
pencils
drawing supplies

TIME/DURATION
90 minutes + presentations

SETTING
Indoors
Outdoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

INVASIVE SPECIES IN THE GREAT LAKES REGION

Invasive species travel, often accidentally, from their native ecosystem to a new ecosystem. Waterborne commerce moves millions of tons of cargo annually through the Great Lakes. Shipping is an economically efficient method of transporting raw materials, finished goods and agricultural products. However, shipping can accidentally introduce nonnative species which may be detrimental to the Great Lakes ecosystem. There are hundreds of examples of invasive species (also known as exotic or nonnative species) around the world. *See student pages for additional information.*

FOOD CHAINS AND FOOD WEBS

Food chains that show feeding relationships in an ecosystem are part of large and complex foodwebs. By exploring these relationships, students become familiar with the concept of food webs, as well as the different plants and animals that inhabit coastal habitats along the Great Lakes. There are many ways to model a food web. It is important that the information on organisms is accurate. Students may be creative with this project – it might be a two-or three-dimensional model. It may take the shape of a puzzle, a web, a mural, a graphic computer-design, or visual model.

PROCEDURE

INTRODUCTION

PART ONE: GREAT LAKES FOOD CHAINS AND FOOD WEBS

1. Students read the background information and answer the introductory questions. Students use the Creature Cards to connect the parts of the food web. Teacher shows the Great Lakes ecosystem food chain and food web as models, pointing out the multiple levels. Discuss how energy is transferred throughout the food web.

2. Assign each student a coastal habitat: sand dune, wetland or prairie. Then, each student will create a food chain of organisms within that coastal habitat. This food chain should include one autotroph (producer) and at least two heterotrophs (consumers): one primary consumer and one secondary consumer.

3. Students divide into groups based on their habitat to create a food web as a group for sand dune, wetland or prairie. Students who created a sand dune food chain gather with other students who created a sand dune food chain. Each group will combine organisms and connections from their food chains to create a food web with at least 10 organisms from their habitat.

PART TWO: GREAT LAKES FOOD WEBS INVASION

4. Students then "introduce" an invasive species (from the background information on the student pages) into their habitat's food web and discuss the following in a group: What type of impact does the invasive species have on the habitat's food web? Does it eat something that is a food source for another species? Does it occupy the same habitat or niche as another species? Does it eat species that do not have a natural predator (i.e. another invasive species)?

5. Then students introduce a second invasive species into their habitat's food web and discuss the impacts of the second species.

6. Each student then re-draws the food web to show the effect that these invasive species could have on other organisms in the habitat. All of the students' food webs might not look exactly the same, as the invasive species may have different effects on the ecosystem. Students are expected to make predictions based-on learned facts, as scientists do; these should not be considered correct or incorrect, but rather as possible implications to the invasion of a non-native species.

DISCUSSION

7. Make clear the difference between the short- and long-term time scales. The imbalance in ecosystems caused by invasive species may be corrected through evolution, but this happens over a very long period of time (thousands of years). In the more immediate future, invasive species may do considerable damage to an ecosystem.

8. Discuss the following questions with your students. Help them to be inquisitive and to problem-solve: What is the answer to problems caused by invasive species? Do students think that the best solution to this problem is to let the food web take its own course in finding a new balance or to try to control the invasive species? What are the possible ways in which invasives could be controlled in the water? *Preventative measures include: washing off a boat so it does not transport invasive species, electric barriers, regulations on shipping ballast water, separation of waterways. Measures to reduce existing numbers of invasives in the Great Lakes include selective poisoning, introducing predators and interfering with reproduction.* What are the possible ways in which they could be controlled on land? *Remove plant seeds and fragments from clothing, hiking boots, and equipment after enjoying outdoor activities. Learn to identify common invasive plants in your backyard and in the natural areas of your neighborhood, and report these plants to the local Department of Natural Resources.*

PART THREE: INVASIVE SPECIES RESEARCH

9. Students return to their food web groups to research potential solutions to the damage caused by their species.

10. Have students research by looking for articles on their species on the following web site: http://www.glerl.noaa.gov/res/Programs/glansis/glansis.html or http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html. Each group should read at least two articles on their species and one article on another species.

11. After reading the articles and doing additional research as necessary, students should brainstorm a list of potential solutions. Have each group choose one solution from their list on which to expand.

WRAP-UP

12. Students each write a one-page essay explaining the impact of the invasive species they have chosen and a possible solution to the problem.

13. Student groups each take five minutes to present their issue and the proposed solution to the class.

14. As a class, discuss what can be done to bring about these proposed solutions. What parties (organizations or individuals) in their community or state would be able to affect change?

EXTENSION

A. Integrate Language Arts: Turn essays into proposal letters to send to the local, state or federal political officials who are in the best positions to affect change. If you choose to do this, it is important to first discuss with students that while they are capable of making change, people are not always successful on their first attempt.

ASSESSMENT

See rubric on page 70.

RESOURCES

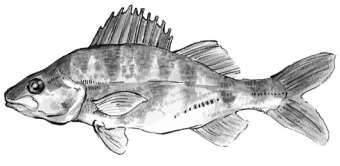
Please see Resource List for additional information related to native and invasive species.

sun

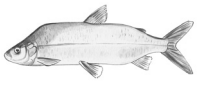
humans

green algae

water strider

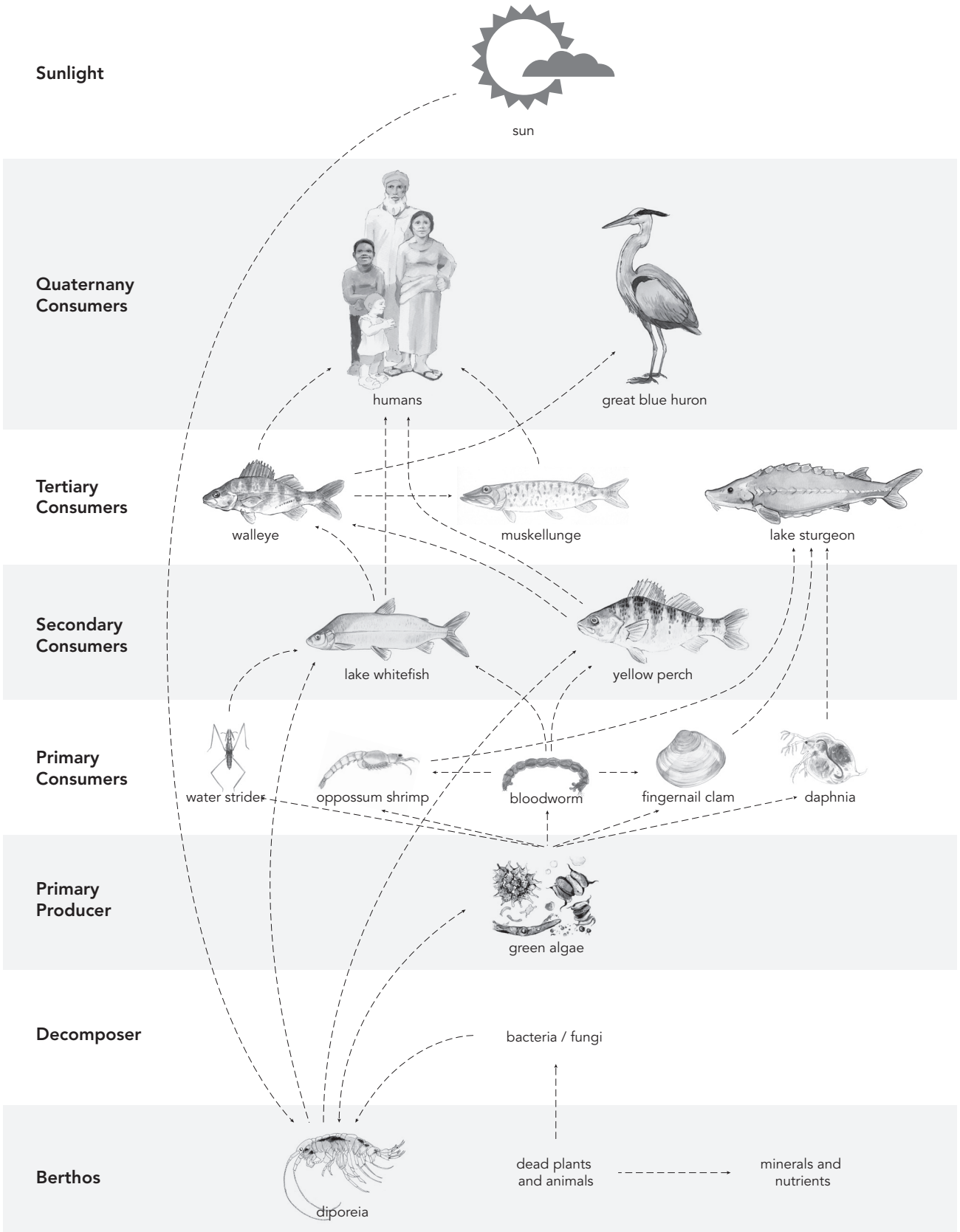


walleye



lake whitefish

GREAT LAKES FOOD WEB



NAME

8
LESSON
STUDENT PAGE

Food Webs Invasion

VOCABULARY

autotroph
primary consumer
decomposer
food chain
food web
heterotroph
invasive species
primary producer
primary consumer
quaternary consumer
secondary consumer
tertiary consumer

BACKGROUND

Invasive species arrive, often accidentally, from their native ecosystem to a new ecosystem. There are hundreds of examples of invasive species (also known as exotic or nonnative species) around the world. An "introduced species" is one that has been intentionally brought from their native ecosystem to a new one. Many times invasive or introduced species cannot survive in these new ecosystems or become a non-threatening part of the ecosystem. However, if the new species is successful, one or more native species populations can suffer, altering the ecosystem. The Great Lakes have been altered and have rebalanced throughout history. Our region is dynamic. In this lesson, you should think about how humans and other species have altered the Great Lakes.

Asian carp are just one of many nuisance animal and plant species that have moved or are poised to move between the Great Lakes and Mississippi River basins via the manmade Chicago Waterway System that has connected the basins for more than 100 years. Other invasive species introduced into the Great Lakes and their coastal habitats are: rusty crayfish, spiny water flea, common carp, Eurasian ruffe, sea lamprey, zebra and quagga mussels, Eurasian water milfoil, garlic mustard, Japanese barberry, Japanese honeysuckle, multiflora rose, oriental bittersweet, purple loosestrife, spotted knapweed, and tree-of-heaven. Life cycles, behaviors, habitats and the abundance of organisms in the Great Lakes have been altered by the intentional and unintentional introduction of invasive plant and animal species.

Food chains show feeding relationships and they are woven into larger and more complex food webs within ecosystems. By exploring these feeding relationships, you will become familiar with the concept of food webs, as well as with the different plants and animals that inhabit coastal habitats along the Great Lakes. Throughout this lesson, you will learn about possible problems from, and solutions to, the introduction of invasive species.

INTRODUCTORY QUESTIONS

1. Draw (or write) an example of a simple food chain. Include at least three organisms (plants or animals). These organisms can be from the Great Lakes region, or from a habitat with which you are familiar. Use arrows to show the connections between these organisms.

2. What do you think will happen when an invasive species is introduced to an ecosystem?

GREAT LAKES FOOD WEB

Connect the creatures in this Great Lakes food web. Draw arrows to show how energy is transferred from one organism to its consumer. Use the Creature Cards to help you.

Sunlight

sun

Quaternany Consumers

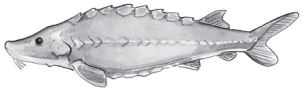
humans

great blue huron

Tertiary Consumers

walleye

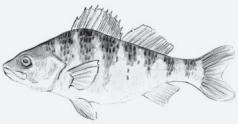
muskellunge



lake sturgeon

Secondary Consumers

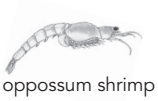
lake whitefish



yellow perch

Primary Consumers

water strider



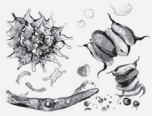
oppossum shrimp

bloodworm

fingernail clam

daphnia

Primary Producer



green algae

Decomposer

bacteria / fungi

Berthos

diporeia

dead plants and animals

minerals and nutrients

FOOD CHAINS

3. Draw an example of a food chain in a _____
(write the name of your coastal habitat on the line above)

Include at least four native species.

FOOD WEBS

4. In a group, combine your food chain with the food chains of your classmates who focused on the same the coastal habitat. This food web should include at least 10 organisms. These organisms should include both autotrophs and heterotrophs, or producers and consumers. Food webs are complex, and they can be messy. Try to organize your food web by showing the layers of the food web from producer to primary consumer all the way up to quaternary consumers and finally to the top predators. Include the sun and decomposers, too. Connect the organisms with arrows to show how energy moves through an ecosystem's food web.

Sketch a food web for your assigned coastal habitat here. Then, as a group, draw your food web on a large poster or chart paper.

FOOD WEB INVASION

As a group, you will "introduce" an invasive species (chosen from the background section) into the habitat's food web and discuss the following:

5. What type of impact does it have on the habitat's food web?

_____

_____

6. Does it eat species that do not have a natural predator (i.e. another invasive species?)

_____

_____

7. Does it eat something that is a food source for another species?

_____

_____

8. Does it occupy the same habitat or niche as another species?

_____

9. Now, introduce a second invasive species into the habitat's food web. What type of impact does it have?

_____

_____

10. On your own, draw the food web again, but this time include these two invasive species. Show the effect these invasive species would have on other organisms in the habitat. Your food web might not look exactly the same as your classmates'.

WRAP-UP QUESTIONS

10. Do you think it is a better solution to let the food web take its own course in finding a new balance or to try and control the invasive species? Why?

11. What are the possible ways in which invasive species could be controlled in the water? On land?

12. What organizations or individuals in their community or in their state would be able to affect change?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
FOOD CHAIN: Student participates in discussion of food web models. Given a specific habitat, student independently draws a food chain that includes at least one autotroph and two heterotrophs.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
FOOD WEB: In a group, student shares his/her food chain and compares it to other possible food chains within their assigned ecosystem. As a group, students draw a food web that includes at least ten organisms from this habitat. Student then introduces invasive species into their habitat and reflects on the effects of invasive species on a food web. Independently, student re-draws the food web to display these changes in the habitat. This food web will include ten native species and two invasive species.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
DISCUSSION: Student actively participates in class discussion about the problems invasive species cause and any solutions to balance or control these organisms.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
INVESTIGATING SOLUTIONS: Student works in their ecosystem groups to research potential solutions to the damage caused by the invasive species using the internet and other resources. Student reads at least three articles (two on their species and one on another) to brainstorm possible solutions.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
ESSAY: Student writes a one-page essay explaining the effects of invasive species on an ecosystem. The essay at least one possible solution to a food web invasion. Essay is well-developed and thorough. All ideas presented are supported with evidence from research. Spelling and grammar are accurate. Sources are cited.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Coastal Careers

Students interview Great Lakes professionals to learn about current coastal issues, coastal professions and coastal restoration efforts.

OBJECTIVES

Ask questions related to Great Lakes professions and issues

Self-analyze to identify professions of interest

SUBJECT
Careers, Language Arts, Science

PREREQUISITE
#6: Explore and Restore

VOCABULARY
career
cover letter
job
profession
resume

MATERIALS
Computers with Internet access

TIME/DURATION
75 minutes in class, 30 minutes outside of class

SETTING
Indoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

This lesson builds on the research completed during "Restore and Explore" on current Great Lakes issues and the organizations involved in restoration efforts related to these issues. If you haven't completed "Restore and Explore", please discuss current issues with students and create a list of careers for students to review.

Exploring, understanding and communicating about the Great Lakes ecosystems are interdisciplinary efforts. They require close collaboration among professionals in science, technology, engineering and math, as well as in public outreach and education.

COASTAL CAREERS

Aquaculture Biologist
Aquarium Curator
Aquatic Biologist
Aquatic/Environmental Chemist
Botanist
Coastal Engineer
Coastal Project Manager
Coastal Resources Specialist
Conservation Law Enforcement Officer
Environmental Educator
Environmental Lawyer
Executive Director
Field Specialist
Fisheries Biologist
Geologist
GIS Analyst
Information Technology (IT) Specialist
Invasive Species Technician
Hydrologist
Maritime Archaeologist
Naturalist
Natural Resource Manager
Outreach Coordinator
Park Ranger
Physical Limnologist
Planner
Policy Advocate
Principal Investigator
Professor
Recreational Guide and Instructor
Research Scientist
Science Writer
U.S. Coast Guard
Underwater Filmmaker
Volunteer Coordinator
Water/Wastewater Plant Operator
Water Quality Specialist
Watershed Manager
Wetland Specialist

And many more…

Ask your students to think about and/or research other jobs, careers or professions that are focused on the Great Lakes.

PROCEDURE

1. Students read the background information on the student pages and answer the introductory questions: What jobs are of interest to you in the near future, any why? Have you researched careers previously? If so, what careers might be of interest to you in the near future, andy why?

2. Explain to students that a job is different than a career, but that a job can lead to a career. For students, choosing a career is an involved process that is based-on a number of aspects, including an individual's interests, skills, work-related values and personality.

3. Students respond to the introductory questions on the student pages: What jobs are of interest to you in the near future? Why? Have you researched careers during school, or on your own? If so, what career(s) might be of interest to you in the future? Why?

CAREER INTEREST INVENTORY

4. If students have not already done so (in another class or with their guidance counselors), ask them to complete a career interest inventory. See the resource list for suggested, web-based, career interest inventories.

CAREER EXPLORATION

5. Students identify Great Lakes professions and professionals to research. Students may choose from the list compiled in "Restore and Explore", the list of professions provided by the teacher, from a career of interest or by using the following method:

a. Students identify an issue, such as pollution, invasive species, climate change or another current issue.

b. Students identify a location, such as a habitat in water, along the coast, or on land. Student identify whether this is in their local community, state, or country, or if it is international?

c. Students identify a related profession: Using the coastal careers list, students identify a career related to the Great Lakes, or another career that might involve focusing on the issue they identified or living in the location that they chose.

d. Students identify a professional within that career: Teachers assist students in identifying someone within this profession.

6. Students interview a professional using some or all of the following questions:

How did the Great Lakes influence your career decision?

Describe a typical day at work.

What skills are necessary for someone in your position?

What entry-level positions are available in your field?

What current issues, such as invasive species, pollution, habitat loss, climate change, or other current issue(s) affect your career?

What change(s) have you affected in the region or in your field?

What goals do you have for your career or your field?

What advice would you give to a high school student interested in a Great Lakes career?

What is your current job and what does it entail?

What was the key factor in your career decision?

What do like most about your career?

What do you like least about your career?

What are your hobbies?

Who are your heroes/heroines?

What advice would you give to a high school student who expressed an interest in pursuing a career in your field?

Are career opportunities in your field increasing or decreasing and why?

What do you imagine that you will be doing 10 years from today?

Suggestion: While students are waiting to schedule time to interview a professional, invite a guest speaker to your classroom to discuss his/her profession. Students can ask this person questions from the list above. Another idea would be to connect with the Language Arts teacher or guidance counselor to teach students how to write resumes and cover letters, and how to fill out applications. Students may write these as if they were applying for a job today based on their current employment status and interests, or these can be a prediction of what their resume might look like in the future (after high school, college, etc.). Provide examples of different resumes and formats.

7. Students create profiles for the professional they interviewed, including information on their educational background, previous jobs, related skills, interests, job description, and the answers to the questions above. Use http://marinecareers.net as a model.

WRAP-UP

8. Discussion: What careers are of interest to students? What careers were not researched but are of interest to students? Which of these careers are Great Lakes-based? Are there ways that someone in the field could give back to the local community?

9. Students can share their profiles, or the teacher can compile them in a book or on a Web site.

10. Students answer the questions on their student pages: Where would you study or train after high school for the job that you have researched? What would you major in, while in college and/or graduate school? What profession would you be a part of? How would you impact your field and/or the Great Lakes region?

EXTENSION

A. Students explore their own career interests using a career interest inventory (some schools have a suggested career interest inventory, or teachers may select one from the resource list at the back of the book).

B. Students create profiles for themselves. These can be for the present, or 5, 10, 15 or more years in the future. Where would they have studied or trained after high school? What jobs would they have had in the past? What profession would they be a part of? How would they have impacted their field or the Great Lakes region?

ASSESSMENT

See rubric on page 77.

RESOURCES

Please see Resource List for additional information related to careers, conservation and restoration efforts and more.

NAME _____

9
LESSON
STUDENT PAGE

Coastal Careers

VOCABULARY

career
cover letter
job
profession
resume

BACKGROUND

Choosing a career is an involved process that is based on a number of factors, including individual interests, skills, work-related values and personality. People may have many jobs throughout their lives, as they search for a long-term career. It is important to discover the long-standing and lasting values that make you who you are, and what interest and inspires you.

Choosing a career is all about you. You first need to discover who you are as an individual and a future professional in the working world. A self-assessment or career inventory can be helpful as a reflection tool. The result from using this tool will be a list of possible careers based on your interests and values. Obviously you can't do everything on your list, nor will you want to. You will need to do some research to narrow down your focus. Once you have selected a few careers of interest, you should begin to gather more information about these careers. Search to find a job description, outlook for the future of the field (will you be able to find a job?), and required training and education.

INTRODUCTORY QUESTIONS

1. What jobs are of interest to you in the near future? Why?

_____

_____

_____

_____

_____

_____

2. Have you researched careers during school, or on your own? If so, what career(s) might be of interest to you in the future? Why?

_____

_____

_____

_____

_____

_____

CAREER INTEREST INVENTORY

If you haven't already completed a career interest inventory, your teacher will provide you with a link to one. Career interest inventories ask you about your interests, your likes and dislikes and the skills you have to help identify possible careers of interest.

3. What are three possible careers of interest as identified by the inventory?

_____

_____

_____

4. How could someone with this career have a positive impact on the local environment? on the Great Lakes?

_____

_____

_____

_____

_____

_____

_____

CAREER EXPLORATION

Choose one of these careers to research. You will interview someone in the field.

