RAVINE Education Program

A Place-Based Activity Guide
for Grades 4-8

Park District of Highland Park

Great Lakes Restoration

GARY BORGER CHAPTER
TROUT UNLIMITED

CITY OF HIGHLAND PARK
INCORPORATED 1869

RAVINE
Education
Program

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INTRODUCTION

Welcome to the Ravine Education Program Activity Guide!

Highland Park is home to a rare and complex system of ravines linking the land with Lake Michigan. This Activity Guide aims to make this natural system more accessible for you and your students. Highland Park's ravines are the signature feature of the Lake Michigan watershed in our community. Together with other ravine systems along the North Shore, they represent one of the last natural drainages to Lake Michigan in Illinois.

Through guided observation and exploration of the ravines, this collection of lesson plans and classroom activities will enable your 4th-8th grade students to understand ecosystems prior to development, the plants and animals that historically used the slopes and streams as refuge, and the species that still depend on ravines today. Additionally, the Guide is linked to the **Next Generation Science Standards (NGSS)** as well as the Commore Core State Standards (CCSS), putting instructors in a unique position to use their local place to provide students with an internationally benchmarked science education.[1] Finally, the Guide aims to help students understand and determine what is still possible in terms of preservation and restoration.

The Park District of Highland Park (PDHP) strives to preserve and restore the ravines in order to provide quality habitat for the native plant and animal species that call the ravines home. As of 2013, the PDHP oversees a particularly exciting project striving to restore the ravine stream at Ravine Drive. Funded by the EPA's Great Lakes Restoration Initiative, the project resulted in improvements to fish spawning habitat.

To learn more about the PDHP's ravine restoration project, visit:

- http://www.pdhp.org/ravines-project/
- hpravines.blogspot.com
- http://garyborger.tu.org/blog-posts/highland-park-ravine-project
- http://triblocal.com/highland-park-highwood/community/stories/2011/07/lake-michiagn-fish-making-use-of-lakefront-ravines/

[1] www.nextgenscience.org. Accessed July 1st, 2013.

HOW TO USE THIS GUIDE

RAVINE Education Program

The Ravine Education Program (REP) Activity Guide is intended for both Formal and Non-formal Education settings. The lesson plans and activities should be used in any of the following situations with students in Grades 4-8:

- In-class utilization by classroom teacher
- In-class guest presentation by Park District of Highland Park Educators
- Field trip at Heller Nature Center, Millard Park, or Rosewood Beach
- Programs at Heller Nature Center and the future interpretive center at Rosewood Beach

The Guide is divided into the following four sections:

- Hydrology of the Watershed
- Measuring Stream and Biotic Health
- Aquatic Life in the Stream and Nearshore
- Are You Fish Friendly? Stories of Stewardship

To achieve the Guide's intended education outcomes, students should experience at least one activity from each of the four sections.

MULTIPLE LEARNING STYLES KEY

Research shows that everyone learns in different ways. Since this guide strives to provide learning opportunities for all learners, activities are coded with icons to alert the user which learning styles are targeted:

- Visual/Spatial
- Aural/Auditory
- Logical/Mathematics
- Solitary/Intrapersonal
- Verbal/Linguistic
- Social/Interpersonal
- Physical/Kinesthetic

Ravine 7L in Highland Park, IL

RAVINE Education Program

Hydrology of the Watershed

Build a Watershed

TIME: 40-60 minutes

GRADES: 4-6

LOCATION: Indoors or outdoors

SAFETY: When outside, stay in groups

KEYWORDS:

Watershed, permeable, stormwater, runoff, ravines, groundwater, sediment

MATERIALS:

- ❑ Paper
- ❑ Pencils
- ❑ Water soluble markers
- ❑ Wet sponges or spray bottles filled with water
- ❑ Compasses
- ❑ Clipboards
- ❑ Buckets
- ❑ Student page

GREEN TIP

Use scrap paper for this activity and recycle when finished.

Ravine 7L in Highland Park, IL

SUMMARY

In this activity, students learn about watersheds and create their own watershed model. They also explore their local watershed and human impacts on these systems.

OBJECTIVES

Students are able to:

1. Explain what a watershed is;
2. Model a watershed and use it to show relationships between the hydrosphere, geosphere, and atmosphere; and
3. Identify one watershed to which they belong.

BACKGROUND

WHAT IS A WATERSHED?

Everyone is part of a watershed. A **watershed** is the area of land where all of the water that is under it or drains off of it goes into the same place. John Wesley Powell, scientist geographer, said that a watershed is: “That area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community.”

HIGHLAND PARK'S LAKE MICHIGAN WATERSHED

Rain that falls east of Green Bay Road flows naturally through steep valleys called **ravines** to Lake Michigan. The ravines in Highland Park are the signature feature of the Lake Michigan watershed in our community. Together with other ravine systems along the North Shore, they represent one of the last natural drainages to Lake Michigan in Illinois.

Each ravine has its own drainage area - a subset (or subwatershed) of the larger watershed. The ravines also have names. They are numbered in order in Illinois from south to north and by county (L)ake and (C)ook or some have place name designations.

It is important to keep our streams clean because Lake Michigan is the primary source of drinking water in Highland Park.

PREPARATION

Educator should select locations for permeability demonstration in advance.

One location should be paved, one should be unpaved.

There are two major watersheds in Highland Park. All rain that falls west of Green Bay Road (green line) enters the Chicago-Calumet Watershed. Rain that falls east enters the Lake Michigan Watershed. *Source: The Park District of Highland Park's District Wide Map can be found at: www.pdhp.org/modules/showdocument.aspx?documentid=14*

PROCEDURE

INTRODUCTION

1. Instructor should begin by determining what students know about how water moves. Ask these questions:

- What are the main steps of the water cycle?
- Where does water go when it falls as precipitation?
- How do we know when water will soak into the ground or move downhill?

2. Next, introduce the concept of a watershed, the area of land where all of the water drains to one place.

Additional vocabulary:

Permeable: able to let a substance, like water, through
Example: If water is added to soil in a houseplant, it soaks through slowly.

Stormwater: water that falls on the land during a storm
Example: During a rainstorm, rain falls on the roof of your house, in your backyard, and on your driveway. This is all stormwater.

Runoff: water that is not absorbed by the ground
Example: If water falls on a street, it doesn't soak through, but instead flows downhill into a stormwater drain.