Aquaculture Biologist
Aquarium Curator
Aquatic Biologist
Aquatic/Environmental Chemist
Botanist
Coastal Engineer
Coastal Project Manager
Coastal Resources Specialist
Conservation Law Enforcement Officer
Environmental Educator
Environmental Lawyer
Executive Director
Field Specialist
Fisheries Biologist
Geologist
GIS Analyst
Information Technology (IT) Specialist
Invasive Species Technician
Hydrologist
Maritime Archaeologist
Naturalist
Natural Resource Manager
Outreach Coordinator
Park Ranger
Physical Limnologist
Planner
Policy Advocate
Principal Investigator
Professor
Recreational Guide and Instructor
Research Scientist
Science Writer
U.S. Coast Guard
Underwater Filmmaker
Volunteer Coordinator
Water/Wastewater Plant Operator
Water Quality Specialist
Watershed Manager
Wetland Specialist

And many more…

Career: _____

Research questions (at least 10):

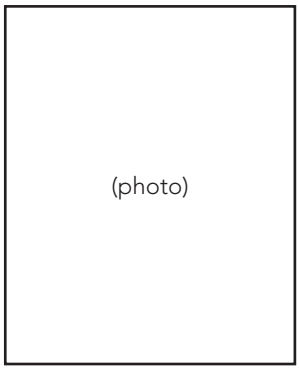
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

COASTAL CAREERS PROFILE

Career: _____

Where does this professional work? _____

Degree(s) required: _____



INTERVIEW QUESTIONS AND ANSWERS

WRAP-UP QUESTIONS

5. Where would you study or train after high school for the job that you have researched? What major would you choose in college?

6. What profession would you be a part of?

7. How would you impact your field or the Great Lakes region?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
SELF-ASSESSMENT: Student lists jobs that they are interested in and which career-path they could lead to. Student takes (or has taken in past) a career interest inventory and reveals the careers of interest identified by the inventory and how they could relate to the Great Lakes.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
CAREER EXPLORATION: Student identifies an issue and/or location of interest and a career complimenting them. Student identifies a professional within that career to interview and makes a list of at least 10 questions to ask.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
INTERVIEW/PROFILING: Student schedules time to interview a professional. Of the questions previously prepared, student creates a profile for the professional interviewed, including educational background, previous jobs, related skills, interests, and job description.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
WRAP UP: Student share profiles and answer the questions in the student pages relating what they have learned to their future plans.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Create-A-Watershed

Students orient themselves to the Great Lakes using maps and learn about watershed management and water pollution

OBJECTIVES

- Identify the Great Lakes watershed on a map
- Describe a watershed
- Locate local watershed(s) on a map
- Research point and nonpoint source pollution in the local watershed

SUBJECT
Geography, Ecology

PREREQUISITE
#2: A Sense of Place
#5: Getting to the Bottom of the Great Lakes

VOCABULARY
acid mine drainage
algal bloom
aquifer
groundwater
hydrologic cycle
infiltration
impervious surface
land cover
nonpoint source pollution
point source pollution
pH
sediments
stakeholder
surface runoff
transpiration
tributary

MATERIALS
computers with internet access and Google Earth installed, or one computer with a projector.

For each group of four students:
- two spray bottles
- five toothpicks with flags
- food coloring, cocoa powder (optional: chocolate chips or candies)
- 9" by 13" glass baking dish (or clear plastic container of a similar size)
- pencils
- sand
- maps: world map, Great Lakes watershed map (one for each student plus one for the classroom), local watershed map (one for each student)

TIME/DURATION
90-120 minutes

SETTING
Indoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

A watershed is an area of land drained by a body of water. For example, all of the water that falls in the Great Lakes Basin eventually drains into one of the Great Lakes. All land is a part of a watershed. Watersheds are nested within each other. The Great Lakes Basin is the land that makes up the Great Lakes watershed. Within the Basin, each lake has its own watershed (see map). Within the lake, watersheds are smaller watersheds of land that drain into rivers. However, as watersheds become more developed and have an increased number of impervious surfaces (rooftops, parking lots, and roads), more water is blocked from soaking into the ground. As stormwater runs across the land, it picks up and transports pollutants to our lakes, rivers and streams. These pollutants can degrade biotic communities, prevent recreational uses and contaminate water supplies.
See student pages for additional background information.

PROCEDURE

1. Students read the background information and respond to the questions on the student pages.

2. Ask students to describe three large landforms that determine where water ends up in North America. Remind them that water always flows downhill, which is why topography is important. *1. The Rocky Mountains (water flows to the Pacific); 2. The Appalachians (water flows into the Atlantic), and in between the Appalachians and the Rockies, the water flows into the Gulf of Mexico; 3. The Great Lakes (water flows into the north Atlantic).* This is a simplistic explanation, but it will spark a discussion about watersheds.

PART ONE: CAUSE AND EFFECT -- *THE INTERCONNECTEDNESS OF A WATERSHED*

3. Use the "Cause and Effect Cards" that are part of this activity. Hand out "effects" to half of the class, so that several students are assigned each effect. Give the other half of the class the "causes" of these problems. Each student should find a partner in order to match the causes and effects. Give each student two copies of the cause or the effect, so that they can give one copy to their partner. Each student should have a complete set. Cause cards are numbered 1-7 and effect cards lettered A-G. Cards match-up accordingly: 1F, 2C, 3B, 4E, 5A, 6G, and 7D.

4. Make several groups so that each cause-effect or watershed problem is represented in each group. Have each student group put these problems in order of most to least important if these issues were to arise in their community's watershed. Which cause-effect watershed problems would affect you and your family? The school?

5. As a class, discuss the various causes and effects. Have groups report out their most important and least important cause-effect relationships and describe why they place more or less importance on different issues.

PART TWO: LAB ACTIVITY -- *A MODEL WATERSHED*

6. At lab tables or in small groups, have students fill a glass baking dish with sand (a similarly shaped, transparent plastic container can also be used). Allow students to form a "landscape." The landscape should include a lot of variety, with hills, ridges, plains and/or depressions.

7. Students draw a sketch of their watershed model. This should include the key elements of a map, as learned in "A Sense of Place" (title, key/legend, cardinal directions or north arrow, scale and labels).

8. Explain to the student that the food coloring will represent pollution.

9. Students are to place five drops of food coloring or cake dye in the following locations:

a. At three places buried in the sand (in the groundwater)

b. At three places on the sand (on the surface or ground level)

10. Choose three places in the landscape to spray water, simulating rain. Mark them with toothpicks with flags. Caution the students not to use the spray bottle until they are directed to do so. Ask students to guess where the water will go when sprinkled on the landscape. Have them point out the toothpick or draw arrows in the sand to mark the water flow. At each of the marked locations, students will use spray bottles to distribute water, or will gently pour water, over the landscape. They should watch carefully to see where the water goes. Did it follow their flags or arrows? Why did the water flow the way it did? (*Water will flow down hills and collect in the basins. If you choose to use sand, some of the water will sink in. This mimics water flow in the natural world. Gravity is the force affecting this flow.*)

Have students point out the bodies of water and the rivers that formed. Explain that an area drained by a body of water is called a watershed. Have students find the watershed for the larger bodies of water in their landscape. Ask them if they notice anything about the water poured over the tops of their hills or ridges. *Water poured over the top of a point will probably flow in both directions, into different watersheds.* These points mark the boundaries between watersheds. Consider using cocoa powder instead of colored water or food that will melt or that has colors that will run (chocolate chips, or other candy) to place in the landscape and simulate pollution (have students think of what pollution they want to represent in their watersheds) and animal waste in the ecosystem. You can also make marks with dots of another color to indicate pesticides and insecticides. Re-spray the landscape and have the students observe and discuss what happens. *Remind students that water flows downhill and eventually ends up in the sea. You can see where water goes by using topography.*

PART THREE: POLLUTION WITHIN A WATERSHED -- *POINT AND NONPOINT*

11. On student page ##, tell students to draw a picture of the watershed model that they created in small groups. Using their watershed model as a visual example, ask students to brainstorm real-life pollution sources. They should answer the questions individually.

12. In small groups or as a whole class, students discuss what problems communities might face in identifying pollution sources. What makes it more difficult to identify nonpoint source pollution in a watershed?

WRAP-UP QUESTIONS

13. Ask students to think of watersheds in the natural landscape. What body of water is nearby? What land do they think is a part of its watershed? Are they standing in a watershed now? *(Every place is in a watershed!)* Tell students that they will look at maps to find their watersheds. If desired, have students sketch the landscape that they've created.

14. How does pollution in your watershed impact the people living in your watershed? How does it impact the ecosystem and the species living within this watershed?

15. If you were to discover a pollution source or other problem within your watershed, what would you do as a community? If you were to organize a meeting to discuss this issue, what stakeholders would you invite? How would you structure the discussion to reach a solution to this problem?

EXTENSION

A. You may do this research in advance or with the class. Go to: http://cfpub.epa.gov/surf/locate/index.cfm or another Web site from the resource list to locate your watershed and find out information about it.

a. To find out more about your watershed, click on: *Environmental Websites Involving This Watershed*. Scroll through the list of web sites and look for a general site about your watershed. Click on the link. The screen will say: *You are now exiting the EPA web server*. Click on the blue link. If you do not find a general web site about your watershed, try http://www.great-lakes.net.

B. Have students mark their watershed on a Great Lakes map with a highlighter. These maps are not very detailed, so you may wish to use them in conjunction with more detailed maps of your area. Comparing the two maps, have students find their watershed on the more detailed map. This will give them a better orientation. They can look for their school and homes on the map, as well.

ASSESSMENT

See rubric on page 88.

RESOURCES

Please see Resource List for additional information related to watersheds and more.

CAUSE-AND-EFFECT: POLLUTION IN OUR WATERSHED

CAUSE - 1

As power plants produce electrical energy, the pressure and temperature within and surrounding their generators increase. Power plants are often developed near a body of water, such as a river or lake. To reduce the heat and pressure, water is used for cooling purposes. This water is taken in from a nearby body of water, such as a river or lake. After the water is used, it is discharged into the lake. Excess heat is discharged and thermal, or heat, pollution often results.

CAUSE - 3

Areas dense in agricultural activities often see increased amounts of nutrients, phosphorus and nitrogen, in the local watershed. This is because some farmers use mass amounts of fertilizer containing phosphorus and nitrogen and during precipitation events, like storms, this fertilizer runs off into local streams and lakes.

CAUSE - 2

Groundwater and surface water can be considered a single resource, because they are connected. Although gasoline on the surface of pavements, such as driveways, parking lots and roads appears to just sit there, this gasoline can be washed away with the rain into permeable surfaces, or into our stormwater drains or local waterways. This is an example of nonpoint source pollution. On the other hand, a leak from an underground gasoline tank would be considered point source pollution. Underground storage tanks (USTs) are prone to corrosion and leaks and are therefore a risky process. The petroleum or hazardous substances stored in these USTs have a chance of leaking into the surrounding groundwater and polluting this precious resource used for drinking water. Groundwater pollution is a huge concern because the majority of many communities' drinking water comes from groundwater, and it takes an extreme amount of time and money to clean out the contaminants from polluted groundwater.

CAUSE - 4

Acid mine drainage is a huge concern in many places near mining operations. Acidic run-off with a low pH arises when iron or aluminum minerals and water become exposed to oxygen. A low pH level means that little to no life can persist. Because of this, acid mine drainage is a large threat to ecosystem health.

CAUSE - 5

The coastal city in which you live has a combined sewer system, which carries both sanitary sewage and stormwater to a treatment plant. In the event of a heavy rainstorm, the combined system may exceed its holding capacity due to an increased amount of stormwater entering the system, and, as a result, this combined sewage is discharged directly into nearby waters. This is referred to as a combined sewer overflow, or CSO, and can results in sewage discharge with E. coli levels up to 250,000 CFU/ 100 mL.

CAUSE - 7

Monitoring data shows high levels of phosphorus near the lake's shoreline. Phosphorus pollution is associated with the growth of algae, which proliferates during warm weather then washes ashore and decays, sending up foul-smelling odors in the hot summer sun that deter swimmers and others from using the beach. The algae can also harbor potential human pathogens such as Salmonella. Another cause for concern are recent changes in climate. Global climate change occurs naturally with fluctuations in ocean currents, oribital and solar variations, volcanism and plate tectonics. However, carbon emissions resulting from the burning of fossil fuels and changes in land use (i.e deforestation) have accelerated this process. Some areas are experiencing heavy rainfall leading to flooding, while other areas are experiencing extreme droughts. Heat waves are becoming more frequent with these increasing temperatures. Some plants, including algae, are blooming earlier in the year. Algae growth also kills fish and other aquatic organisms by lowering oxygen levels in the water. The nutrients we spread on our lawns, gardens and farmfields to spur healthy plant growth similarly spur algae growth in the lakes when carried there in runoff. Nutrients also reach the lakes via untreated sewage discharges and the use of phosphorus-based detergents at home.

CAUSE - 6

One of the most common ways pharmaceutical compounds enter our watersheds are through our wastewater. Humans and animals alike are given medications, however, their bodies do not fully metabolize or absorb them. The excess drugs are excreted as waste. Another possible cause would be from unused prescription medications that are flushed down the toilet or some other drain by humans. These drugs then enter our wastewater. If effluent isn't treated, these traces of pharmaceuticals may be discharged into our watersheds. Not all wastewater treatment plants can remove these chemicals from the water. The long term effects of pharmaceutical pollution are not known, but there are ways to dispose of pharmaceuticals in a safe way. Pharmacies, nursing homes, hospitals and residents are prompted to bring their unused medications to a "take-back" or safe disposal location.

EFFECT - A

Today, a few of your nearby Great Lakes beaches were closed due to high levels of E. coli in the water. While E. coli is commonly found in low levels most everywhere in the environment, it can cause illness in humans. Humans and most warm-blooded animals carry it in their systems, and excrete it in their fecal matter. The U.S. Environmental Protection Agency recommends that there be no more than 235 CFU ("Colony Forming Units" or cells) per 100 mL in recreational waters. At one of these beaches, you notice a large pipe upstream from where you usually swim at this beach. What may have caused these increased levels of E. coli in the water?

EFFECT - B

The Illinois Department of Natural Resources (IDNR) has identified an algal bloom in a local lake. Algal blooms occur when excessive nutrients from fertilizers allow bacteria and algae to grow beyond the natural level and deplete the oxygen that fish and other wildlife in the ecosystem need to survive. Where do you think extra fertilizer is coming from to destroy the native ecosystem of this lake?

EFFECT - D

It's early spring, but the sun is shining and there is algae growing on the surface of the lake. Lately, the lake has an increase in algae, including some large algal blooms. What could be causing these algal blooms?

EFFECT - C

The United States Geological Survey (USGS) has been assessing the groundwater near underground storage tanks (USTs) filled with petroleum that are located near a gas station in your community. Why do you think the USGS has been carefully monitoring the USTs? Explain.

EFFECT - E

Yesterday, the pH level of a river was measured and it was extremely low, or acidic. The color of the stream was also a bright orange. Geoscientists are exploring where this acidity could have originated from, because the river isn't directly connected to any industry. This river is one of the few remaining functioning rivers in this mining town and the health of the river is crucial to the functioning of the community. Where do you suppose the abnormal acidity is originating from?

EFFECT - F

The Environmental Protection Agency (EPA) has recently discovered increased temperatures in a river populated with several power plants. Where do you think this heat pollution is coming from?

EFFECT - G

Trace amounts of pharmaceutical chemicals were found in the local drinking water supply. Scientists are concerned about the health effects of drinking these low-level concentrations over an extended period of time. The public is notified immediately if certain regulated contaminants are found in the drinking water supply, however there are no requirements to notify if pharmaceuticals are detected. How do you think these pharmaceutical chemicals are getting into our watersheds?

NAME

10
LESSON
STUDENT PAGE

Create-A-Watershed

VOCABULARY

acid mine drainage
algal bloom
aquifer
groundwater
hydrologic cycle
impervious surface
infiltration
land cover
nonpoint source pollution
point source pollution
pH
sediment
stakeholder
surface runoff
transpiration
tributary

BACKGROUND

A watershed is the area of land drained by a body of water. For example, all of the water that falls into the Great Lakes Basin eventually drains into one of the Great Lakes. All of this land is part of a watershed. Watersheds are nested within each other. The United States could be divided into Atlantic and Pacific watersheds, then into smaller watersheds of rivers and lakes and then into even smaller watersheds of the tributaries of rivers. The Great Lakes Basin is the land that makes up the Great Lakes watershed. Within the basin, each lake has its own watershed (see map). Within the lake, watersheds are smaller watersheds of land that drain into rivers. Within the Great Lakes system, water flows from Lake Superior and Lake Michigan to Lake Huron, through Lake St. Clair into Lake Erie, over Niagara Falls and into Lake Ontario before flowing through the St. Lawrence River into the ocean. Rivers and streams transport nutrients, dissolved gases, salts and minerals, sediments and pollutants from watersheds into the Great Lakes.

When precipitation falls on the land, most of it infiltrates the soil, evaporates, is taken up and transpired by plants, or runs across the surface of the land into our waters as surface runoff. Under natural conditions, a relatively small amount of water leaves as surface runoff, while the majority of the water soaks into the ground or is taken up by plants. Soil and plants absorb the water and provide the natural filtration of pollutants. Some water that infiltrates the soil remains near the surface, where it gradually moves downhill, through the soil, and eventually into a nearby stream or water body. Some of the water may infiltrate much deeper, into the aquifers. Water can travel long distances or remain in storage for long periods before returning to the surface. The amount of water that will soak in over time depends on the land cover and soil characteristics and the slope of the lane. In many communities and along many shorelines, more impervious surfaces (rooftops, parking lots, and roads) are being developed within watersheds, and thus more water is blocked from soaking into the ground. Water then remains on the surface and becomes stormwater. Stormwater, either discharging from the end of a pipe or entering a body of water after flowing over the land, is a key threat to water quality. Stormwater may carry a variety of substances as it makes its way to the water: grit, oils and litter from city streets and parking lots; waste from domestic and wild animals; nutrients such as phosphorous from lawns, gardens and farms; yard waste; and sediment and bacteria. All of these substances can harm water quality.

Nonpoint source (or NPS) pollution comes from many different, diffuse sources and is extremely difficult to regulate and control, which makes it a hazard facing the Great Lakes today. NPS pollution is mainly caused by runoff, when rain and snowmelt move over the land, picking up pollutants along the way and eventually dumping the pollutants into rivers and lakes. Some common NPS pollutants include fertilizers and pesticides from agricultural lands and homeowners; oil, grease and salt from highways; sediment from construction sites and eroding shorelines; and animal and human waste.

In contrast, point source pollution is when pollutants enter a waterway though a specific entry point, such as a drainpipe draining directly into a river or lake. Industrial water discharges and sewage treatment plants are the main culprits of this type of pollution. Point source pollutants can include many different organic and inorganic substances, including human waste and toxic metals. Point source pollution can be traced to a specific discharge point and owner; therefore, it has been the easiest source of pollution to control and regulate, although it continues to be a problem.

Atmospheric pollution (or air deposition), which comes from the sky, is another form of nonpoint source pollution. As water moves through the hydrologic cycle, it falls as rain or snow and then evaporates into the air from land and surface

water. Pollutants emitted into the air, such as through smoke stacks, follow this same path, and can be carried through the atmosphere and deposited into waterways hundreds of miles away from their sources. Acid rain is a well-known form of atmospheric pollution. The major sources of atmospheric pollution include coal-burning energy plants and waste incinerators. The combustion of fossil fuels and waste (such as that from hospitals) produces large amounts of mercury, which travel into the air. Mercury is a toxic chemical that is fatal to humans and animals in large quantities. Phosphorus and polychlorinated biphenyls (PCBs) are also transported to waterways via air deposition.

Because water does not follow our municipal and political boundaries, communities must work together to address nonpoint source pollution and the impacts of land use decisions on our water resources. Watershed management is an effective way to cross traditional boundaries and bring people in different regions together to effectively manage land, increase public understanding and awareness about water quality issues, and promote better stewardship of private and public lands. Watershed management integrates scientific and social considerations to take a holistic approach to protecting and improving a water body. By the end of this lesson, you will understand the issues facing watersheds and you will identify techniques for remediating these issues.

INTRODUCTORY QUESTIONS

1. What are three main features that determine how water flows in North America? (Hint: Think big.)

2. What are two examples of point source pollution? Nonpoint source pollution?

LAB PROCEDURE/QUESTIONS

PART 1: CAUSE AND EFFECT -- POINT AND NONPOINT SOURCE POLLUTION

3. Which cause and effect watershed problems would affect you and your family? The school?

4. What were the most and least important cause-effect relationships? Describe why you placed more or less importance on different issues.

PART 2: LAB ACTIVITY -- A MODEL WATERSHED

5. Form a "landscape" in a glass baking dish using sand. Your landscape should have a lot of variety, such as hills, ridges, plains and depressions.

6. Place five drops of food coloring or cake dye (pollution) in the following locations:
   a. At three places buried in the sand (in the ground water)
   b. At three places at the surface (ground level)

7. Choose three places on the landscape to spray water, simulating rain. Mark them with toothpicks with flags.

8. Either point the toothpick flag or draw arrows in the sand to mark where you think the water will flow.

9. Now, spray water on these surfaces, and observe where the water flows.

PART 3: POLLUTION WITHIN A WATERSHED -- POINT AND NONPOINT SOURCES

10. Sketch a simple map of your watershed model. Include the five key elements of a map: title, key/legend, cardinal directions or north arrow, scale and labels.

11. Draw arrows to show where the water drains.

12. Identify sources of pollution and delineate between point and nonpoint source pollution. Label pollution sources as either P (point source pollution) or N (nonpoint source pollution).

13. What makes it difficult to identify, monitor and address nonpoint source pollution in a watershed?

WRAP-UP QUESTIONS

14. Describe how water flows in a watershed.

15. What are the problems associated with point and nonpoint source pollution?

16. What are impervious surfaces and what is their connection to pollution sources in a watershed?

17. Based on your understanding of watersheds, where would the best location be if you were building a house in this watershed? Where would you build a school or park? Why?

18. What can you do to decrease pollution problems in your watershed?

19. If you were to discover a pollution source or other problem within your watershed, what would you as a community do?

20. If you were to organize a meeting, what stakeholders (people who are interested and/or involved in the topic being discussed) would you invite?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
BACKGROUND/QUESTIONS: Student reads background information about watersheds, nonpoint source pollution, and point source pollution and answers introductory questions in the student pages.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
WATERSHED ISSUES: Student identifies cause and effect relationships between issues within a watershed and the effects they have on the watershed. Students work together to discuss these issues and determine how important they are to the community's watershed. Student shares his/her views with the rest of the class.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
MODELING: Student works with a group to construct a model of a landscape consisting of hills, depressions, ridges and plains. Student applies food dye (pollution) at different locations (above and below the ground), and predicts where the water will flow by marking with toothpicks or flags. Student simulates precipitation by using a spray bottle of water in three areas of the model, observing how the water flows through the watershed.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
MAPPING: Student sketches a map of the watershed model. All five key elements of the map are included (title, key, cardinal directions or north arrow, scale and labels), arrows are used to show the water flow direction, and point and nonpoint sources of pollution are labeled. Student uses model and map to answer the wrap-up questions and discuss with the class.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Bird's Eye View

Students orient themselves to the Great Lakes using a geographic information system

OBJECTIVES

Use geographic information systems (GIS) to virtually explore the Great Lakes watershed

Discuss the impacts of pollution and urbanization on a watershed

SUBJECT
Geography, Environmental Science

PREREQUISITE
#2: A Sense of Place
#5: Getting to the Bottom of the Lakes

VOCABULARY
Geographic Information System (GIS)
Global Positioning System (GPS)
layering
metadata
orienteering
panning
satellite
topography
transboundary pollution
watershed

MATERIALS
computers with internet access and Google Earth installed, or one computer with a projector

TIME/DURATION
90-120 minutes

SETTING
Indoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

Geographic information systems (GIS) are finding their way into the hands (or onto the computers) of many professionals. Politicians, government administrators, scientists, natural resource managers, developers and professionals in real estate and even insurance can benefit from understanding how to use the data in GIS. A well-known GIS system that many students may be familiar with is Google Earth, a virtual globe, map and geographical information system (GIS). Google Earth maps the Earth by the superimposition of images obtained from satellite imagery, aerial photography and GIS 3D globe.

PROCEDURE

Note: this activity can be done with one computer and projector, or with a computer for each student.

1. Discussion: Students read the background information and answer the introductory questions on their student pages.
2. Google Earth must be installed on each computer. For a free download, go to http://www.google.com/earth/index.html. You must also download the Great Lakes Watershed map data. To do this, go to http://edna.usgs.gov/watersheds/kml_index.htm and click the "Great Lakes" link. Then click "save." This will be a .kmz file, which should be saved to the desktop.
3. You have two options to open the Great Lakes Watershed GIS data file:

a. Open Google Earth. Then, go to "File," then "Open." Then go to where you saved the Great Lakes data file (your desktop) and select the Great Lakes .kmz file and click "Ok."

b. After downloading and saving the Great Lakes .kmz file, select open or double click on the file. Google Earth should automatically open with the Great Lakes watershed boundary file.

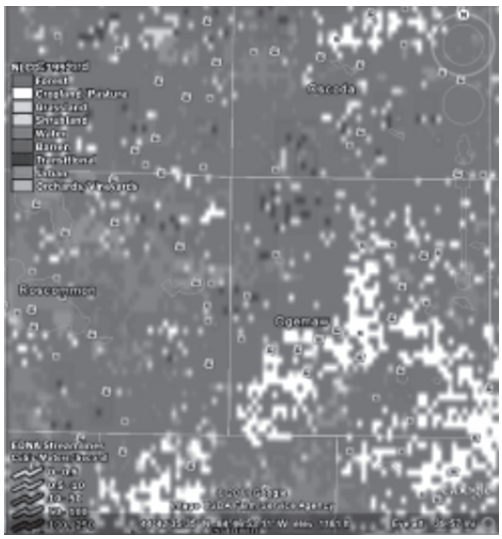
4. After opening the file, search for your location by entering your address into the "fly to" box.

a. In order to navigate in Google Earth, you may use the white hand tool to click and pan.

b. In addition, you may move the "N" icon, changing where "North" is, to turn the image around. You can also click on the four arrows inside the circle to pan, as well.

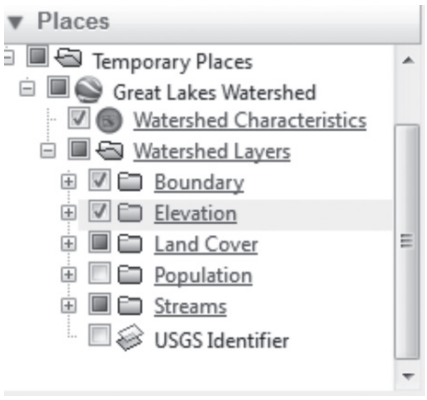
5. Discussion: Ask students the following questions after locating the school in Google Earth. What bodies of water are nearby? Can you see streams, rivers, lakes, wetlands, or other coastal habitats through Google Earth? What is the name of our local watershed? Is the school part of the Great Lakes watershed (is it inside the red line)? Tell students to record their answers on the student pages.

6. Great Lakes Watershed Political Boundaries: In Google Earth, zoom in (or out) until you see the political boundary lines found in light green.



7. Ask students: How do the political boundaries in the Great Lakes match up with watershed boundaries? Why do you think this is? Have them record their answers on the student pages.

8. Elevation and Political Boundaries: In the "Places" box on the lefthand side, check the elevation box. Zoom out so that you can see more of the elevation differences, but still keep the political boundaries in view. This is called layering, which is a useful process for understanding how different facets of an area relate to each other. Layering can make maps difficult to read, however, if too many layers are included in one map.



9. You can use the hand tool to move around the map to look at a variety of locations. This is called "panning," which is a useful process for exploring an area virtually.

10. Ask students: What do you notice about the watershed boundaries and their locations with respect to elevation? Hint: In order to get a better look at the terrain, use the arrows located near the "north" indicator to tilt your view, or hold down the "shift" key and roll the middle button on your mouse.

11. Ask students: What do you notice about town/political boundaries? Do they seem to follow the terrain in some cases? Do they seem arbitrary in other cases?

12. Discussion Points: Note the arbitrary nature of the political boundaries, and that they have been chosen for reasons that are often diplomatic and have little to do with terrain. The watershed boundaries fall along elevation peaks. The points of lowest elevation (often streams) may double as political boundaries. This leads to a very large discrepancy in the types of boundaries because they often follow opposite rules.

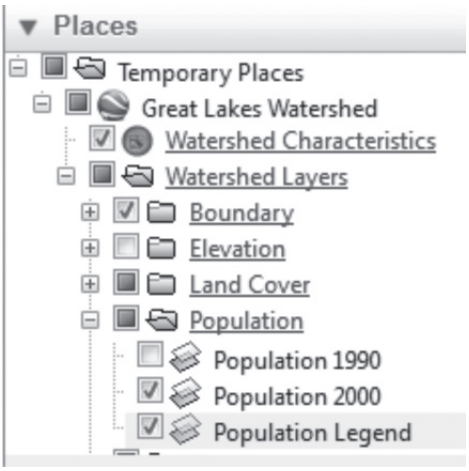
13. Describe the definition of transboundary pollution. It is pollution that originates in one country but, by crossing the border through pathways of water or air, is able to cause damage to the environments in another country.

14. In Google Earth: Uncheck the elevation level in the "Places" box. Zoom in to the Maumee River. It is located on the left most side of Lake Erie.

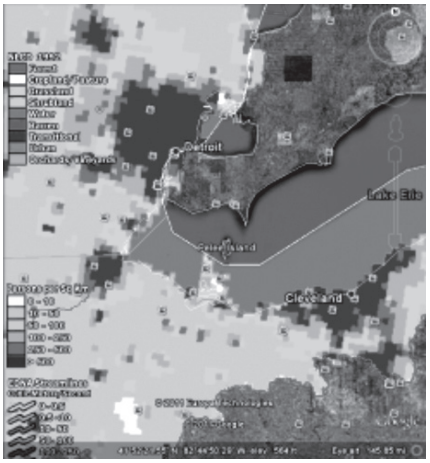
15. Next, starting at Lake Erie, follow the Maumee downstream.

16. Ask the students to describe and record where the river goes.

17. Under the "Places" box, click the plus sign next to the "Population" tab. Check both the "Population 2000" and the "Population Legend" tabs.



18. Take notice what city the river runs through. *(Toledo)*

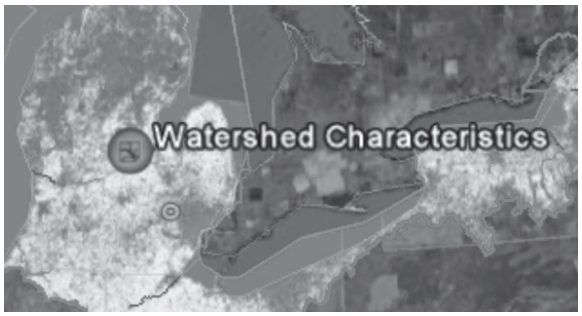


19. Uncheck the "Population" tabs and take note of the types of land cover the river runs through. *(urban, cropland/pasture)*

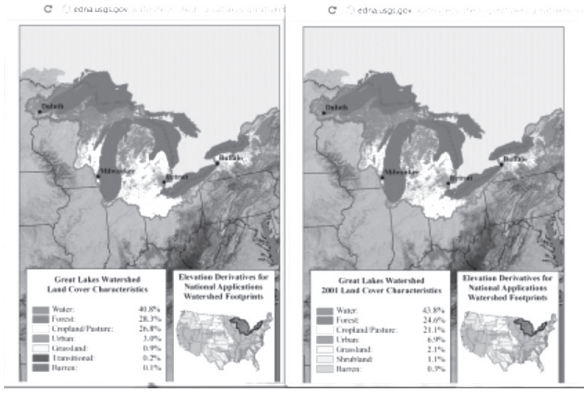
20. Ask students: What implications does this have for monitoring the health of this river? What would your policy recommendation be for dealing with this boundary discrepancy and the evident transboundary pollution problem?

21. Discussion Points: The Maumee River stems from Lake Erie and then runs through four different counties with different types of population and land cover. This makes the management of the water quality of the river exponentially more difficult because it involves coordination among different counties, as well as examining all of the different aspects affecting the lake.

22. In Google Earth: Click the "Watershed Characteristics" button.



23. Click on "Land Cover 2001." This will open a Web page. Then click "Land Cover 1992." Place the two Web pages side by side.



24. Look at the differences and changes between the two, both graphically and numerically.

25. Ask the students: What do you think could be the cause of the land cover changes? What do you predict the land cover would look like now? (The most recent, available data at the time of printing is from 2001.) In another 10 years? *Students will note a trend toward urbanization (increase of urban area and decrease of forested land).*

26. Discussion Points: There is a decline in both forests and cropland/pasture and an increase in urban areas. There is an increase in water, grassland, and barren land.

WRAP-UP QUESTIONS

27. What are the impacts of increased urbanization? What do you think humans should do, or not do, about increased urbanization? Discuss this briefly as a class. Have students write a one-to-two page persuasive essay in response to these questions.

EXTENSION

A. You may do this research in advance or with the class. Go to: http://cfpub.epa.gov/surf/locate/index.cfm or another Web site from the resource list to locate your watershed and find out information about it.

To find out more about your watershed, click on: *Environmental Websites Involving This Watershed*. Scroll through the list of Web sites and look for a general site about your watershed. Click on the link. The screen will say: *You are now exiting the EPA web server*. Click on the blue link.

Note: If you do not find a general website about your watershed, try http://www.great-lakes.net.

B. Have students mark their watershed on a Great Lakes map with a highlighter. These maps are not very detailed, so you may wish to use them in conjunction with more detailed maps of your area. Comparing the two maps, have students find their watershed on the more detailed map. This will give students a better orientation. They can look for their school and homes on the map, as well. Topographic maps are great for this.

ASSESSMENT

See rubric on page 95.

RESOURCES

Please see Resource List for additional information related to mapping, GIS and GPS.

NAME

11
LESSON
STUDENT PAGE

Bird's Eye View

BACKGROUND

When you think back to the early days of exploration, you may recall that people once thought the world was flat. Since then, humans have traveled to outer space and seen the earth from thousands of miles away. Presently, there are a couple thousand artificial satellites orbiting the earth. These satellites are collecting, recording and transmitting images and other data back to scientists on Earth. Ordinary citizens, including students, have access to some of this data through the Internet. In this lesson, you will study the earth and in particular, the Great Lakes watershed, through the geographic information system Google Earth.

VOCABULARY

Geographic Information System (GIS)
Global Positioning System (GPS)
layering
metadata
orienteering
panning
satellite
topography
transboundary pollution
watershed

INTRODUCTORY QUESTIONS

1. In what situations have you used a device with a global positioning satellite (GPS)?

_____

_____

_____

_____

2. Are you familiar with the term geographic information system, or GIS? Have you used Google Earth or another GIS?

_____

_____

_____

LAB PROCEDURE/QUESTIONS

DISCOVERING THE GREAT LAKES WATERSHED

1. Where are your school and local streams or bodies of water? What is the name of your watershed?

_____

_____

_____

_____

_____

_____

2. How do the political boundaries match up with watershed boundaries? Why do you think this is?

3. What do you notice about the watershed boundaries and their location with respect to elevation?

4. What do you notice about town/political boundaries? Do they seem to follow the terrain in some cases? Do they seem arbitrary in other cases?

5. Describe where the river goes.

6. What implications does this have for monitoring the health of this river?

7. What would your policy recommendation(s) be for dealing with this boundary discrepancy and the evident transboundary pollution problem?

8. What do you think could be the cause of the land cover changes?

WRAP-UP QUESTIONS

9. What do you predict the land cover to look like now? In another 10 years?

10. Use what you learned to think of ways you can have a positive impact on your local watershed and the coastal habitats of the Great Lakes?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
LAB/ QUESTIONS: Student uses the GIS tool, Google Earth, to navigate through different communities and watersheds. Student observes boundaries, water flows and watershed characteristics. Student identifies impervious and pervious surfaces. Student answers questions on student pages while navigating through the lab.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
ESSAY: Student writes a one-to-two page persuasive essay in response to the questions raised about urbanization. Student describes the impacts and solutions of urbanization on a watershed. Essay has minimal spelling and grammatical errors. Sources are cited.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Coastal Community Planning

Students take on roles in a small group to create a Great Lakes coastal community that equally values social, economic and ecological ideals.

OBJECTIVES

- Define a sustainable coastal community
- Discuss stakeholder involvement in decision making
- Discuss elements to consider in community and land-management planning
- With a team, plan a sustainable community, which includes at least two coastal habitats
- Discuss how students can make positive changes within their communities

SUBJECT

Social Studies, Geography

PREREQUISITE

#2: A Sense of Place
#5: Getting to the Bottom of the Lakes
#10: Create-A-Watershed

VOCABULARY

community
green infrastructure
impervious surface
invasive species
low impact development
native species
nonrenewable resource
renewable resource
smart growth
sustainable

MATERIALS

pencils
journals
art supplies (colored pencils or fine tip markers)
large paper or poster board for each group

TIME/DURATION

90 minutes

SETTING

Indoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

Communities shape the way the world works. In creating a community, students will need to think about many different aspects of community life. In this activity, students will plan a "sustainable community." These are communities in which equal importance is placed on social, economic and ecological values. The 1996 Sustainable Communities Task Force Report defines sustainable communities as "... cities and towns that prosper because people work together to produce a high quality of life that they want to sustain and constantly improve. They are communities that flourish because they build a mutually supportive, dynamic balance between social well-being, economic opportunity, and environmental quality."

Sustainability can refer to what a neighborhood, city, state, region or country can do to be sustainable, but it can also refer to what individuals can do. The term "sustainable" can mean many things, including: a) relating to a method of using a resource so that the resource is not depleted or permanently damaged; b) relating to a lifestyle involving the use of sustainable methods; c) sustainable society. There are many natural resources available on our planet; some are renewable, but others are not. Renewable resources include water, soil, plants, and animals, which can be produced, grown or generated, so long as they are conserved, or used sustainably. Nonrenewable resources cannot be produced, grown, generated, or sustained, and thus will not exist after they are all used up. Examples of nonrenewable resources include metals, minerals and fossil fuels. These nonrenewable resources can last for a long time if they are consumed sustainably, or if they are recycled or reused.

Communities and individuals can act more sustainably when it comes to energy use, waste, land use, food production

and water use. Examples of sustainable actions include: energy (lowering consumption and/or choosing renewable energy), waste (reducing, reusing and recycling), land use (preserving natural areas and/or protecting water, land and air from pollution), food systems (sustainable or organic farming) and water conservation (reducing consumption and/or building green infrastructure).

Access to water is important to the sustainability of communities around the Great Lakes. Many communities are located outside the watershed boundaries and are experiencing water shortages. Managing Great Lakes water resources is a complex issue at local, regional, state and national levels.

It is suggested that classes take time to explore their communities to identify the key elements in their communities. As a class or through individual reflection, students should assess whether their neighborhoods or cities are sustainable or not. What would they want to see added to, or removed from, their communities in order to improve them?

Another suggestion for introducing this lesson is to plan a visit from someone in community planning or parks and recreation to give some background information about these topics to the students.

PROCEDURE

1. Look at the images representing sustainability. Ask students: What could these models mean?

2. Discuss:

a. What does it mean for something to be "sustainable?" When we talk about living "sustainably", what does that mean? What does it mean to live in a community? What are the core components of a community?

b. What is a "sustainable community"? Do you live in a sustainable community? What does it mean to place equal value on social, economic and ecological values? What would be the pros and cons of living in a place like this? Brainstorm the elements that might exist in a balanced or sustainable community.

c. Ask for examples of what has to be planned in order to create a sustainable community. *(Some examples might be: How would you create energy that is less polluting than fossil fuels? How would you work to reduce prejudice in the community? How are decisions made within a community? Who decides how sustainable a community is?)*

3. Divide students into groups of four. Tell them that they will design their own communities. Show students the rubric so that they know how they will be evaluated. Teachers can also provide an example of a planned community as a model for student groups.

4. Students read background information and answers the first two introductory questions on the student pages: 1. What does sustainable mean? Explain. *(See explanations on sustainability images.)* 2. What is a sustainable community? How can we plan for sustainability? *(A sustainable community will have long-term positive economic stability and environmental health. These communities are planned with a collective vision for the future.)*

5. Give each group a copy of the "Community Regulations" page, or develop this list as a class through brainstorming.

6. Each student adopts a role within the group (see list of roles in students' journal pages). Another option is to have this be a student-led activity in which the students come up with the roles and the questions to be answered.

7. Students answer the remaining introductory questions on the student pages: 3. What is your role in your Coastal Community Planning group? *(See the choices on the student pages.)* 4. Why did you choose this role? *(You may want to give students information on these roles or give them time to look for information online to better understand their roles.)* 5. What is the economic driving force in your community? See Community Regulations. *(This might be a good place to discuss how the easy and available access to freshwater which can encourage the steel industry to locate itself on the shores of some lakes or the fur industry encouraged the growth of some communities.)*

8. Have students begin to plan their communities and answer the questions on the student pages, based on the role they chose. This can be done in class or as homework.

9. Students share their responses to the questions and then work together in their groups to plan and map a community on large paper or poster board.

a. Students' maps of their communities should include the five key elements of maps (scale, compass or north arrow, key/legend, title and labels. Students label roads, waterways, boundary lines and landmarks. Students also develop a system of symbols for each of these landmarks or green spaces (i.e. national parks, local parks, or preserved lands), buildings and other natural or manmade community features (i.e. a tent to symbolize a campground). Students should label impervious surfaces, such as roads or parking lots, to identify areas that may be prone to flooding.

WRAP-UP

10. Have student groups present their communities to each other.

11. Discuss the following questions as a class: Would you like to live in the community you have created? Why or why not?

12. What elements from your created community would you like to see in your real community? Why? The teacher should choose one idea and work with the students to figure out how the class might take steps toward making this really happen in your own community.

13. Students evaluate each other's work using the rubric provided or one that the students create themselves, based-on the criteria for the project.

EXTENSION

A. Students select one green space from their community map to plan out in detail. These detailed maps of a coastal habitat should include boundaries, access points, topography, elevation, land use, recreational and natural areas, impervious surfaces, flora, fauna and additional natural or manmade features.

B. As a class, make a list of banned activities. Students then role-play a debate to weigh the pros and cons of each ban. Discuss what led to the ban of this particular activity, whether or not this ban was effective and what should be done in the future to help protect the Great Lakes.

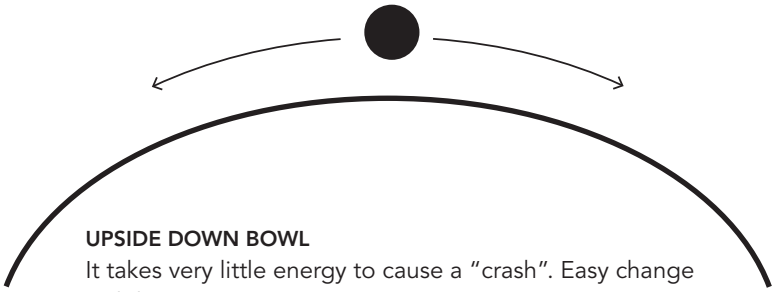
ASSESSMENT

See rubric on page 109.

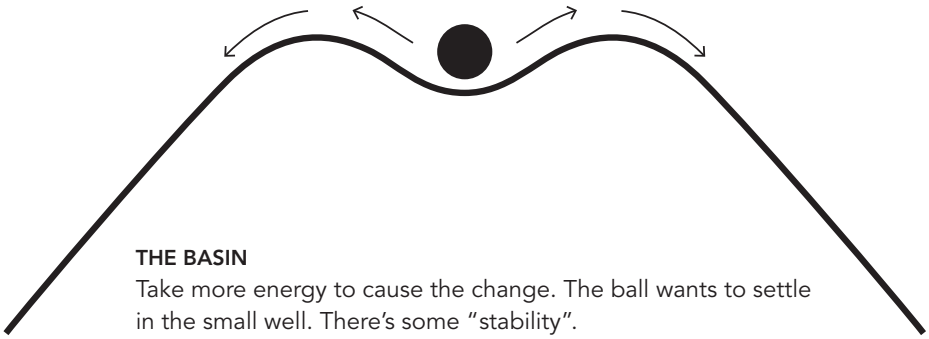
RESOURCES

Please see Resource List for additional information related to conservation and restoration.

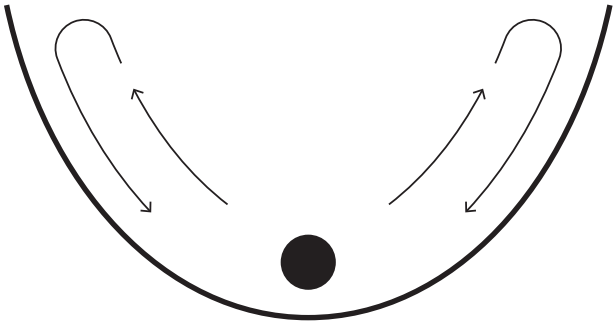
FLAT SURFACE
If you push the marble there is no resistance to change, but no real consequence for that change.



UPSIDE DOWN BOWL
It takes very little energy to cause a "crash". Easy change with big consequences



THE BASIN
Take more energy to cause the change. The ball wants to settle in the small well. There's some "stability".



THE WELL
The ball will always return to the bottom. It will always be attracted to the bottom.

NAME

12
LESSON
STUDENT PAGE

Coastal Community Planning

VOCABULARY

community
green infrastructure
impervious surface
invasive species
low impact development
native species
nonrenewable resource
renewable resource
smart growth
sustainable

BACKGROUND

Communities shape the way the world works. In this activity, you will work to plan a "sustainable community." Sustainable communities can be defined as "...cities and towns that prosper because people work together to produce a high quality of life that they want to sustain and constantly improve. They are communities that flourish because they build a mutually supportive, dynamic balance between social well-being, economic opportunity, and environmental quality."

Sustainability can refer to what a neighborhood, city, state, region or country can do to be sustainable, but it can also refer to what individuals can do. The term "sustainable" can mean many things, including: a) relating to a method of using a resource so that the resource is not depleted or permanently damaged; b) relating to a lifestyle involving the use of sustainable methods; c) sustainable society. There are many natural resources available on our planet; some are renewable, but others are not. Renewable resources include water, soil, plants, and animals, which can be produced, grown or generated, so long as they are conserved, or used sustainably. Nonrenewable resources cannot be produced, grown, generated, or sustained, and thus will not exist after they are all used up. Examples of nonrenewable resources include metals, minerals and fossil fuels. These nonrenewable resources can last for a long time if they are consumed sustainably, or if they are recycled or reused.

Access to water is important to the sustainability and growth of communities around the Great Lakes. Many communities are located outside the watershed boundaries and are experiencing water shortages. Managing Great Lakes water resources is a complex issue.

Communities and individuals can act more sustainably when it comes to energy use, waste, land use, food production and water use. Examples of sustainable actions include: energy (lowering consumption and/or choosing renewable energy), waste (reducing, reusing and recycling), land use (preserving natural areas and/or protecting water, land and air from pollution), food systems (sustainable or organic farming) and water conservation (reducing consumption and/or building green infrastructure).

INTRODUCTORY QUESTIONS

1. What does sustainable mean? Explain.

2. What is a sustainable community? How can we plan for sustainability?

3. What is your role in your Coastal Community Planning group? (See the choices on the following pages.) What responsibilities does this role hold? Why did you choose this role?

4. What is the economic driving force in your community?

5. Now, answer the questions assigned to you on the appropriate page, depending on your role in your group.

6. How will your Great Lake be affected by your responsibilities?

ZONING ECOLOGIST: IN CHARGE OF THE WAY PUBLIC LAND IS USED.

1. Where are parks and wild spaces located? Explain.

2. How are these spaces taken care of? Do you use herbicides and pesticides? Explain.

3. How does the community include space for wildlife? Why is (or isn't) this important?

4. How does the community contribute to the safety of humans and wildlife that live in the area? Explain.

5. What key natural areas, including at least two coastal habitats, are part of their community?.

6. What type(s) of vegetation are planted there? (Hint: What is the difference between native and invasive species? Advantages and/or disadvantages? Edible or non-edible flora?) Explain.

7. Where is the beach located? What about the harbor? How are they kept clean? Explain.

RESOURCE MANAGER: IN CHARGE OF THE WAY THE COMMUNITY USES AND MAINTAINS ITS RESOURCES.

1. Where does drinking water come from? How is it cleaned? Where does it go after it is cleaned? How is the waste from the water treatment process handled, cleaned, and disposed of?

2. How are the homes of residents heated and cooled?

3. Where does electricity come from? (Think renewable energy, i.e. solar.)

4. How does the community use resources so that they will last indefinitely? Or does it use resources in a lasting manner?

5. How does the community minimize waste?

6. How does the community minimize its air, water, and land pollution?

7. Is there one or more forms of public transportation? What kind(s)?

PLANNING COMMISSIONER: COORDINATES THE WAY THE LAND IS USED, AND ENSURES THAT TWO PEOPLE DO NOT USE AN AREA OF LAND FOR DIFFERENT PURPOSES

1. Where will you place the required buildings?

2. What additional buildings will the community have?

3. How many houses/apartment buildings do you need? Where will they be?

4. If the town population doubles in five years, how will everyone's housing needs be met?

5. How will you ensure that residents have adequate and convenient green space?

HEAD OF CULTURAL AND RECREATIONAL AFFAIRS: RESPONSIBLE FOR FUN AND EDUCATIONAL ENTERTAINMENT AND RECREATION IN THE COMMUNITY.

1. What kind of outdoor recreation is available? How are people able to enjoy nature all year round?

2. How do people learn while having fun?

3. What kind(s) of entertainment will be present in the community?

4. Where is the entertainment located?

5. How does the culture support equality among different races, genders, ages, and ability levels?

6. What are healthy and fun options for all different kinds of people?

7. How is your Great Lake be affected by your responsibilities?

COMMUNITY REGULATIONS

The community must be adjacent to a Great Lake. The minimum population is 1,000 people.
Community must have at least:

- One beach
- One stream, river or coastal wetland
- One additional coastal habitat
- One water treatment plant
- One harbor for boats
- One facility for generating power
- One post office
- One school
- One bank
- One restaurant
- One government building
- One grocery store
- One economic driving force (This can include the original reason the area was settled, or a current company or industry. It can also include tourism; farm services, due to a large number of nearby farms; or a factory, due to a large source of raw material.)

1. After you have answered the questions, work with your group to create a map on posterboard of the community you plan and design. Sketch your community design below.

WRAP UP QUESTIONS

1. Would you like to live in the community you have created? Why or why not?

2. What elements from your created community would you like to see in your real community? Why?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
DISCUSSION: Student references images representing sustainability and discusses with the class the components of a community. Student describes how communities can be sustainable by balancing social, economic and environmental values. Student brainstorms the elements that make up a balanced, sustainable community.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
GROUP WORK/ROLE PLAY: Student works with group members to design a sustainable community with a focus on long-term positive economic stability and environmental health. Communities must comply with the "Community Regulations" provided. Each student chooses a role to play within the community. To understand the role, students individually answer the questions pertaining to his/her role. Each group works together as their roles would in real life to design a community they would like to live in.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
MAPPING: Student works with their group to construct a visual representation of their newly planned sustainable community to share with the class. Maps should include five key elements maps (title, key, compass or north arrow, scale and labels). Students also labels roads, waterways, boundary lines and landmarks. Student develops a system of symbols to label landmarks, green spaces, buildings and other natural or manmade community features. Impervious surfaces (roads/parking lots) are labeled to recognize potential flood areas in the community.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
PRESENTATION: Student presents newly designed community with their group to the rest of the class. Student discusses what makes this community sustainable. Student explains how the information they learned could relate to the local community. Student shares any ideas of how the class might take steps toward implementing any design features into their own community.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Plant Plans

Students create an indoor or outdoor garden of native species.

OBJECTIVES

Identify native species within the Great Lakes region

Describe the impact of global climate change on native plants

Compare/contrast methods of propagation

SUBJECT
Biology, Agriculture

PREREQUISITE
#7: The Great Race for Survival

VOCABULARY
carbon dioxide sequestration
deforestation
grafting
native species
pool
propagation
reforestation
restoration
sink
source

MATERIALS
The specific materials needed will be determined by students as they plan their gardens or schoolyard habitats.

TIME/DURATION
90 minutes

SETTING
Parts one and two indoors; Part three (optional): greenhouse or outdoor garden

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

Note: Prior to this lesson, students should have an understanding of the carbon cycle, photosynthesis, cellular respiration, the greenhouse effect, and global climate change. See resources for more information or reference available science textbooks.

The Great Lakes watershed contains 20 percent of the Earth's fresh surface water. A change in climate will alter water availability and quality in the Great Lakes, in the region's groundwater and in the many wetlands, lakes and streams in the region. Throughout this century, the region's climate is expected to become warmer in both the summer and winter. Projected changes in seasonal precipitation are that winter and spring precipitation could increase, while summer rain could decrease by as much as half. Heavy summer downpours are likely to become more frequent, with dry periods in between, and lake levels are expected to drop overall. Some of these changes have already been detected in regional climate trends. The Great Lakes region depends on water for drinking (for 40+ million people), shipping, irrigation and industrial processes.

Possible Changes: A change in the climate could cause a number of impacts in the Great Lake region:

- Heavier rainfall and flooding
- Worsening water quality due to higher water temperatures and heavy run-off that transports pollutants, nutrients and sediment
- Lower groundwater recharge rates
- Less soil moisture in the summer, which could harm crops, forests and ecosystems
- Wetland and wildlife habitat loss and the reduction of flood retention and of water purifying functions
- Drying up of smaller streams during the summer season as a result of earlier snowmelt and lower summer water levels
- Changes in fish distribution due to warmer lake and stream water temperatures, and an increased risk of dead zones in lakes
- Lower lake levels due to higher evaporation and reduced ice cover

WHAT'S GOING ON?

The Greenhouse Effect and Global Climate Change

The "greenhouse effect" refers to the natural phenomenon that keeps the Earth in a temperature range that allows life to flourish. The sun's energy keeps the Earth's surface and atmosphere warm. When this energy radiates from the Earth back toward space as heat, some of it is absorbed by heat-trapping gases (including carbon dioxide and methane) in the atmosphere, which creates an insulating layer. The greenhouse effect keeps the Earth's average temperature at 59 degrees Fahrenheit (15 degrees Celsius). Without it, the average surface temperature would be 0 degrees Fahrenheit (-18 degrees Celsius), a temperature so low that the Earth would be frozen and would be unable to sustain life. This is called the greenhouse effect because it is the same process that occurs in a greenhouse: The glass reflects some of the heat back into the room, instead of allowing it to escape.

Global climate change (formally referred to as "global warming") refers to the rise in the Earth's temperature which results from an increase in heat-trapping gases in the atmosphere. Global warming is caused when increased levels of greenhouse gases, such as carbon dioxide, cause additional amounts of the sun's energy to be reflected back to the Earth as heat.

WHAT CAUSES GLOBAL CLIMATE CHANGE?

Scientists have concluded that human activities are contributing to global warming by adding large amounts of heat-trapping gases to the atmosphere. Our use of fossil fuels is the main source of these gases. We use fossil fuels when we drive a car, use electricity from coal-fired power plants, or heat our homes with oil or natural gas. The second most important source of greenhouse gases is deforestation (forests hold and store carbon), and other land-use changes.

WHAT CAN WE DO ABOUT GLOBAL CLIMATE CHANGE?

We can take action to reduce emissions of heat-trapping gases.

Governments can adopt different options for reducing greenhouse gas emissions. They can:

- Increase energy efficiency standards
- Encourage the use of renewable energy (wind and solar power)
- Eliminate subsidies that encourage the use of coal and oil by making them artificially cheap
- Protect and restore forests, which serve as important storehouses of carbon

Individuals can reduce the need for fossil fuels and often save money. They can:

- Drive less and drive more fuel-efficient and less-polluting cars
- Use energy-efficient appliances
- Insulate homes
- Use less electricity or choose environmentally-friendly power, when there is an option
- Plant a tree, since they store carbon and provide much-needed shade in the summer, reducing energy bills and fossil fuel use
- Let elected officials know you are concerned

For more information, see the website for the Union of Concerned Scientists: http://www.ucsusa.org/greatlakes/glsolutionsperson.html.

The total amount of carbon in the Earth's atmosphere doesn't change, but it is always cycling through different chemical forms and locations. Anywhere that carbon is found can be considered a pool, or reservoir. The global carbon cycle includes pools such as deep ocean sediment, biomass, and the atmosphere. Carbon cycles through these pools at all times, even though one carbon atom may spend anywhere from seconds to tens of millions of years in any given pool. Today, humans are influencing and altering the carbon cycle. Humans are altering how land is used, burning large areas of forest, paving over land that used to be fields, and replanting land with different trees, crops, and grasses than those that originally existed there. All of these activities change the abilities of plants and animals to cycle carbon dioxide (CO2) into and out of the atmosphere.

Sources and sinks within the carbon cycle were described previously. When we think of parts of the carbon cycle that directly contribute to increases in greenhouse gases, we focus on the atmospheric pool of carbon. From this perspective, a source would be a process that releases carbon into the atmosphere and a sink would be a reservoir that takes up carbon from the atmosphere. Sources and sinks can be natural or caused by humans.

Natural sources include plant and animal decay, respiration, volcanic eruptions and forest fires. Sources resulting from human activity include the burning of fossil fuels and deforestation, the destruction of forests by cutting down or burning trees. The main problem thus arises when human activities convert sinks into sources. Examples of this include coral bleaching, limestone mining, deforestation, forest fires that are used to clear land, and the burning of fossil fuels.

Natural carbon sinks include growing plants, soil, corals, sediment and sedimentary rocks, and wetlands. Humans can also influence carbon sinks through reforestation, or replanting trees in areas where forests have been destroyed. Trees help to store carbon in their tissues, and also move carbon from the atmosphere into the soil, where it will take even longer to return to the atmospheric pool. This process of taking up CO2 through photosynthesis, releasing oxygen back into the atmosphere, but storing the carbon in plant tissues and soil, is called carbon sequestration.

While trees are very efficient at storing carbon in this way, all plants - especially those with deep roots - can move carbon from the atmosphere to a pool where it can be stored longer. For this reason, restoration of natural ecosystems, such as the tallgrass prairies native to Illinois, can help to counteract the build-up of CO2 in the atmosphere.

INVASIVE PLANTS

During the industrialization years, the natural ecosystems of North America were developed at an exponential rate, with paved surfaces and turf grasses replacing native plants, such as prairie grasses. There are many reasons why turf grasses were planted instead of native plants, such as aesthetics, economics, and the idea that turf grasses were tamed. The negative effects such as surface runoff, lack of biodiversity, and loss of habitat have only been recently discovered. There is now a movement to re-plant native landscapes in hopes of improving and restoring natural ecosystems. By restoring native ecosystems and through other actions, humans are working to offset the negative effects of invasive plants and reduce their own carbon "footprints" in order to someday become carbon neutral.

PROCEDURE

PART ONE: GLOBAL CLIMATE CHANGE AND THE EARTH'S PROCESSES

1. Present diagrams of the carbon cycle, photosynthesis, cellular respiration, the greenhouse effect, and global climate change (see resources on the USB, look for images online or reference scientific journals and textbooks). Teachers lead a classroom discussion to help students understand the interconnectedness of these natural processes. What can be done? *Plant native plants*

Note: Students should have some background knowledge of these topics, and you may use the information from the background section of this lesson and use textbooks, library or Internet resources to teach students about these processes.

2. Discuss the following: What "hot topic" issue is related to these processes? *Climate change or global warming*
3. What issues might arise as a result of climate change? *Decreased biodiversity, increased temperature, loss of populations*
4. What can be done to alleviate these issues? *Refer to the list in the background information for possible responses. For this lesson we will focus on planting native plants.*

PART TWO: INVASIVE VS. NATIVE

5. Classroom discussion: What are the negative effects of invasive plants? *Invasive plants decrease biodiversity. Invasive plants are not parts of the habitats of native wildlife. Invasive plants may have shallower root systems that can result in erosion and surface runoff.* What are the benefits of native plants? *Native plants do not require fertilizers. Native plants require fewer pesticides than lawns. Native plants require less water than lawns. Native plants help reduce air pollution. Native plants provide shelter and food for wildlife. Native plants promote biodiversity and stewardship of our natural heritage. Native plants need little long-term management and can help save money.*
6. Facilitate a discussion related to native plants.

a. What do plants need in order to grow?

b. What processes do plants undergo in order to survive? *Photosynthesis, cellular respiration*

c. How do plants relate to the carbon cycle?

d. How do native plants promote biodiversity within a coastal habitat?

PART THREE: PLANT PLANS

7. Discuss ways that students could bring native plants to, or reduce the impact of, invasive plants in their town/city: *plant a native plant in their yard or the school grounds, plant a native garden, work on a site restoration project, work on an invasive species removal project, other local opportunities*
8. If possible, take next steps to have the students plan a hands-on experience with native plants. Options include: reaching out to local organizations to work on restoration projects, to partner or offer assistance; plan a garden on-site at the students' school, at their homes or at a nearby site; select and plant native flowers for an in-classroom garden, or to give the plants away as gifts or as donations to the school district, park district, town or forest preserve district.

9. Students can plan a garden and then plant it if an adequate site, appropriate resources, and time are available. Students would need permission to actually follow through with the plans and install a garden. Schoolyard habitats are great places to start, and can often involve the community. Students should document and share the work they undertake. Steps can include:

a. Choosing a site

b. Identifying native plants to include

c. Collecting gardening resources and materials

d. Researching propagation techniques

e. Designing the garden

f. Planting the garden

g. Developing a maintenance schedule (daily, weekly, monthly, seasonally)

WRAP-UP QUESTIONS

10. What benefit(s) do native plants bring to a habitat? An ecosystem? A region? *(Biodiversity)* What other problems can native plants help alleviate? *(Erosion, storm water runoff - wetland plants filter water in a watershed)*

11. How could invasive plants affect your native garden? *(See information above and on the student pages.)* How would you identify an invasive plant species? *(Using a field guide or dichotomous key. Ask an expert.)* What methods could be used to control or remove potential invasive species from your garden? *(Weed or physically remove the plant. Plant native plants in their place)*

EXTENSION

A. Invite a guest speaker from the state DNR, county forest preserve, soil and water outreach coordinator or other site to talk to your students about native planting, invasive control and climate change, or visit a local site to assist with restoration (i.e. prairie or wetland restoration).

B. As stated above, students can plan and plant a garden for their yard, or apartment/condominium grounds.

C. Investigate native plant propagation or gardening techniques. Consider working with the National Wildlife Federation's Schoolyard Habitat program: http://www.nwf.org/Get-Outside/Outdoor-Activities/Garden-for-Wildlife/Schoolyard-Habitats.aspx.

ASSESSMENT

See rubric on page 117.

RESOURCES

Please see Resource List for additional information related to conservation and restoration, native and invasive species and more.

NAME

13
LESSON
STUDENT PAGE

Plant Plans

VOCABULARY

biodiversity
carbon dioxide sequestration
restoration
deforestation
grafting
pool
propagation
reforestation
sink
source

BACKGROUND

The Great Lakes Basin contains 20 percent of the Earth's fresh surface water. A change in climate will alter water availability and quality in the Great Lakes, in the region's groundwater and in the many wetlands, lakes and streams in the region. Throughout this century, the region's climate is expected to become warmer in both the summer and winter. Projected changes in seasonal precipitation are that winter and spring precipitation could increase, while summer rains could decrease by as much as half. Heavy summer downpours are likely to become more frequent, with dry periods in between, and lake levels are expected to drop overall. Some of these changes have already been detected in regional climate trends. The Great Lakes region depends on water for drinking, shipping, irrigation and industrial processes. After going through this lesson you should be able to understand the benefits of native plants as well as the impacts of invasive plant species.

Your teacher has additional background information related to the carbon cycle, photosynthesis, cellular respiration, the greenhouse effect, and global climate change, as do textbooks, libraries and the internet. If these concepts are new to you, your teacher will lead you in learning more about these processes.

INTRODUCTORY QUESTIONS

1. What are everyday things that you do that could contribute to global warming?

2. What issues might arise as a result of climate change?

3. What do plants need in order to grow?

4. What processes do plants undergo in order to survive?

5. What role do plants play in the carbon cycle?

NATIVE PLANTS

6. How can you help to increase the number of native plants in your state, city, town, community, school yard or own backyard? What about along the shores of your nearest Great Lake?

7. How can you help to decrease the number of invasive plants in your state, city, town, community, schoolyard or own backyard? What about along the shores of your nearest Great Lake?

8. Optional: Plan a native garden, or a rain garden. Steps can include:

   a. Choosing a site
   b. Identifying native plants to include
   c. Collecting gardening resources and materials
   d. Researching propagation techniques
   e. Designing the garden
   f. Planting the garden
   g. Developing a maintenance schedule (daily, weekly, monthly, seasonally)

WRAP-UP QUESTIONS

9. What benefit(s) do native plants bring to a habitat? an ecosystem? a region? What other problems can native plants help alleviate?

10. How would invasive or nonnative plants affect your native garden?

11. What methods could be used to control or remove potential invasive species from your garden?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
BACKGROUND: Student familiarizes him/herself with the carbon cycle, photosynthesis, cellular respiration, the greenhouse effect and global climate change. Student participates in class discussion about "hot topics" associated with these processes.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
DISCUSSION: Student actively participates in discussion about the negative effects of invasive plants and the benefits of native plants. Student connects the processes in the background discussion to native and invasive plants in coastal habitats. Student participates in a brainstorming activity of how they could reduce the impact of invasive plants in their community and restore native plant communities.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
NATIVE PLANT PLANNING: Student participates with the class as a whole to design a garden consisting of native plants (schoolyard or local grounds). Student documents the site, which plants to include, gardening resources and materials needed and propagation techniques. Student plans and designs a garden, and develops a maintenance schedule (daily, weekly, monthly, seasonally) for the garden.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
WRAP-UP: Student answers questions pertaining to their garden on the student pages.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Habitat Analysis

Students analyze data from a coastal habitat scenario, plan a presentation and decide on steps to improve the health of the habitat, and present their projects.

OBJECTIVES

Analyze data to reach conclusions

Develop action plans for addressing coastal restoration issues

SUBJECT
Ecology, Geology, Environmental Science, Hydrology

PREREQUISITE
#1: Coastal Journey

VOCABULARY
colony forming unit (cfu)
concentration
macrophyte
ravine
stream
stream flow
turbidity

MATERIALS
data charts
pencils

TIME/DURATION
90 minutes

SETTING
Indoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

Collecting data can be an interesting and worthwhile endeavor for students. However, the real interest and potential for critical thinking is in understanding what the data means. This activity allows students to practice analyzing and synthesizing data related to beach health, especially when done in conjunction with Lesson #16: Adopt-a-Habitat. Teachers can also seek out other citizen science data collection projects in their local community. This activity can serve as a way to get students to interpret data and understand how to look for trends and possible cause-and-effect relationships.

pH: refers to the acidity of the water. Lower number means more acidic, higher number means more basic. Values in the range of 6.5 to 8.5 are normal.

Dissolved Oxygen (DO): a measure of oxygen content in the water. Oxygen is critical for the survival of fish and other wildlife in the water. Decreases in DO stress the ecosystem. There may be natural fluctuations in the DO level due to seasonal variations in temperature; however, pollution can also impact the DO of the water. Bacteria, algae, and other organic matter consume oxygen, causing DO levels to drop. DO levels below 5 mg/L will cause ecosystem stress; 1-2 mg/L will result in fish kills.

E. coli/Fecal Coliform/Enterococcus Bacteria: These bacteria are used as indicators to determine if fecal matter is present in the water and to evaluate if a body of water supports safe recreational use. Beach monitoring typically involves testing for E. coli and sometimes fecal coliform to determine if the water is safe for swimming. Enterococci is another bacteria that is used as an indicator. Enterococci is traditionally used to monitor marine bathing water, but it is also suitable to use as an indicator for freshwater. The U.S. EPA recommends the posting of beach advisories if a measurement of E. coli exceeds 235 cfu/100 mL. If enterococci levels are above 61 cfu/100mL, this could also lead to a beach advisory. Elevated bacteria levels can be due to a few full diapers on the beach, bird droppings, or sewage discharges after a heavy rainfall.

Phosphate and Nitrate (or Phosphorus and Nitrogen): concentration of nutrients such as phosphorus and nitrogen influence the growth rates of organisms in the water. If there is an excessive amount of nutrients, particularly phosphorus,

algal blooms can appear. Algae is slimy and smells bad. Some types of algae can release toxins, as well. Algal blooms result in decreased DO content. Excessive nutrients can come from sewage treatment plants or agricultural (fertilizer or animal waste) runoff. The U.S. EPA recommends that the total amount of phosphorus should not exceed 0.05 mg/L in a stream at a point where it enters a lake or reservoir, or 0.025 mg/L within the lake or reservoir. The recommended levels of nitrogen and nitrogen compounds (nitrate, nitrite, ammonia) are site specific and depend on the type of habitat.

PROCEDURE

Divide the class into two groups: ravine/tributary and beach.

RAVINE/TRIBUTARY GROUP

1. Give the students the following scenario: A local high school has adopted a nearby stream that flows into a Great Lake. This stream is a ravine system tributary. The students made four visits throughout the fall and spring, looking at the shoreline and the surrounding area, the types and quantity of aquatic species, the quality of the water and the presence of pollution. They are ready to analyze their data and create an action plan to create positive change at this ravine site.

2. Give the students the data in the journal pages. Data on water quality and macroinvertebrate populations was collected during each visit, on separate charts. Have them compare the visits based on the data and use the journal questions to make note of their observations. As a class, discuss the data. *This may include noticing problems with increased water temperature, decreased populations or increased pollution following precipitation events.*

3. Introduce the idea of taking action to help the beach. Divide students into smaller groups and have each group pick one problem on which they will focus their attention. *Problems might include litter along the shoreline or in the water, lack of educational signage, storm water runoff from a parking lot. What type of project can students create that will address these issues?*

4. Have students develop an action project to address the issue, including a presentation of results to each other in the "roles" of city officials.

BEACH GROUP

5. Give students the following scenario: A local high school has adopted a nearby beach. Students have made four visits throughout the fall and spring looking at the shoreline and surrounding area, the type and amount of litter, and the presence of E. coli bacteria. They are ready to analyze their data and create an action plan to create positive change at their beach.

6. Give students the data in the journal pages. Data on litter condition and water quality was collected each time, on separate charts. Have them compare the visits based on the data and use the journal questions to make note of their observations. As a class, discuss the data. *This may include noticing problems with overflowing trash cans, consistent seagull waste, and a possible sewage overflow on the second visit.*

7. Introduce the idea of taking action to help the beach. Divide students into smaller groups and have each group pick one problem on which they will focus their attention. *Problems might include overflowing trash cans, consistent seagull waste, possible sewage overflows, lack of educational signage, stormwater runoff from the paved parking lot.* What type of project can students create that will address these issues?

8. Have students develop an action project to address the issue, including a presentation of results to each other in the "roles" of city officials.

WRAP-UP

9. Have each group take turns presenting their action project while the other group role-plays the group hearing the results.

10. After both groups have presented, use the rubrics from the student pages to evaluate the presentations. Did the students prefer presenting or hearing the presentation? What did the other group do well? What could they do better? If your classroom were to really arrange a meeting, what other things should be considered?

EXTENSION

A. Students take results from their habitat analysis and create an action plan to help a coastal habitat.

B. Use this activity as a model for presenting actual data to community decision-makers.

C. Have the students participate in the Alliance for the Great Lakes' ongoing Adopt-a-Beach™ program: http://www.greatlakesadopt.org or participate in the International Coastal Cleanup, which occurs on the third Saturday of every September: www.oceanconservancy.org.

ASSESSMENT

See rubric on page 125.

RESOURCES

Please see Resource List for additional information related to conservation and restoration, native and invasive species and more.

NAME

14
LESSON
STUDENT PAGE

Habitat Analysis

VOCABULARY

colony forming unit (cfu)
concentration
macrophyte
ravine
stream
stream flow
turbidity

BACKGROUND

Collecting data can be an interesting and worthwhile endeavor. However, the real interest and potential for critical thinking is in understanding what the data means. This activity can serve as a way to interpret data and understand how to look for trends and possible cause-and-effect relationships. Following this lesson you will be able to analyze and synthesize data relating to coastal habitat health.

DATA SET #1 (RAVINE/TRIBUTARY)

1. Description of the stream (name, location of the stream's headwaters, length, where it flows, where it empties):

_____

_____

_____

_____

_____

_____

_____

_____

GENERAL CONDITIONS

	1st Visit 9/22	2nd Visit 9/25	3rd Visit 9/30	4th Visit 10/02
Air temperature (degrees Celsius)	28	25	21	22
Recent precipitation event (date)	none	9/25	9/27	10/01
Recent precipitation event (description)	n/a	Mild rainstorm	Light rain	Heavy rainstorm
Current sky conditions	Sunny	Cloudy	Cloudy, Windy	Partly cloudy

WATER QUALITY MONITORING

	1st Visit 9/22	2nd Visit 9/25	3rd Visit 9/30	4th Visit 10/02
Depth of stream (feet)	60.2	64.4	62.8	63.1
Stream flow	Mild	Moderate	Moderate	Rapid
pH	6.3	6.4	7.1	7.5
Dissolved oxygen content (mg/L)	14.0	12.7	13.4	13.1
E. coli (cfu/100 mL)	0	100	0	0
Fecal coliform (cfu/100 mL)	300	200	100	400
Phosphate (mg/L)	78	71	79	75
Nitrate (ppm) (mg/L)	54	51	54	53
Water temperature (degrees Celsius)	24	20	21	24
Odor	Odorless	Foul	Odorless	Odorless
Turbidity	Slightly cloudy	Cloudy	Opaque	Slightly cloudy

MACROINVERTEBRATE (AQUATIC INSECT) POPULATION MONITORING

	1st Visit 9/22	2nd Visit 9/25	3rd Visit 9/30	4th Visit 10/02
Caddis fly	600/2000	685/2000	659/2000	670/2000
Damselfly	203/2000	198/2000	271/2000	350/2000
Stonefly	145/2000	167/2000	206/2000	109/2000
Scuds	179/2000	225/2000	203/2000	235/2000
Clams and mussels	366/2000	105/2000	200/2000	130/2000
Gilled snails	290/2000	200/2000	190/2000	162/2000
Riffle beetles	147/2000	178/2000	165/2000	136/2000
Crayfish	120/2000	225/2000	60/2000	130/2000
Mayfly	18/2000	17/2000	6/2000	78/2000
Other:	None	None	None	None
Other:	None	None	None	None

STREAM HABITAT TYPE MONITORING

	1st Visit 9/22	2nd Visit 9/25	3rd Visit 9/30	4th Visit 10/02
Woody debris or snags	4/20	3/20	4/20	3/20
Vegetated banks	3/20	3/20	3/20	5/20
Sand and fine sediment	6/20	4/20	5/20	4/20
Cobble (hard substrate)	3/20	4/20	4/20	3/20
Aquatic plants (macrophytes)	4/20	6/20	4/20	5/20

DATA SET #2 (BEACH)

2. Description of the beach (location, length or size of shoreline, adjacent body of water)

_____

_____

_____

_____

_____

_____

_____

_____

GENERAL CONDITIONS

	1st Visit 9/22	2nd Visit 10/14	3rd Visit 4/22	4th Visit 5/14
Air Temperature (degrees Celsius)	28	20	18	22
Recent precipitation event (date)	9/20	none	4/21	5/12
Recent precipitation event (description)	Severe rain	n/a	Rain	Severe rainstorm
Current sky conditions	Cloudy	Partly sunny	Sunny	Cloudy

WATER QUALITY MONITORING

	1st Visit 9/22	2nd Visit 10/14	3rd Visit 4/22	4th Visit 5/14
Current wave height (feet)	2.3	2.6	2.7	3.1
Intensity of the waves	Calm	Calm	Somewhat intense	Intense
pH	7.6	7.9	7.3	7.8
Dissolved Oxygen Content (mg/L)	14.1	15.2	14.7	14.9
E. coli - water (cfu/100 mL)	100	0	50	400
Fecal Coliform (cfu/100 mL)	700	75	300	1500
Enterococcus (cfu/100 mL)	50	14.9	20	90
E. coli - sand (cfu/100 mL)	9	10	7	6
Water temperature (degrees Celsius)	23	17	16	17
Odor	Foul	No odor	No odor	Rotten egg smell
Turbidity	Cloudy	Pretty clear	Slightly cloudy	Opaque

POTENTIAL POLLUTION SOURCE **COMBINED SEWER OUTFALL_____**

	1st Visit 9/22	2nd Visit 10/14	3rd Visit 4/22	4th Visit 5/14
Flow rate	Medium	n/a	Low	Medium
Water color	Brown	n/a	Light brown	Brown
Characteristics	Smelly	n/a	n/a	n/a
E. coli - water (cfu/100 mL)	1900	n/a	600	800
Fecal coliform (cfu/100 mL)	5000	n/a	1000	1500
Enterococcus (cfu/100 mL)	1000	0	200	120
E. coli - sand (cfu/100 mL)	10	4	7	9
Algae in the water near the shore (amount)	Low	Moderate	Moderate	Moderate
Algae in the water near the shore (type)	Black Brush	Staghorn	Greenspot	Greenspot
Algae in the water near the shore (color)	Black	Green	Green	Green
Algae on the beach (amount)	Low	Low	Low	Moderate

WILDLIFE ON THE BEACH POPULATION MONITORING

	1st Visit 9/22	2nd Visit 10/14	3rd Visit 4/22	4th Visit 5/14
Geese (living)	47	22	19	36
Gulls (living)	28	32	26	22
Dogs (living)	1	5	7	4
Other:	n/a	n/a	n/a	n/a
Common loon (dead)	2	0	1	0
Herring gull (dead)	0	3	2	1
Ring-billed gull (dead)	1	0	0	0
Double-crested Cormorant (dead)	0	0	0	0
Horned grebe (dead)	0	1	0	0
Fish (dead)	2	3	2	1
Other:	n/a	n/a	n/a	n/a

LITTER MONITORING

	1st Visit 9/22	2nd Visit 10/14	3rd Visit 4/22	4th Visit 5/14
Litter condition	Fair	Moderate	Moderate	Moderate
Trash cans (quantity)	8	8	8	8
Animal waste (source)	Dog	Seagull	Seagull/dog	Dog
Restrooms	Fair	Fair	Fair	Fair
Cigarette filters	45	32	28	36
Food wrappers and containers	22	31	36	42
Caps and lids	33	39	40	37
Straws and stirrers	21	20	29	26
Plastic beverage containers	35	38	39	22
Balloons	0	3	1	0
Other:	n/a	n/a	n/a	n/a
Other:	n/a	n/a	n/a	n/a

HABITAT ANALYSIS

3. Describe your observations as you analyze the data. Identify possible issues at this coastal site.

ACTION PROJECT

4. In small groups, identify one problem that you would like to investigate. Describe that issue here:

5. What are the possible causes of this issue?

6. What actions can you take to address this issue?

7. On a separate page or on a computer, develop an action plan for your site. Then, create a presentation to describe your action plan.

WRAP-UP QUESTIONS

8. Did you prefer presenting or hearing the presentation?

9. What did the other group do well?

10. What could they do better?

11. If your classroom were to really arrange a meeting, what other things should be considered?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
DATA ANALYSIS: Student thoroughly reads the journal pages that include all data from habitat site visits. Student notes his/her observations of the data and summarizes their findings (i.e. potential reasons for increases or decreases in quantity of bacteria in a water sample).	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
ACTION PROJECT: Student works in a group to investigate one problem associated with the coastal habitat. Student develops an action plan to address the problem. Student role play as a city official or community stakeholder. Groups highlight what the problem is, where it is coming from and who is involved. As a class, students identify possible solutions to the problem. Students evaluate each other and discuss what should be considered if a meeting were really to be arranged.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Watershed Mysteries

Students analyze data from a coastal habitat scenario, plan a presentation, decide on actions for improving the health of the habitat and present their action projects

OBJECTIVES

Identify and role-play the participants in ecosystem health scenarios

Weigh risks and benefits of coastal habitat planning decisions

Defend one view on an environmental issue related to coastal habitats

SUBJECT
Ecology, Debate, Land Management

PREREQUISITE
#4: Explore and Restore
#6: Coastal Habitat Research

VOCABULARY
flux
groundwater
headwaters
infiltration
invasive species
permeable
reservoir
runoff
surface water
wetland

MATERIALS
scenarios
chart paper
library access
internet access

TIME/DURATION
90 minutes + 60 minutes for each additional "public meeting"

SETTING
Indoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

Public meetings are held in local or relatively large communities to debate or discuss issues, including land management and watershed planning. Students will discuss multiple scenarios, and debate these issues as they relate to Great Lakes restoration and coastal habitat management. They will also take on different roles and look at different perspectives as they debate and research Great Lakes issues, discussing the pros and cons of issues.

Debates can range from having detailed and formal structures, like Lincoln-Douglas Debates, which are presented by some debate teams (see resource list for more information). Debates can also be simple and informal, such as when students are paired to research and discuss the pros and cons of an issue. As they identify, research, and argue about complex ideas, they will hone their skills in critical thinking, organization, persuasion, public speaking, research and teamwork.

PROCEDURE

PART ONE: LARGE GROUP DISCUSSION

1. Introduce the topic of Great Lakes restoration and coastal habitat management. What current issues are the open waters of the Great Lakes facing? What current issues are the coastal habitats of the Great Lakes facing? What current issues are the communities within the Great Lakes basin, or Great Lakes watershed, facing?
2. Discuss what makes a good debate. Have students brainstorm a list of ideas for ways to make the debate successful. *The list might include: Listening to each other, talking loudly enough for others to hear, being polite, choosing a moderator to facilitate, etc.*

Note: This activity includes four scenarios that Great Lakes communities have faced. The teacher can select one of these issues ahead of time, or the teacher can read all four scenarios to the students and ask students which scenario they would like to debate or discuss as a class.

3. As a class, brainstorm a list of relevant characters involved in the decision-making and problem-solving of these Great Lakes issues, which can be gleaned from the articles that students have read. Another option is to give students the included "scenario cards," but they may have additional or alternate ideas for who should participate in the debate.

4. As a class, decide on the roles needed for the debate or have students work in teams to create solid arguments for the roles provided on the "scenario cards." For example, there could be a group of residents or a water company group that works together to prepare their roles for the debate.

5. Once the roles have been chosen, students should review their own roles, as well as the roles of others within the community. Students will create a written summary of the statements that they would like to contribute to the debate. In addition, students should write a three-to-five sentence summary of their personal beliefs on the issue.

PART TWO: (MOCK) PUBLIC MEETING

6. Review the elements of a successful public meeting and determine which scenario the class will debate or discuss.

7. Assign each student a role. One person's role should be the moderator. The moderator (the educator, or another student,) calls the class to order.

8. Each character group will have two minutes to make an initial statement. Once this is complete, each will have two minutes to make counter-arguments.

9. The group should attempt to come to some sort of consensus, or one "character" or group could make the final decision.

10. Observers should report on their observations. Discuss as a class: What was positive about the public meeting and how could it have been more effective?

PART THREE: RESEARCHING A GREAT LAKES ISSUE

11. Students conduct independent research on a Great Lakes issue using the library, Internet and/or teacher's resources.

12. Students write an essay summarizing the Great Lakes restoration or coastal management issue that was debated in class. The essay should explain their stances on the issue. The opinions should be backed up by facts found through independent research and/or from the background information that was provided.

WRAP-UP

13. Students use their observations of the public meeting and their written summaries to answer the journal questions and discuss them as a class.

EXTENSION

A. Have students research other current issues facing the Great Lakes and host a public meeting as they did with the scenarios from the student pages.

B. Students write a letter to their senator or representative expressing their views on Great Lakes protection. A list of senators and their addresses can be found at the U.S. Senate's homepage (http://www.senate.gov/general/contact_information/senators_cfm.cfm).

ASSESSMENT

See rubric on page 138.

RESOURCES

Please see Resource List for additional information related to resources and organizations, watersheds and more.

SCENARIO 1

What is Watershed Management?

Watershed Management is a collaborative process of creating and implementing plans, projects and programs to sustain and enhance watershed functions that affect animal, plant and human communities within a watershed. Such topics for watershed management include drainage, water rights, stormwater runoff, and water quality and supply. Landowners, environmental specialists, stormwater management experts, citizens and land-use agencies are all involved in managing watersheds.

SCENARIO OBJECTIVES

Practice decision-making skills in a mock town meeting

Gain experience in recognizing potential hazards to the community's water supply

Weigh the risks and benefits of community development

In Clearwater, the local farmers have been using excess fertilizer on their soybean crops to combat the increased incidence of an invasive beetle that has been eating the soybeans. Three separate hydrologists have discovered a rapid increase in nitrogen and phosphorus concentrations in the nearby streams, compared with baseline data. Since a watershed is fed by these streams, the hydrologists have become concerned with the health of the watershed and have consulted with the Illinois Department of Natural Resources (IDNR) to hold a meeting today. This meeting is urgent because the health of the entire watershed is at stake due to fertilizer runoff within the local farming economy.

The meeting will be comprised of local farmers, citizens, the Environmental Protection Agency (EPA), the state DNR, and state and local officials. Students will be actively involved in an in-class simulation of the meeting to discover how watershed management is a cooperative process involving state, federal, and local stakeholders.

Three to five local farmers: This group seeks to dodge the idea that the rises in nitrogen and phosphorus levels are directly linked to their fertilizers. They will argue that the health of the crops is beneficial for everyone and if they had to cut back on fertilizer, the community would suffer from a lack of healthy produce.

Three hydrologists: These highly specialized water technicians are adamantly opposed to the increased concentrations of nitrogen and phosphorus in the watershed. Although nitrogen and phosphorus occur naturally in low concentrations, excessive amounts of phosphorus and nitrogen can enter waterways from agricultural runoff, untreated sewage discharges and phosphorus-based fertilizers and detergents. If there is too much of these nutrients in the water, then the amount of algae also rises – transforming the water into a green soup of algae and bacteria that can cause foul-smelling water, algae blooms, fish kills, and health threats such as toxic algae and contaminated drinking water. Since they completed field work where the levels of nitrogen and phosphorus were off the charts, and witnessed algal blooms, the hydrologists have become convinced that pollution is having a very negative impact on the watershed. Since the health of the watershed is fragile, they would argue, the streams are biologically, ecologically and chemically in danger.

One person from the IDNR: The meeting today was led by this particular person, who tried to find a balance between local economic growth and the ecological health of the watershed. They are most concerned with hearing from the public, in terms of reaching a conclusion.

One person from the local government: This individual would like to promote the strength of the local farming economy because they would personally benefit from that, since they are elected by the citizens of Clearwater, based on economic growth. If the local economy were to decline because of a decrease in the use of fertilizer, this local government official fears that they would not be re-elected.

One person from the state government: The state government is concerned with how this region in Clearwater is going to affect other areas in the state. If the streams are polluted in Clearwater, the state government official fears that the pollution will spread to other populated areas in Clearwater, causing further distress. This state official would like to see a rapid decline in the farmers' use of fertilizer.

One person from the EPA: This person serves as a federal employee and must seek to find a solution that balances the needs and wants of the local and state stakeholders. They would argue that the local farmers should try to use more sustainable fertilizers that aren't harmful to the watershed. Such organic or sustainable fertilizers may help both the farmers succeed in growing crops and also help the entire watershed flourish from a drop in pollution.

Citizens of Clearwater (the rest of the class): This role is crucial, because without the citizens of Clearwater at the meeting, it's difficult to know what the perspective of the community is. The citizens have valuable input into how their drinking water has been greatly affected by the excess nitrogen and phosphorus. They want to argue for a better fertilizer substitute or none at all.

SCENARIO 2

What is Land-Use planning?

Land-use planning is a branch of public policy which includes different disciplines, focusing on how to use land in an efficient and ethical manner, preventing land-use conflicts.

SCENARIO OBJECTIVES

Practice decision-making skills in a mock city hall meeting

Gain experience in recognizing potential threats to ecosystems

Weigh the risks and benefits of land use

A new plan proposes constructing an outlet shopping mall in what is now a wetland preserve. The new economic oasis would, in theory, collect millions of dollars each year stimulating the local and state economy, but at what cost would this development succeed? The existing wetland oasis is a thriving ecosystem with native plants, animals and insects, and it helps water enter, or infiltrate, into the soil. Local environmental organizations have been outraged by this new plan, and have decided to hold a meeting at City Hall today.

This meeting will include the city planner, mayor, state governmental officials, environmental scientists, citizens, and the new outlet shopping mall developers. The purpose of the meeting is to establish a balance between urban development and ecological gems, such as wetlands. The class will randomly divide up into different roles to come to a conclusion using an active and involved discourse.

One city planner: This person's job is primarily to oversee all of the development and planning of the city. They are concerned with the aesthetics of the town and argue that there is greater value in wetlands than in a concrete shopping mall, because too many strip malls will degrade the value of the community. This kind of development may scare people away instead of bringing people to the town.

Five to ten environmental scientists: The environmental scientists obviously argue against the development of the outlet shopping mall because such a structure would disrupt the entire ecosystem of the wetland. Without the tall grasses, water will definitely run off at a very strong rate instead of infiltrating into the long roots of the native plants. By paving over wetlands, water has the ability to run off instead of infiltrate, which can disrupt the water cycle that the community has relied on for decades. The biodiversity would decline at an extreme rate, threatening the extinction of many rare native plants, birds, insects and other animals. The environmental scientists have data including examples of wetlands that have been converted into paved shopping centers, which supports their arguments.

One mayor: The mayor is in favor of preserving and restoring the wetland area because they grew up in this town and know that, without the wetlands, the entire ecosystem and town would degrade in its number and variety of species, as well as in its appearance.

Two state governmental officials: These individuals are in favor of the construction of the new outlet shopping center because it will bring great growth to the entire state. These officials argue that the economic benefits outweigh the ecological costs and support the continuation of the development of the outlet shopping mall.

Five to ten outlet mall developers: These outlet mall developers are obviously in favor of the construction of the new shopping haven and believe that the economic profits are so great that it would be foolish not to take advantage of this prime spot by Lake Michigan. Disregarding the severe ecological threats, the developers think that turf grass and paved cement will only have a small negative impact on how well the urban ecosystem functions.

Citizens: Some citizens support the idea of the outlet mall, for it will bring jobs and tourism into the local community, and some fear that the increased development of the area will lead to the ecological decline of the unique community. The town was originally all wetlands, but a large amount of development there in the twentieth century resulted in only a few wetlands remaining. This led many of the citizens to agree that their ecological gem should be guarded and preserved forever. It takes hundreds of years to create a wetland community and future generations should be able to enjoy the beauty of the wetland.

SCENARIO 3

What is Coastal Land-Use Planning?

Coastal land-use planning is similar to land-use planning, but focuses on carefully using and protecting the coasts near bodies of water, creating a balance between urban development and natural ecosystems.

SCENARIO OBJECTIVES

Practice decision-making skills in a mock city hall meeting

Understand the delicate balance between urban development and natural ecosystems

Weigh the risks and benefits of land use

Residents have built homes on the coasts of Lake Michigan for decades. Recently passed legislation determined that homes can no longer be built on these coasts for fear of the erosion of the Indiana Dunes and of coastal ecosystem degradation. Local citizens are outraged that they can no longer reside directly on the shores of Lake Michigan. Coastal land managers have been consulted by the Indiana Department of Natural Resources, the Alliance for the Great Lakes, residential developers, and local citizens. Randomly divide up the classroom and then hold a mock town hall meeting to discuss the recent state legislation regarding coastal land development. Decide as a class what should be done to homes that have been built on the coasts, and what actions should be taken regarding the new or future construction of homes along the Great Lakes coasts.

One coastal land manager: This individual has been assessing the condition of the coastal region of Lake Michigan for 30 years and has witnessed severe erosion from the development of homes on pristine sand dunes. The abnormal erosion rates, he argues, are a good enough reason to stop development completely on the coasts of Lake Michigan. He has set a distance of 1,000 feet away from the coast as a guideline for all new construction.

Three members of the Indiana Department of Natural Resources: These individuals are strongly opposed to any new construction on the coasts of Lake Michigan, because of the importance they place on public tourism. They are concerned that the past development of the area has degraded the beaches, and that the new construction projects will decimate them further.

Three members of the Alliance for the Great Lakes: These informed environmental advocates have direct relationships with the Indiana Dunes and have witnessed severe erosion rates from an increase in residential property on the coasts of Lake Michigan. These citizens firmly believe that the coasts of Lake Michigan are public and should be available for all to enjoy instead of a select few. They also argue that coastal ecosystems would thrive without residential development.

Six local residential developers: These individuals feel that the communities of Lake Michigan are running out of space for development, and that the coasts are prime spots for houses, since this has been the custom for years. The developers don't see any long-term problems with developing the coasts, and threaten to build without permits.

Local citizens (the rest of the class): The local citizens are split on making a decision in the scenario; some are outraged by the construction but some feel that the state is taking away the freedom of choosing where to live.

NAME _____

15
LESSON
STUDENT PAGE

Watershed Mysteries

BACKGROUND

Given a variety of scenarios, you will investigate Great Lakes restoration and coastal habitat management issues. After being assigned a role, you will participate in a public meeting to discuss and debate these topics. To complete the lesson, you will then do further research of some of the issues facing the Great Lakes and its coastal habitats.

VOCABULARY

flux
groundwater
headwaters
infiltration
invasive species
permeable
reservoir
runoff
surface water
wetland

INTRODUCTORY QUESTIONS

1. What issues have you debated with your parents or friends? List at least three examples.

2. What issues might professionals debate, which are related to the Great Lakes coast and watershed? List at least three examples.

3. What are the elements of a good debate?

_____

_____

_____

_____

_____

_____

_____

_____

PART 1 -- (MOCK) PUBLIC MEETING

Review the following scenarios, and then as a class select one to discuss. You will host a public meeting, inviting stakeholders to share their opinions on the situation.

SCENARIO 1: WHAT IS WATERSHED MANAGEMENT?

Watershed Management is a collaborative process of creating and implementing plans, projects, and programs to sustain and enhance watershed functions that affect animal, plant, and human communities within a watershed. Topics related to watershed management include drainage, water rights, stormwater runoff, water quality and water supply. Landowners, environmental specialists, stormwater management experts, citizens and land use agencies are all involved in managing watersheds.

SCENARIO OBJECTIVES

Practice decision-making skills in a mock town meeting
Gain experience in recognizing potential hazards to the community's water supply
Weigh the risks and benefits of community development

In Clearwater, the local farmers have been using excess fertilizer on their soybean crops to combat the increased incidence of an invasive beetle that has been eating the soybeans. Three separate hydrologists have discovered a rapid increase in nitrogen and phosphorus concentrations in nearby streams, compared with baseline data. Since a watershed is fed by these streams, the hydrologists have become concerned with the health of the watershed and have consulted with the Illinois Department of Natural Resources (IDNR) to hold a meeting today. This meeting is urgent because the health of the entire watershed is at stake because of the fertilizer runoff used to support the local farming economy.

SCENARIO 2: WHAT IS LAND-USE PLANNING?

Land-use planning is a branch of public policy which includes different disciplines that seek to use land in an efficient and ethical manner, helping to prevent land-use conflicts.

SCENARIO OBJECTIVES

Practice decision-making skills in a mock city hall meeting
Gain experience in recognizing potential threats to ecosystems
Weigh the risks and benefits of land use

There has been a recent proposal to build a new outlet shopping mall in what is now a wetland preserve. The new economic oasis is supposed to collect millions of dollars each year, stimulating the local and state economies, but at what cost should this development succeed? The existing wetland oasis is a thriving ecosystem with native plants, animals, and insects, which provides the entrance, or infiltration, of water into the soil. Local environmental organizations have been outraged by this new plan, and have decided to gather at a meeting at City Hall today.

SCENARIO 3: WHAT IS COASTAL LAND-USE PLANNING?

Coastal land-use planning is similar to general land-use planning, but focuses on carefully using and protecting coasts that are near bodies of water, to create a balance between urban development and natural ecosystems.

SCENARIO OBJECTIVES

Practice decision-making skills in a mock city hall meeting
Understand the delicate balance between urban development and natural ecosystems
Weigh the risks and benefits of land use

On Lake Michigan, residents have been building homes on the coasts for decades. Recently-passed legislation has determined that homes can no longer be built on the coasts of Lake Michigan, for fear of erosion of the Indiana Dunes and of coastal ecosystem degradation. Local citizens are outraged that they can no longer reside directly on the shores of Lake Michigan. Coastal land managers have been consulted by the Indiana Department of Natural Resources, the Save the Dunes Conservation Fund, residential developers and local citizens. Your classroom will hold a mock town hall meeting to discuss the recent state legislature regarding coastal land development. Decide as a class what should be done to homes that have been located on the coasts for decades.

BEFORE THE PUBLIC MEETING

4. Write three sentences summarizing the background information related to the issue that you have been assigned. If you need more information, ask your teacher for an outside article on the issue.

5. List the possible characters that would be involved in a debate on this issue. Circle the names or titles of the characters which the class chooses for the (Mock) Public Meeting.

6. My character in the public meeting is: _____

7. Brainstorm a list of issues or opinions that are relevant to your character.

8. Write five to eight sentences summarizing how you or your group will contribute to the public meeting on behalf of your character. Include at least three of the vocabulary terms from this lesson in your summary.

9. Write five to eight sentences summarizing your personal beliefs on the issue. Explain if they are similar to, or different from, those your character will voice in the public meeting.

10. Write your opening statement here: (You will have two minutes to present this statement).

DURING THE PUBLIC MEETING

11. Make notes here during the public meeting for your counter-argument: (You will have two minutes to present this).

AFTER THE PUBLIC MEETING

12. How has your initial stance on the issue changed or not changed as a result of the public meeting?

13. What makes this a difficult issue to debate?

14. Which group do you believe had the strongest argument? Explain why you feel it was strong.

15. What made this public meeting work well?

16. What aspects of the public meeting could be improved?

17. Why is it important to learn about and listen to all sides of an issue?

PART 2 -- RESEARCHING GREAT LAKES RESTORATION

18. What are the main points that you are making in your essay and/or letter about this issue?

19. Conduct further research on Great Lakes restoration, and record the information below. Write down the source, title and author. Then write a three-sentence summary of each source.

a. Source:

Title:

Author:

Summary:

b. Source:

Title:

Author:

Summary:

c. Source:

Title:

Author:

Summary:

20. What evidence have you found to back up your claims?

21. Write your essay/letter on a separate page or on a computer. Cite all sources.

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
BACKGROUND: Student reads the background information of the scenario that the class will debate. Student uses additional resources to brainstorm and writes five to eight sentences (using vocabulary words) that will describe their character's opinions in the debate. Student writes another five to eight sentences describing their personal belief on the issue and if it is the same or different than their character's. Student prepares an opening statement for the debate.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
ROLE PLAY: Student is well prepared for the debate and actively participates in character. Student uses background information that has been researched with validating points. Student speaks loud and clear, listens to others while they speak their opinions, and is polite. Student takes notes during debate to use for counter-argument and follow-up questions in student pages.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
ESSAY: Student conducts further research on the coastal management issue that was debated. Student writes an essay explaining the student's stance on the issue with at least three documented resources. Spelling and grammatical errors are minimal.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Adopt-a-Habitat

Students work in small groups to record observations of a coastal habitat and make connections between its plants, animals, soil, water and topography. Students identify a potential natural restoration need within this habitat.

OBJECTIVES

- Discuss how people can help their community
- Observe and collect data on litter, water and soil quality, and physical characteristics of the coastal habitat
- List relationships that exist within the habitat
- Analyze data for trends and patterns
- Identify a potential natural restoration need within the habitat
- Create solutions based on identifiable concerns
- Discuss the significance of the coastal ecosystem to the Great Lakes

SUBJECT
Ecology

PREREQUISITE
#6: Coastal Habitat Research
#7: The Great Race for Survival
#8: Food Web Invasion

VOCABULARY
coastal habitat
commensalism
groundwater
mutualism
outlet
parasitism
symbiosis

MATERIALS
glass jars with lids
quart-sized sealable bags
journals
pencils
field guides
clipboards
pond nets
chaperones
hand lenses
appropriate attire, footwear, etc.

TIME/DURATION
Multiple days

SETTING
Outdoors

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

Students will be observing aspects of a coastal habitat or various coastal habitats. The class can visit any of the following coastal habitats: prairies, dunes and swales, beaches, wetlands, rivers, swamps, lakes, bogs/fens, marshes, ravines, savannas or forests.

Observation is the basis of science. Students must learn to be keen observers of their natural surroundings in order to formulate questions and make connections. Through observation, students will identify problems or issues within a natural coastal habitat. Students may identify a method for alleviating this problem and visit or "adopt" the habitat through repeated visits.

Citizen science refers to projects in which volunteers research real-world problems and collect scientific data. Service learning integrates community service into a curriculum, and connects schools with agencies and neighborhoods. These experiences build an understanding of a community, enrich learning and help youth develop personally, socially and academically. Service learning incorporates such steps as: research, investigation, analysis, action, reflection and celebration. The Alliance for the Great Lakes' Adopt-a-BeachTM program and curriculum is an easy and fun way for groups to connect with Great Lakes' habitats. Adopters generally commit to two to five visits per year. During the visits, adopters use special forms to collect data on three different aspects of their habitat.

PROCEDURE

PART ONE: OBSERVATION SKILLS

Note: This part of the activity can also be done at school before the field trip.

1. Ask each student to take five minutes to walk around and look for a rock that fits into their hand to bring back to the group. If this part of the activity is done in the classroom, another object, such as a pencil, could be used in place of a rock.

2. Have students sit in a circle on the ground. (This can be done in two groups.) Give them time to make some observations about their rocks and record them in their journals.

3. Have students place their rocks into the center of the circle, and then close their eyes (or turn around). When their eyes are closed, mix up the pile of rocks.

4. After mixing up the pile of rocks, have everyone face the center of the circle. Ask for a volunteer to look through the pile and find their rock. The student should tell the class two defining features that make their rock different from all of the others. Allow for a few more volunteers.

5. Ask students what sorts of things about their rocks might be important to observe and record. How detailed do observations need to be? What about observations of the coastal habitat? The more detailed the students' observations and journal entries are, the more information they will have to refer to later. As time goes by, it will be more difficult to recall details unless they have been recorded.

PART TWO: SMALL-GROUP OBSERVATION AT A COASTAL HABITAT

6. Explain that students will be making focused observations about the coastal habitat and recording them in their journals. Like the rock activity, it is important that their observations are detailed. They may make notes, ask questions, sketch the ecosystem, and/or create charts to include the necessary content. They should follow the directions on the student pages.

7. Divide students into four groups with chaperones for each group (two abiotic groups: physical environment and soil; two biotic groups: plants and animals). You may have students rotate through each of these stations, or spend time at only one station, depending on the time available. If they are not rotating through all of the stations, they only need to answer journal questions for their own group, but should read through or discuss the questions for other groups.

8. If students do not rotate through all of the stations, form new groups made up of one student from each original group, a technique also known as "jigsaw." Students should each spend three to five minutes sharing their journal responses with the new group members.

9. At some point during the day, all students should take some time to sketch the coastal habitat.

PART THREE: ADOPT THE HABITAT

10. The class continues to collect data on topography, flora, fauna and physical characteristics (water quality, soil quality, topography) during at least one additional visit. They then use the data to create positive change in the coastal habitat.

11. Pre-Visit Reflection: Have the students answer the first set of journal questions.

12. Go to your adopted coastal habitat and collect data as you did during Part Two.

13. Once back from each visit to the coastal habitat, have students answer the second set of journal questions. Provide one copy of this page for each visit. Discuss as a class.

14. Tally all data, review the data as a class and analyze the data during the course of your visits, looking for trends and issues in your coastal habitat. Graph the data in order to gain a greater understanding of issues.

15. Discussion: Ask the students to think of creative ways to display their data, through graphs, posters and presentations. Based on the analysis of the data collected, what information is most important to share? What groups or individuals would be interested in learning more about this data? How would it be best to reach this audience?

16. Discussion: What are some of the problems this habitat has? What ideas do the students have for solving these problems?

WRAP-UP

17. Students work either individually or in pairs to find connections between the parts of a habitat, and record them in the student pages.

18. They are looking for ways in which their biotic or abiotic components interact or depend on each other for survival. For example, plants need soil to root in, and the roots in turn hold the soil in place; animals eat each other to gain nutrients and energy. The goal is to find as many connections as possible. A connection might be a predator-prey relationship, or other ways in which organisms depend on each other.

19. Once the connections have been made, students present their findings to the class. Students should explain how the connections benefit the habitat for which they chose to examine. Ask the students to think about how this is related to the Great Lakes. For example, the elements of a wetland work together to provide habitat for organisms, to hold and release water into the Great Lakes, and to filter water before it reaches the Great Lakes.

20. Student describes the overall health of the coastal habitat in which they chose. How could they share this information with others?

21. Student reflects on experience and lists two new things that they have learned about the coastal habitat they studied and provide any additional questions they may still have.

EXTENSION

A. Have students share their knowledge, experiences and data with others in the school or community.

B. Stage a celebration that includes others who will appreciate learning about your adopted coastal habitat and what students have done for it.

C. Students adopt a coastal habitat within the Great Lakes Basin and visit it two to five times to collect data and make observations. Students complete a project to further improve their coastal habitat. Projects might include educating others within the school about keeping our Great Lakes coastal habitats healthy; trying to get additional receptacles for waste in order to decrease the litter in a coastal habitat; or adding, or having educational signage added to, a habitat. Use this as an opportunity to teach students about selecting projects carefully. Many projects are larger than students realize, and would not succeed because of this. Teach students to select a manageable project at which they can succeed.

ASSESSMENT

See rubric on page 152.

RESOURCES

Please see Resource List for additional information related to wetlands, watersheds and more.

NAME

16
LESSON
STUDENT PAGE

Adopt-a-Habitat

VOCABULARY

coastal habitat
commensalism
groundwater
mutualism
outlet
parasitism
symbiosis

BACKGROUND

Observation is the basis of science. Students must learn to be keen observers of their natural surroundings in order to formulate questions and make connections. Through observation, students will identify problems or issues within a natural coastal habitat. They may identify a method for alleviating a problem and visit or "adopt" the habitat through repeated visits. At the end of this lesson and using your previous knowledge, students should be able to identify and classify various habitats.

INTRODUCTORY QUESTIONS

Answer these questions BEFORE your first visit to a coastal habitat.

1. How often do you visit habitats in nature? What types of coastal habitats do you visit?

2. When you visit a habitat, what do you do there?

3. What do you like best about coastal habitats and the Great Lakes?

4. What factors determine the health of a coastal habitat?

5. When was the last precipitation event (rain, snow, hail) and how might this impact the habitat?

6. What litter did you find in the habitat? How do you think it arrived in this environment?

7. What ideas do you have for creating positive change in this habitat?

8. What are you looking forward to as part of Adopt-a-Habitat?

ANSWER THESE QUESTIONS AFTER EACH VISIT TO A COASTAL HABITAT.

9. Sketch the habitat here.

10. What did you like best about your visit to a coastal habitat?

11. What surprised you about the visit to the coastal habitat?

12. What did you learn from the data you collected?

13. List at least two questions that you have about the habitat and/or its inhabitants.

14. Based on your data, what ideas do you have for creating positive change within this habitat?

PHYSICAL ENVIRONMENT OBSERVATIONS

Date:_____ Time:_____ Location:_____

15. Weather (cloud cover, wind, approximate temperature, precipitation, humidity).

16. What are the major landforms? For example, hills, valleys, ridges, plains.

17. What is the approximate size of the habitat? Estimate the length and width in meters.

18. Is the habitat exposed to the sun? How much so?

19. How is the habitat connected to the local Great Lake?

20. What is its source of water (if any)? Does it have an inlet?

21. If there is water in the habitat, do you think it seeps into the groundwater? How might you be able to tell? Does the habitat have an outlet?

22. What surrounds the habitat?

23. Other observations:

WILDLIFE (FAUNA) OBSERVATIONS

24. Choose one animal to sketch. Look for animals on land, in the sky, and in the water. Remember that insects are animals. If you cannot see an animal, look for signs of animals, such as tracks, feathers, fur, burrows, shells, chewed twigs or scat (animal droppings).

25. Write a description of the animal you've selected, or of signs of the animal.

26. Now, focus on a small animal, such as an insect. Observe it for several minutes before answering these questions:

a. Where is the animal? _____

b. What is it doing? _____

c. Is it in the water or on land? Why? _____

d. Can you tell or guess what it eats? _____

e. What role might this animal play in the food chain or food web of this ecosystem? _____

f. Is the animal interacting with another animal? If so, how? _____

g. Is the animal interacting with any plants? If so, how? _____

h. Do you think that this animal could be found in the Great Lakes? Why or why not? _____

PLANT (FLORA) OBSERVATIONS

27. Record the common plants and their locations. If a field guide is available, try to identify them. Describe several plants:

28. Do you think that this plant could be found in the Great Lakes? Why or why not?

29. Draw the plant and fill in the information. Label important characterstics on the drawing.

TYPE (circle one)
Woody/Herbaceous

BRANCHING
Opposite • Alternate

FLOWERS
Yes • No
Number of Petals _____
Color_____

SEEDS
Fruit • Nut • Parachute
Hitchhiker • Other

LEAVES
Color_____
Shape _____
Height _____

OTHER INFORMATION ___
_____
_____
_____

SUNLIGHT
Sunny • Shady

SOIL
Wet • Medium • Dry
Clayey • Sandy • Mixed

LOCATION
Underwater • Emerging from the water • At the edge of the water • On land

ABUNDANCE
High Number • Medium
Very Few

OTHER PLANTS NEARBY
_____
_____
_____
_____
_____
_____
_____

SOIL OBSERVATIONS

Conduct some tests to learn about the soil. Test one sample from the interior or wetter area, and one from the edge of the habitat.

30. Fill a jar three-quarters of the way to the top with water. Add a handful of soil to the jar. Secure the lid and shake. Let the jar stand undisturbed for 15 minutes. The soil will separate into its parts, which could include sand on the bottom, then silt above it, then clay, and then organic material, which would float on top. Note: All of these parts may not necessarily be present. Repeat this with soil from the edge of the wetland.

31. While waiting for the soil to separate, conduct another test to determine the soil type. Pick up some wet soil. Roll it between your palms into a worm shape. Try to bend the worm into a circle. If the circle cracks or falls apart, the soil contains more sand than clay; if it stays smooth, it contains more clay than sand.

32. Draw the jars of soil and label the layers of sand, silt, clay and organic material.

33. How do the soil samples compare?

34. What is the breakdown of soils in the jar (amounts of sand, silt, clay and organic material)

35. What makes up most of the soil in each of these areas?

36. If you can, compare the soil from the bottom of your Great Lake with the soil from the habitat. How do they compare? Why do you think this is the case?

SYNTHESIS OF OBSERVATIONS

37. What is the significance of the following parts of this habitat?

Landforms _____

Location _____

Sunlight/Shade _____

Soil Type _____

Animals _____

Plants _____

38. What water sources are located inside, or along the edge of, this habitat? How did/does water get into the habitat?

39. How does the water leave the habitat and where does it go?

40. Based on your observations, what makes this habitat an important place?

ANSWER THESE QUESTIONS AFTER AT LEAST TWO VISITS.

41. What are your favorite ideas for ways to create positive change in this habitat?

42. Choose one idea you would like to carry out. Write it here.

43. What resources (time, money, etc.) are needed for this project?

44. What challenges might you face while working on this project?

45. How will you overcome these challenges?

46. List the first steps you think the class should take.

WRAP-UP

47. Here are examples of connections between abiotic and biotic factors. How many more can your group find?

FACTOR A	FACTOR B	RELATIONSHIP
Dragon Fly	Mosquito	Predator-prey relationship
Cattail	Soil	Plants need soil to root in
Frog	Water	Animals need water to drink and help them lay eggs
Roundworm	Crustacean	Parasitism

48. Describe the overall health of the coastal habitat. How could you share this information with others?

49. What two new things have you learned about the habitat you studied? What additional questions do you have about the Great Lakes coastal habitats?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
OBSERVATIONAL SKILLS: Student participates in group activity by finding an object (i.e. rock or pencil) and noting all characteristics of the object on the student pages. Student identifies his/her object when mixed up with other student's using only observations written in journal pages.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
JOURNAL QUESTIONS: Student answers all introductory questions found on student pages prior to visiting a coastal habitat. Student reads through the lab prior to attending coastal habitat to ensure s/he knows what type of observations to make.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
FIELD WORK: Student makes observations of his/her "station" and answers all questions on the student pages. Using each other as resources and their observations, students sketch the coastal habitat to get a visual representation. Student repeats this process once more after visiting the habitat once more for comparison.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
ANALYSIS: Student tallies up all data and looks for any trends or issues that they noticed between the two separate visits. Student may use Microsoft Excel as a tool to aid in any statistical analysis if available.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
GRAPHING: Student uses the data to make a visual representation of their findings (i.e. graphs, posters and/or presentations). Student describes their results, highlighting trends and explaining their conclusions as to why they think the results were as they were. Graphs include key features (title, key, cardinal directions or north arrow, scale and legend).	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Great Lakes Action Plan

Based on observation of the local watershed and habitat, students develop an action plan for restoring or maintaining the natural area.

OBJECTIVES

Identify at least one coastal habitat restoration issue or watershed issue

Develop a restoration plan for alleviating the restoration issue

SUBJECT
Ecology, Environmental Science, Environmental Law, Public Policy

PREREQUISITE
#4: Restore and Explore
#16: Adopt-a-Habitat

VOCABULARY
best management practices (BMPs)
incentive
indicator
regulation

MATERIALS
pencils

TIME/DURATION
Long-term project

SETTING
Indoors and outdoors (independent projects will be completed throughout the community)

This Great Lakes in My World 9-12 activity is aligned to the Common Core State Standards (as available). This alignment is available on your Great Lakes in My World 9-12 USB flash drive in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

BACKGROUND

There are four ways in which coastal habitats are protected: regulations, landowner protections (e.g. park districts, organizations like The Nature Conservancy, etc.), economic incentives and public education. Certain habitats are federally protected under the Clean Water Act, the U.S. Fish and Wildlife Services' Coastal Habitat Conservation Program and other coastal management programs. State and local governments may also have their own regulations. Public education about the value of coastal habitats is a preventative protection measure. The theory behind this environmental education is that if people understand and value their habitats, they are more likely to work to preserve, conserve and restore these diverse ecosystems.

Based on the information that students have gathered in previous lessons, they will work as a class to identify an issue in their local watershed, or within another coastal habitat in the Great Lakes watershed. Students will then work independently to prioritize these problems and then identify possible solutions to one of these issues. These solutions should focus on best management practices (BMPs) for conserving, restoring and preserving natural habitats. Students will then develop an action plan and then, if possible, implement this plan. These action projects will connect the classroom curriculum with service projects in the community. Service learning engages students in projects that serve the community while building social, civic, and academic skills. These experiences will build an understanding of a community, enrich learning and help youth develop personally, socially and academically. Service learning action projects incorporate such steps as: research, investigation, analysis, action, reflection and celebration. Finally, students will develop a portfolio or presentation that analyzes the success and effects of their action project.

See student page for additional information.

PROCEDURE

1. Introduction: Students read background information and answer introductory questions: What are five ways that humans are currently harming the environment? What are five easy ways for humans to preserve the environment? What are three examples of how the Clean Water Act has had an impact?

ACTION PROJECT

STEP 1: RESEARCH
Before students can develop and implement an action project (which may include service learning), they must have an understanding of Great Lakes ecosystems. Prior lessons from this curriculum (see the "prerequisites" listed) provide students with the background knowledge needed to begin this lesson. If students have not completed these lesson plans, they should use other means to engage in information gathering through direct observation, data collection and analysis, research (Internet searches, library resources, interviews, etc.). You may also invite guest speakers to discuss local past, current or future restoration projects.

STEP 2: INVESTIGATION
As a class, create a list of restoration issues within the local watershed, or within another coastal habitat in the Great Lakes watershed. These can include point source and nonpoint source (NPS) water pollution, invasive species (aquatic or terrestrial), or another coastal habitat restoration need.

STEP 3: ANALYSIS
Prioritize problems/issues. Students will analyze them by examining them from different perspectives. How do/would these issues impact the environment, human health, recreation and the economy?

STEP 4: ACTION
Each student then selects one problem to address. They should ask themselves, "What are possible solutions to this problem? What do I want to see happen to improve this issue? What process would help to achieve a solution?" Each student will then develop a list of possible solutions to the problem that they selected.

Students will then develop a plan for addressing their issue. Their plan can be a:

i. watershed plan
ii. pollution management plan
iii. land management (or land use) plan
iv. community development plan
v. coastal management plan
vi. another service learning plan

Each of these plans must include the following components:

a. Observation of the area
b. Description of the problem
c. Map of the area (what does the area look like now, and what do you plan to change?)
d. Indicators (how will we measure success?)

See resource list for websites giving examples of these restoration plans.

Additional suggestions: Teachers meet with their students regularly to discuss the progress of each step of the action project. Students share their plans with their classmates as a peer review process. Students should communicate with the experts of the problem or geographic area they choose. Any responses from the experts should be included in the project plan.

WRAP-UP

STEP 5: REFLECTION
Discuss the following questions and have students respond to them on the student pages: How can you educate others on how to conserve natural resources and protect nature? What are some negative reactions to protecting the environment? What eco-friendly choices have you made in your life? How has your work on this project changed your values and understanding of the Great Lakes' ecosystems?

STEP 6: CELEBRATION
If desired, take steps to share the educational projects or the coastal habitat management or restoration plans. This may mean passing out flyers, making presentations, hanging up signs, or working with a television or radio crew.

EXTENSION

A. Communicate actions and results to the school, district or local community via a Web page, public service announcement (PSA), media outlet or other communication tool. Attend a town meeting to present a project that could benefit the community. Students should include photos, data and quotes from others in the community.

ASSESSMENT

See rubric on page 159.

RESOURCES

Please see Resource List for additional information related to organizations, Department of Natural Resources and more.

NAME

17
LESSON
STUDENT PAGE

Great Lakes Action Plan

BACKGROUND

There are four ways in which coastal habitats are protected: regulations, landowner protections (e.g. park districts, organizations like The Nature Conservancy, etc.), economic incentives and public education. Certain habitats are federally protected under the Clean Water Act, the U.S. Fish and Wildlife Services' Coastal Habitat Conservation Program and other coastal management programs. State and local governments may also have their own regulations.

VOCABULARY

best management practices (BMPs)
incentive
indicator
regulation

CLEAN WATER ACT

Clean water is a very valuable natural resource and is relied on for drinking, recreation, manufacturing, energy development, agriculture, commercial fishing, tourism, and many other purposes that are essential to public health and the economy. By the mid-1900s, the water quality of the Great Lakes had declined due to certain ways humans were using the lakes. In order to address this, legislation such as the Clean Water Act (1972) and the Great Lakes Water Quality Agreement (1972) were passed and continue to be upheld. The Clean Water Act set a new national goal "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters", with interim goals that all waters be fishable and swimmable where possible. Since 1972, the Clean Water Act has protected our health and environment by reducing the pollution in streams, lakes, rivers, wetlands and other waterways.

CURRENT ISSUES

UNTREATED SEWAGE OVERFLOWS

Each year over 24 billion gallons of combined untreated sewage and storm water are dumped in the Great Lakes. High concentrations of bacteria and viruses present in the overflows of untreated sewage pose a significant health risk and result in beach advisories across the region. Other pollutants from urban and agricultural run-off also end up in the waterways. Causes of municipal sewage overflows consist of outdated infrastructures, heavy rainfall in which excess storm water and raw sewage are diverted directly to coastal waterways, and several wastewater treatment plants. According to the U.S. EPA, the principal pollutants found in CSOs are: microbial pathogens, oxygen-depleting substances, total suspended solids, toxic materials, nutrients, floatables and trash. Sewage overflows result in water quality impairments, human contact with pathogens, and long term exposure and accumulations of pollutants in aquatic systems.

INVASIVE SPECIES

The jumping, jumbo-sized Asian carp is the most notorious invasive species to travel up the Mississippi River and knock on Lake Michigan's door - gateway to the Great Lakes and the world's largest surface freshwater system. Experiences in Illinois and other places where the carp have a foothold show us the threat is real. Once established in the Great Lakes, the fast-growing carp could gobble up the food that sustains native fish, devastating the region's $7 billion fishing industry and forever changing how boaters, anglers and tourists enjoy the lakes. The Asian carp's arrival has prompted serious questions about how to protect the lakes against these and other invaders.

Public education about the value of coastal habitats is a preventative protection measure. The theory behind environmental education is that if people understand and value their habitats, they are more likely to work to preserve, conserve and restore these diverse ecosystems. You will develop ideas for a plan for a Great Lakes restoration project or another Great Lakes-related action plan.

INTRODUCTORY QUESTIONS

1. What are five ways that humans are currently working to conserve and restore the natural environment?

2. What are five ways that humans are currently harming the natural environment?

3. What are two actions you can take to protect the environment?

4. What are three examples of how the Clean Water Act has had an impact on humans and the environment?

ACTION PROJECT

5. List various restoration issues within your local watershed, or within another coastal habitat in the Great Lakes watershed.

6. How do these issues impact the environment, human health, recreation, and the economy?

7. Identify one problem to address.

8. What are possible solutions to this problem? What needs to happen in order to improve this issue? What process would help achieve a solution?

9. Using a computer or a separate sheet of paper, develop an action plan for addressing your issue. The plan must include the following components:

   a. Observation of the area
   b. Description of the problem
   c. Map of the area (what does the area look like now, and what do you plan to change?)
   d. Indicators (how will you measure success?)

WRAP-UP QUESTIONS

10. How can you educate others about how to conserve natural resources and protect nature?

11. What are some negative reactions to protecting the environment?

12. What eco-friendly choices have you made in your life?

13. How has your work on this project changed your values and your understanding of the Great Lakes ecosystems?

RUBRIC

ELEMENTS	☆☆☆☆	☆☆☆	☆☆	☆
RESEARCH: Student investigates environmental issues related to their local community, their watershed and/or a coastal habitat. Student uses available resources (internet searches, library, interviews, etc.) to conduct research. Student uses the introductory questions as a basis for where to start their research.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
INVESTIGATION: Student participates in class discussion creating a list of restoration issues affecting their local watershed. Student uses the initial research they performed individually to engage in ideas.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
ANALYSIS: Student prioritizes the list of issues in order of importance; separates them into categories of impact on: the environment (land, water, ecology, etc.), human health, recreation, and/or economy; and determines the feasibility of creating a service project out of one of them.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
ACTION: Student chooses an issue to address, developing a list of possible solutions with expected results. A plan of action is written including- observation of the area, description of the problem, map of the area both present and future, and indicators (measures of success).	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components
REFLECTION: Students review each other's plans. During assessment, student both receives and gives constructive criticism in a positive way. Student reflects on what they have learned throughout the lesson by answering the questions on the student pages.	Addresses all of the components	Missing one of the components	Missing two components	Missing three or more components

Great Lakes in My World 9-12
Glossary

autotroph (producer): an organism that can synthesize its own food by photosynthesis, usually a green plant; can also be chemosynthetic

abiotic: non-living (such as sand, water, sunlight)

acid mine drainage: refers to the outflow of acidic water from (usually abandoned) metal mines or coal mines

algal blooms: a rapid increase or accumulation in the population of algae in an aquatic system

alternate leaves: leaves rising singly along the stem, not in pairs or whorls

annual: having a life cycle completed in one year or season

aquifer: a geologic formation that contains sufficient permeable material to yield significant quantities of water to springs and wells

areas of concern: seriously contaminated sites in the Great Lakes that impair beneficial uses of the Great Lakes by causing harm to wildlife, habitat, and drinking water hotspots impair beneficial uses of the Great Lakes by causing harm to wildlife, habitat and drinking water

basal leaves: leaves at the base of the stem

basin: a hollow or depression in the earth's surface, wholly or partly surrounded by higher land

bathymetric map: map that uses contour lines to show the depths of a body of water; measures distance below sea level

bathymetry: features of the depths of lake or ocean floors

beach: the zone extending from the water's edge to the limit of the highest storm waves. This area acts as the first region of a coastal zone, or can be interspersed with coastal wetlands and emergent marshes

best management practices (BMPs): principal techniques or guidelines for preserving biodiversity, water quality and habitats

biennial: growing vegetatively (not flowering) during the first year and flowering, fruiting and dying during the second

biodiversity: The number, variety, and genetic variation of different organisms found within a specified geographic region

biotic: living (such as insects, birds, plants)

bog: a nutrient-poor peatland characterized by acidic, saturated soil and the prevalence of peat mosses and shrubs

career: an occupation or profession, especially one requiring special training, followed as one's lifework

cartography: the study and practice of making maps

cfu: colony-forming unit (the US EPA's recommended limit of E. Coli is 235 cfu per 100 mL of recreational water, Coliform bacteria limits are around 200 cfu per 100 mL of recreational water)

coastal habitat: a habitat near a body of water such as sand dunes, ravines, gravel beaches, estuaries lagoons and coastal marshes

commensalism: relationship in which one organism benefits and the organism is neither significantly harmed nor significantly helped

compound leaf: a leaf divided into leaflets

concentration: abundance of a constituent divided by the total volume of a mixture

conservation: careful utilization of a natural resource in order to prevent depletion or degradation

contour lines: curved lines on a topographic or bathymetric map that connect points between places with the same depth or elevation

cover letter: a document sent with your resume to provide additional information on your skills and experience

decomposer: organisms that break down dead or decaying organisms

dichotomous key: an outline of the distinguishing characteristics of a group of species, used as an identification guide

dune: a sand hill or sand ridge formed by the wind, usually in desert regions or near lakes and oceans.

ecosystem: a system made up of an ecological community and its environment especially under natural conditions

emergent marshes: type of wetland characterized by shallow water and saturated soils; contains bulrushes, cat-tails, and other emergent species, but also submergent and/or floating vegetation.

fauna: all animal life found in a particular region, period, or spacial environment

fen: sedge- and rush-dominated wetland that occurs on calcareous (limestone or marble) rock beds in coastal embayments.

field guide: handbook used to identify and learn about specific plants or animals

flora: all of the plant life found in a particular region, period, or spacial environment

flux: process in the water cycle by which water moves between reservoirs such as evaporation, infiltration, precipitation, or runoff

food chain: a series of organisms each dependent on the next as a source of food

food web: the whole group of interacting food chains in a living community

foredune: in a series of coastal dunes, the dune closest to the front

forested shoreline (or boreal forest): a broad band of mixed coniferous and deciduous trees that stretches across northern North America (and also Europe and Asia); its northernmost edge, the taiga, intergrades with the arctic tundra

germination: to develop into a plant or individual, as a seed, spore, or bulb

GIS - Geographic information systems or geospatial information systems: technology that captures, stores and shares geographically referenced data using satellites and a system of computers. Geographic data is any data that has location information attached to it.

GPS - Global Positioning System: system of satellites that determines the latitude and longitude of a receiver on Earth by calculating how long it takes signals to travel from the satellite to the receiver.

Great Lakes basin: the land where water from the ground, rivers and streams flow into the Great Lakes; includes the Great Lakes and the surrounding lands in the states of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin in the United States, and the province of Ontario in Canada; also known as Great Lakes watershed

groundwater: water located beneath the ground in soil and in the fractures of rock formations

habitat: the home or environment of an animal, plant, or other organism

headwaters: the place from which the water in the river or stream originates

herbaceous: a plant that has leaves and stems that die down at the end of the growing season to the soil level

heterotroph (consumer): an organism that cannot synthesize its own food and consumes other organisms in a food chain

hydrologic cycle: the continuous movement fo water on, above, and below the surface of Earth

Hydrologic Unit Codes (HUC's): the numbers that are used in the United States to identify watersheds (i.e. 8, 10, 12)

impervious surfaces: impenetrable, usually artificial, surfaces that do not allow the passing of water from the sky to the ground below, thus are causes of flooding; examples include roads, parking lots, driveways and sidewalks

infiltration: the process by which water enters the soil or substrate material of the ground

invasive (non-native) species: plant or animal that enters an ecosystem to which it is not native and competes with one or more native species for food, shelter, and/or reproductive opportunities

invasive plant: a plant that enters an ecosystem to which it is not native and competes with one or more native species for food, shelter and/or reproductive opportunities; also referred to as non-native, exotic, non-indigenous, alien or noxious

job: a post of employment; full-time or part-time position

lakeplain prairie (coastal lake plain): low-lying, wet prairie-like area adjacent to or very close to water; prone to seasonal flooding and includes small pockets that remain wet throughout the year

land cover: physical material at the suface of the Earth (i.e. grass, asphalt, trees, bare ground, water, etc.)

lobes: any of the parts, not entirely separate from each other, into which a flattened plant part, such as a leaf, is divided

macrophytes: aquatic plants

mammoth: any large extinct elephant of the Pleistocene genus Mammuthus (or Elephas), such as M. primigenius (woolly mammoth), having a hairy coat and long curved tusks

map: a visual representation of an area

mental map: an individual's own perception of their own world

mutualism: relationship in which both organisms benefit

native plant: flora and fauna species that occur naturally in a given area or region; also referred to as indigenous species

node: the place on a stem from which a leaf or a branch grows

nomad: a person who continually moves from place to place; wanderer

nonpoint source (NPS) pollution: pollution (usually affecting water) from diffuse sources, such as precipitation, atmospheric deposition or runoff

nonpoint source pollution: pollution which cannot be traced back to a single origin or source such as storm water

runoff, water runoff from urban areas and failed septic systems.

opposite leaves: leaves occurring in pairs at a node, with one leaf on either side of the stem

parasitism: relationship in which one organism benefits and the organism is harmed

pelt: the untanned hide or skin of an animal

perennial: present at all times of the year; in reference to a plant, one that lives for more than two years, usually producing flowers, fruits, and seeds annually

permeable: capable of being passed through or permeated, especially by liquids or gases

pH: is a measure of the acidity or basicity of a solution; lower pH means more acidic and higher pH means more basic

physical maps: a type of map that shows countries of the world, major cities, and bodies of water highlighting landforms such as mountains, deserts, and plains

point source pollution: air, water, thermal, noise, or light pollution that can be traced back to a single origin or source such as a sewage treatment plant discharge

political map: a type of map that displays borders defining countries, states, or territories

ppb: parts per billion

ppm: parts per million

preservation: protection and management of a natural resource, habitat or ecosystem in order to prevent damage or destruction

primary consumer: the organism that eats the producer

primary producer: organisms that synthesize organic materials from inorganic materials

profession: a vocation requiring specialized knowledge through intensive academic preparation

quaternary consumer: an organism that eats tertiary consumers

ravine: a narrow valley created by running water, such as a stream or river; often located adjacent to a beach or cliff

reservoir: body of water in the water cycle such as stream, lake, river, glacier, or ocean

restoration: renewing degraded, damaged, or destroyed ecosystems and habitats

résumé: a brief written account of personal, educational, and professional qualifications and experience, as that prepared by an applicant for a job

river: a natural stream of water of fairly large size flowing in a definite course or channel or series of diverging and converging channels

runoff: the water flow that occurs when soil is infiltrated to full capacity and excess water from rain, meltwater, or other sources flows over the land

sand dunes: giant, shifting mounds of sand that form whenever there is enough sand, a consistent onshore wind of at least eight miles an hour, and a place for the sand to accumulate

savanna: a grassland ecosystem characterized by the trees being sufficiently small or widely spaced so that the canopy does not close

secondary consumer: the organism that eats or derives nutrients from the first-order consumer

sedimentation: the tendency for a particle in suspension to settle out of the fluid in which they are entrained and come to rest against a barrier

sediments: naturally occurring material that is broken down by the processes of weathering and erosion and is transported by the action of fluids

stakeholder: a person, group, or organization member or system that can be affected by an organization's actions

stream flow: Average Width(ft.) x Average Depth(ft.) x Stream Velocity(ft/sec)

stream: a body of water with a current, confined within a bed and stream banks; often flows into or out of a larger body of water, such as a lake

surface water: water collecting on the ground or in a stream, river, lake, wetland, or ocean

swale: a low place in a tract of land, usually moister and often having ranker vegetation than the adjacent higher land

swamp: a type of wetland characterized by woody vegetation (shrubs or trees) that are partially covered by water; a wetland is considered a swamp if it has about thirty percent tree cover with seventy percent open, slow-moving or stagnant water

symbiosis: relationship or ongoing interactions between two or more organisms in an ecosystem; can be classified as mutualistically, commensally or parasitically symbiotic

tertiary consumer: an animal that feeds on secondary consumers in a food chain, usually the top predators in an

ecosystem or food chain

thermal pollution: pollution or change in the temperature of water that degrades water quality

topographic map: map that uses contour lines to show the changes in elevation of a land feature; measures distance above sea level

topography: physical features of a landscape, with special attention paid to changes in elevation

transpiration: loss of water vapor from parts of plants (similar to sweating)

tributary: a stream or river that flows into a main stem river or lake

turbidity or Total Suspended Sediments (TSS): is the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye

veins: made up of the xylem and phyloem of a leaf located in the spongy layer of the mesophyll

voyageur: a person who is an expert woodsman, boatman, and guide in remote regions, especially one employed by fur companies to transport supplies to and from their distant stations

watershed: the region or area drained by a river, stream, or other body of water; drainage area

wetlands: lands on which water covers the soil or is present seasonally or permanently; considered the most biologically diverse of all ecosystems and includes marshes, bogs, swamps, fens, bogs and swales.

whorls: the attachment of petals, sepals, leaves, or branches at a single point

Great Lakes in My World 9-12 Resource List

Books (alphabetical by title)

Borne of the Wind: An Introduction to the Ecology of Michigan's Sand Dunes, Dennis Albert
Discovering Great Lakes Dunes, Elizabeth Brockwell-Tillman and Earl Wolf
The Dynamic Great Lakes, Barbara Spring
Encyclopedia of Mammals, David Macdonald
Evolution of the Great Lakes Water Quality Agreement, Lee Botts and Paul Muldoon

Eye Witness: Pond and River, Steve Parker
Field Guide to Lakes, Jacob Verduin
A Good Catch: Managing Fisheries to Meet the Nation's Demand for Seafood, Taylor Morrison
Great Lakes Atlas, United States Environmental Protection Agency
Great Lakes Dune Ecosystems, Michigan State University Extension

Great Lakes Nature: An Outdoor Year, Mary Blocksma
Great Lakes Water Levels, Communications Centre
Groundwater in the Great Lakes Basin, International Joint Commission
Guide to the Study of Freshwater Biology, Needham and Needham
A Guidebook to Groundwater Resources, Great Lakes Commission

How to Know Immature Insects, H.F. Chu
Illinois Native Peoples, Andrew Santella
The Inland Seas: A Journey Through the Great Lakes, Paul Vasey
Invasion Ecology, Marianne E. Krasny and the Environmental Inquiry Team
The Image of the City, Kevin Lynch

The Living Great Lakes, Jerry Dennis
Maritime Chicago, Theodore Karamanski and Deane Tank Sr.
On the Brink, Dave Dempsey
People of the Lakes, editors of Time-Life Books
Pond and Brook: a Guide to Nature in Freshwater Environments, Michael Caduto

River Road Publication, Inc., *www.riverroadpublications.com*
Sooper Yooper, Mark Newman
Stories From Where We Live: The Great Lakes, Sara St. Antoine
Wild Lake Michigan, John & Ann Mahan

Great Lakes Field Guides

Amphibians and Reptiles of the Great Lakes Region, James H. Harding
Animal Tracks of the Great Lakes, Chris Stall
Chicago Wilderness: An Atlas of Biodiversity
Dune Country: A Hiker's Guide to the Indiana Dunes
A Field Guide to Fish Invaders of the Great Lakes Region, Minnesota Sea Grant
Guide to Common Invertebrates of North America
Guide to Great Lakes Fishes, Gerald R. Smith
Insects of the Great Lakes Region, Gary A. Dunn
Mammals of the Great Lakes Region, Allen Kurta
Scats and Tracks of the Great Lakes Region, James Halfpenny
What's Doin' the Bloomin'? Revised Edition: A Pictorial Guide to Wildflowers of the Upper Great Lakes Regions, Eastern Canada and Northeastern U.S.A, Clayton and Michele Oslund

Additional Field Guides

Audubon Field Guides
Fandex Family Field Guides
Golden Guides
Newcomb's Wildflower Guide, *Lawrence Newcomb*
Peterson Field Guides
Pocket Naturalist Series
Take Along Guides

Magazines

EEK! (online): Wisconsin Department of Natural Resources, *www.dnr.state.wi.us/org/caer/ce/eek*
Tracks Magazine, Michigan United Conservation Clubs *www.mucc.org/index.php/tracks*

Web sites

Resources and Organizations

Alliance for the Great Lakes, www.greatlakes.org
Center for Great Lakes Environmental Education, www.greatlakesed.org
COSEE Great Lakes, www.coseegreatlakes.net
Environment Canada: Great Lakes Kids and Our Great Lakes, www.on.ec.gc.ca/greatlakeskids
Environmental Education Association of Illinois, www.eeai.net

Environmental Education in Wisconsin, www.eeinwisconsin.org
Environmental Protection Agency Region 5 Office, www.epa.gov/region5
Freshwater Future, www.glhabitat.org
The Globe Program, www.globe.gov
Grand Valley State University, Annis Water Resources Institute, Education Resources, www.gvsu.edu/wri/education

Great Lakes Atlas, www.epa.gov/glnpo/atlas/index.html
Great Lakes Aquarium, www.glaquarium.org
Great Lakes Directory, www.greatlakesdirectory.org
Great Lakes Fisheries Education Resources, www-personal.umich.edu/~zintmich/GLFT
The Great Lakes Green Book, www.glu.org/en/campaigns/restoration/green_book

Great Lakes Image Collection, www.epa.gov/glnpo/image
Great Lakes Information Network, www.great-lakes.net
Great Lakes National Programs Office, www.epa.gov/glnpo
Great Lakes Research and Education Center, www.nps.gov/indu/naturescience/glrec.htm
Great Lakes Sea Grant, www.greatlakesseagrant.org/about.html

Great Lakes Science Center, www.greatscience.com
Great Lakes United, www.glu.org
Illinois-Indiana Sea Grant: Education Resources, www.iisgcp.orgeducation/topics_education.html
Indiana Dunes National Lakeshore, www.nps.gov/indu/forteachers
Inland Seas Education Association, www.schoolship.org

International Joint Commission, www.ijc.org
John G. Shedd Aquarium, Shedd Educational Adventures, www.sheddaquarium.org/sea
Lake Superior Youth Symposium, www.wupcenter.mtu.edu/education/lake_superior_symposium
Lakewide Management Plans, www.epa.gov/glnpo/gl2000/lamps
L.A.P.'s, Michigan Department of Natural Resources, www.dnr.state.mi.us/edu

Michigan Department of Environmental Quality, Michigan Environmental Education Curriculum Support, www.michigan.gov/deq/0,1607,7-135-3307_3580_29678---,00.html
Michigan Environmental Council, www.environmentalcouncil.org
Michigan Alliance for Environmental and Outdoor Education, www.michiganenvironmentaled.org
Michigan Sea Grant: Education Resources, www.miseagrant.umich.edu/education/index.html
Michigan United Conservation Clubs: Education Resources, www.mucc.org/index.php/youth-outreach

Minnesota Center for Environmental Education, www.d.umn.edu/ceed
Minnesota Sea Grant: Education Resources, www.seagrant.umn.edu/educators
National Wildlife Federation, www.nwf.org/Kids.aspx
National Wildlife Federation: eNature, www.enature.com/home
National Wildlife Federation: Happenin' Habitats, http://happeninhabitats.pwnet.org/index.php
National Wildlife Federation: Schoolyard Habitats and Resources, www.nwf.org/schoolyard
New York Sea Grant, www.seagrant.sunysb.edu
Ocean Arks International, www.oceanarks.org
Ohio Sea Grant, www.ohioseagrant.osu.edu
Ohio Sea Grant: Great Lakes Literacy, www.greatlakesliteracy.net

Peggy Notebaert Nature Museum: Education Resources, www.naturemuseum.org/education
Pennsylvania Sea Grant: Education Resources, www.seagrant.psu.edu/education/resources.htm
Pier Wisconsin, www.pierwisconsin.org
TEACH Great Lakes, www.great-lakes.net/teach
TEACH Great Lakes, Education Resources, www.great-lakes.net/teach/links

TIfft Nature Preserve, Buffalo Museum of Science, www.sciencebuff.org
Tom Ridge Environmental Center, www.trecpi.org
Union of Concerned Scientists: Great Lakes Communities and Ecosystems at Risk, www.ucsusa.org/greatlakes
US Fish and Wildlife Service, www.fws.gov
Wisconsin Great Lakes Education Clearinghouse on EE in Wisconsin, www.eeinwisconsin.org/core/item/page.aspx?s=83585.0.0.2209

Wisconsin Maritime Museum, www.wisconsinmaritime.org
Wisconsin Sea Grant: Education Resources, www.seagrant.wisc.edu/education
Wolf Ridge Environmental Learning Center, www.wolfridge.org

Departments of Natural Resources by States and Provinces
Illinois Department of Natural Resources, www.dnr.illinois.gov
Indiana Department of Natural Resources, www.in.gov/dnr
Michigan Department of Natural Resources, www.michigan.gov/dnr
Michigan Department of Natural Resources: Wildlife and Habitat, www.michigan.gov/dnr/0,1607,7-153-10370---,00.html
Michigan Department of Natural Resources: Wildlife Educational Resources, www.michigan.gov/dnr/0,1607,7-153-10369-57667--,00.html

Minnesota Department of Natural Resources, www.dnr.state.mn.us
New York State Department of Environmental Conservation, www.dec.ny.gov
Ohio Department of Natural Resources, www.dnr.state.oh.us
Ontario Ministry of Natural Resources, www.mnr.gov.on.ca/en/index.html
Pennsylvania Department of Conservation and Natural Resources, www.dcnr.state.pa.us
Wisconsin Department of Natural Resources, www.dnr.wi.gov

Wetland Sites by States and Provinces

Illinois Wetlands, www.district96.k12.il.us/TG/Wetlands/Wetlands.html
Indiana Wetlands, www.in.gov/wetlands
Michigan Environmental Council, www.environmentalcouncil.org
Michigan Natural Habitats: http://web4.msue.msu.edu/mnfi/communities/index.cfm
New York State Wetlands Forum, www.wetlandsforum.org

Ohio Wetlands Foundation, www.ohiowetlands.org
Ontario Wetlands, www.ec.gc.ca/tho-wlo
Wisconsin Wetlands Association, www.wisconsinwetlands.org
Wisconsin Department of Administration, Coastal Management Program, www.doa.state.wi.us/section.asp?linkid=65&locid=9
U.S. Fish and Wildlife Service Wetlands Mapper: http://www.fws.gov/wetlands/Data/Mapper.html

Additional Wetland Sites

Definition of Wetland: http://www.water.ncsu.edu/watershedss/info/wetlands/definit.html
Digital Coastal Change Analysis Data: http://www.csc.noaa.gov/digitalcoast/data/ccapregional/
EPA – Great Lakes ecosystem overview: http://www.epa.gov/ecopage/wetlands/glc/glctext.html
Great Lakes Coastal Wetlands Consortium: http://glc.org/wetlands/flora-fauna.html
Michigan Sea Grant – Great Lakes Coastal Habitats: http://www.miseagrant.umich.edu/explore/coastal-habitat/index.html

Sand Dune Sites

Indiana Dunes National Lakeshore, www.nps.gov/indu
Parks in the Great Lakes, www.great-lakes.net/tourism/rec/parks.html
Preserve the Dunes, www.sosdunes.org
Sand Dune Park Geology Tour, www.nature.nps.gov/geology/tour/sanddune.cfm
Sand Dune Ridges and Dunes in the Calumet Region, www.newton.dep.anl.gov/natbltn/700-799/nb709.htm

The Unofficial Sleeping Bear Dunes Home Page, www.leelanau.com/dunes/dunes
Save the Dunes Council, www.savedunes.org
Sleeping Bear Dunes, www2.nature.nps.gov/geology/parks/slbe

Careers

Career Clickers eXpanded www.learnmoreindiana.org
Career Interest Inventory: http://www.careerperfect.com/content/career-planning-work-preference-inventory/
Forestry career: http://www.forestrycareers.org/sub_disciplines.php
Great Lakes Careers: www.schoolship.org/careers
Great Lakes, Great Careers: http://www.miseagrantumich.edu/flow/pdf/U3/FLOW-U3-L5-MICHU-08-403.pdf
Great Lakes Information Network Jobs Listserv: http:www.great-lakes.net/pipermail/glin-jobs/last30/date.html
Great Lakes Marine Careers: www.marinecareers.net
Survey: www.learnmoreindiana.org/careers/exploring/Pages/IndepthCareerInterestInventory.aspx

Conservation/Restoration

Biodiversity in the Great Lakes Basin: http://www.epa.gov/ecopage/glbd/issues/intro.html
Chicago Metropolitan Agency for Planning: http://www.cmap.illinois.gov/
Great Lakes Commission: http://www.glc.org/
Great Lakes Fishery Commission: http://www.glfc.org/fishmgmt/
Great Lakes Restoration Projects: http://www.great-lakes.net/links/envt/

Great Lakes Today: Concerns: http://www.epa.gov/greatlakes/atlas/glat-ch4.html
GLRI Projects: http://www.epa.gov/glnpo/glri/2010GLRIProgramsProjects.pdf
Great Lakes Restoration Initiative Action Plan: http://yosemite.epa.gov/sab/sabproduct.nsf/RSSRecentHappeningsBOARD/750D38466C98D0818525771A0068B925?OpenDocument
Highland Park Waterfront Restoration: http://www.bluearitan.org/Studio/HPReport.pdf
The Kinnickinnic River Corridor: http://www.groundworkmke.org/pdf/kk.pdf

Lakewide Management Plans: http://www.epa.gov/greatlakes/lamp/index.html
The Nature Conservancy in Indiana – Ivanhoe Dune and Swale Nature Preserve: http://www.nature.org/wherewework/northamerica/states/indiana/misc/art32172.html
NOAA, Coastal Zone Management:http://oceanservice.noaa.gov/tools/czm/ ; http://coastalmanagement.noaa.gov/programs/czm.html
NOAA, Damage Assessment, Remediation, and Restoration Program: http://www.darrp.noaa.gov/greatlakes/index.html

NOAA, Great Lakes Habitat Restoration: http://www.habitat.noaa.gov/restoration/programs/greatlakes.html
Northwest Indiana Regional Planning Commission: http://www.nirpc.org/
Nonpoint Source Pollution: http://oceanservice.noaa.gov/education/kits/pollution/supp_pollution_roadmap.html
Sustain Our Great Lakes: http://www.sustainourgreatlakes.org
Water Quality Project: http://www.michigan.gov/documents/deq/ess-nps-fs-harper-beadle_208829_7.pdf

Mapping/GIS/GPS

ArcGIS http://www.esri.com/software/arcgis/index.html
Bathymetry and Lakes: http://lakewatch.ifas.ufl.edu/circpdffolder/Morph2ndEdPt2.pdf
Geodata's federal, state, and local geographic data: http://gos2.geodata.gov/wps/portal/gos/kcxml/04_Sj9SPykssy0xPLMnMz0vM0Y_QjzKL9443cnIFSYGYfpb6kehCFgghX4_83FR9b_0A_YLc0IhyR0VFAEZ_VEU!/delta/base64xml/L3dJdyEvUUd3QndNQSEvNElVRS82X0xfSVI GIS Tip Sheet: http://www.classroomearth.org/GIS_Tips
Great Lakes Ecological Assessment – GIS Maps: http://www.ncrs.fs.fed.us/gla/maps.htm
The Great Lakes Information Network (GLIN): http://gis.glin.net/

Make a topo map: http://www.education.com/activity/article/Make_Topographic_Map/
Make a topo map: http://spaceplace.jpl.nasa.gov/en/kids/srtm_make1a.shtml
Maplandia: http://www.maplandia.com/united-states/illinois/lake-county/great-lakes/
Mapping: http://www.socialstudiesforkids.com/articles/geography/mapsavvy1.htm
Maps and Graphics: http://www.amaps.com/mapstoprint/GREATLAKESDOWNLOAD.htm

Maps, Maps, Maps: http://www.pbs.org/edens/denali/maps.htm
Map symbols: http://egsc.usgs.gov/isb/pubs/booklets/symbols
National Map Viewer: http://viewer.nationalmap.gov/viewer/
National Land Cover Database: http://gisdata.usgs.net/website/MRLC/viewer.htm
Natural Connections green infrastructure maps (14 counties in WI, IL, IN): http://www.greenmapping.org/maps/

Teaching with Google Earth: http://serc.carleton.edu/introgeo/google_earth/index.html
Topographic Maps: http://ngmdb.usgs.gov/Other_Resources/rdb_topo.html,
Topographic Maps: http://store.usgs.gov/b2c_usgs/b2c/start/(xcm=r3standardpitrex_prd)/.do
Topographic Maps-Natural Resources Canada: http://maps.nrcan.gc.ca/topo101/index_e.php

Native and Invasive Species

Center for Invasive Plant Management: http://www.weedcenter.org/education/k-12.html
Dichotomous Key: http://creekconnections.allegheny.edu/Modules/On-LineActivities/Wetlands/ThisPlantKeyIsAllWet.pdf
Dichotomous Key (trees): www.forestry.about.com/library/treekey
Guide to Dichotomous Key (trees): http://www.dnr.state.wi.us/org/caer/ce/eek/veg/treekey/index.htm
Great Lakes Invasive Species: http://www.glerl.noaa.gov/res/Programs/glansis/glansis.html
Identifying Trees: http://www.fw.vt.edu/dendro/dendrology/syllabus/factsheet.cfm?ID=184
Invasive Species: http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html
The Lionfish Invasion: http://oceanservice.noaa.gov/education/stories/lionfish/teachers.html
Using a Dichotomous Key: http://www.cteonline.org/portal/default/Curriculum/Viewer/Curriculum?action=2&cmobjid=203121&view=viewer&refcmobjid=202344
A Walk in the Forest: http://nationalzoo.si.edu/Education/ConservationCentral/walk/walk4.html

Watersheds

Adopt a Watershed: http://www.epa.gov/owow_keep/adopt/index.html
Locate Your Watershed: http://water.usgs.gov/wsc/map_index.html
Surf Your Watershed: http://cfpub.epa.gov/surf/locate/index.cfm
Watershed Model: http://www.watershedactivities.com/projects/fall/h2omodel.htmlWatershed Project: http://www.michigan.gov/documents/deq/ess-nps-wmp-battle-creek-river_208908_7.pdf

Miscellaneous

Gardening: http://www.plantnative.org/how_intro.htm
Making Books: http://www.makingbooks.com/freeprojects.shtml
National Wildlife Federation's Schoolyard Habitat Program: http://www.nwf.org/Get-Outside/Outdoor-Activities/Garden-for-Wildlife/Schoolyard-Habitats.aspx
Service Learning: http://servicelearning.cps.k12.il.us/Guidelines.html

Curricula

Drinking Water Activity: http://water.epa.gov/learn/kids/drinkingwater/index.cfm
ESCAPE: Exotic Species Compendium of Activities to Protect the Ecosystem, Illinois/Indiana Sea Grant, www.iisgcp.org/catalog/ed/esc.htm
Exploring the Great Lakes: A Logbook of Adventures, Patricia Westfield and Nan Soper, www.riverroadpublications.com/HTML/StateStudies.html
Fresh and Salt, COSEE Great Lakes, www.coseegreatlakes.net/curriculum
Great Lakes in My World K-8, www.greatlakes.org/GLiMW

Great Minds? Great Lakes!, United States Environmental Protection Agency, Great Lakes National Programs Office, www.epa.gov/glnpo/monitoring/great_minds_great_lakes/
Greatest of the Great Lakes, COSEE Great Lakes, www.coseegreatlakes.net/news/20070402
Lake Rhymes: Folk Songs of the Great Lakes (includes a cd), Lee and Joann Murdock, www.leemurdock.com/lm_html/music/lakerhymes.htm

Learning to Give: A Day at the Beach, www.learningtogive.org/lessons/unit85/overview.html

Michigan Department of Environmental Quality: Michigan Environmental Education Curriculum Support (MEECS), www.michigan.gov/deq/0,1607,7-135-3307_3580_29678---,00.html

Ohio Sea Grant Publications (ES-EAGLS): Land and Water Interactions in the Great Lakes, Great Lakes Climate and Water Movement, Great Lakes Shipping, Life in the Great Lakes, Great Lakes Environmental Issues, http://earthsys.ag.ohio-state.edu/project/pubs/ES_EAGLS.html

Paddle-to-the-Sea: Supplemental Curriculum Activities, http://earthsys.ag.ohio-state.edu/project/pubs/Paddle.html

Pollution Lesson Plan: http://www.cacaponinstitute.org/pollution_lesson_plan.htm

Pollution Worksheets: http://www.lessoncorner.com/Science/Environment/Pollution?page=3

Project Flow, Michigan Sea Grant Extension, Michigan State University, www.miseagrant.umich.edu/flow/

The Science Spot: http://sciencespot.net/Pages/classgpslsn.html

Topographical Mapping: http://www.its.umn.edu/Education/k12outreach/modules/TopographicMapping/
http://stwww.weizmann.ac.il/g-earth/geogroup/whole_articles/a11-whole.pdf

Wetland Activity: http://resources.cas.psu.edu/ipm/lessons/strife.pdf

Wisconsin Center for Education, K-12 Educational Resources, www.uwsp.edu/cnr/wcee/PDF/Bibs/LandUse.PDF

Working With Water: Wisconsin Waterways, Teacher's Guide and Student Materials, Wisconsin Historical Society, Office of School Services, www.wisconsinhistory.org/whspress/books/book.asp?book_id=242

Visual Media

The Great Lakes Research and Education Center: Materials for Loan – Video Collection, call: 219-395-1987, or visit: www.nps.gov/indu/forteachers/materialsforloan_videos.htm

Compact Discs

Biodiversity Around the Great Lakes, US EPA Great Lakes National Programs Office

Exploring the Great Lakes, US EPA Great Lakes National Programs Office

Wetlands Educational Curriculum, US EPA

Great Lakes in My World 9-12 www.greatlakes.org	Coastal Journey	A Sense of Place	State of the Great Lakes Coast	Restore and Explore	Getting to the Bottom of the Lakes	Coastal Habitat Re-search	The Great Race for Survival	Food Web Invasion	Coastal Careers	Create-a-Wa-tershed	Bird's Eye view	Coastal Com-munity Plan-ning	Plant Plans	Habitat Analysis	Water-shed Myster-ies	Adopt-A-Habitat	Coastal Habitat Action Plan
	9-12	9-12	9-12	9-12	9-12	9-12	9-12	9-12	9-12	9-12	9-12	9-12	9-12	9-12	9-12	9-12	9-12
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ecology	x		x		x	x	x	x		x			x	x	x	x	x
Geography	x	x			x					x	x	x		x		x	
Career planning				x					x			x					
Current events				x					x			x			x		x
History			x	x	x												
Water quality				x						x		x		x	x	x	x
Invasive species				x			x	x				x	x		x	x	
Environmental science	x		x	x		x	x			x	x	x	x	x	x	x	x
Maps	x				x					x	x	x				x	
Watershed					x					x	x	x	x	x		x	x
Place-based education		x							x			x	x		x	x	x
Outdoor education		x											x			x	
GIS		x			x					x	x						
GPS		x			x					x	x						
Food webs								x					x			x	
Coastal restoration				x		x					x	x	x	x	x	x	x
Native species				x		x	x	x				x	x	x	x	x	
Horticulture				x		x	x	x				x	x	x		x	
Habitat assessment			x	x		x				x	x	x	x	x	x	x	x
English / Language Arts (writing)	x					x		x	x		x				x		x
English / Language Arts (speaking)		x	x			x		x				x		x	x		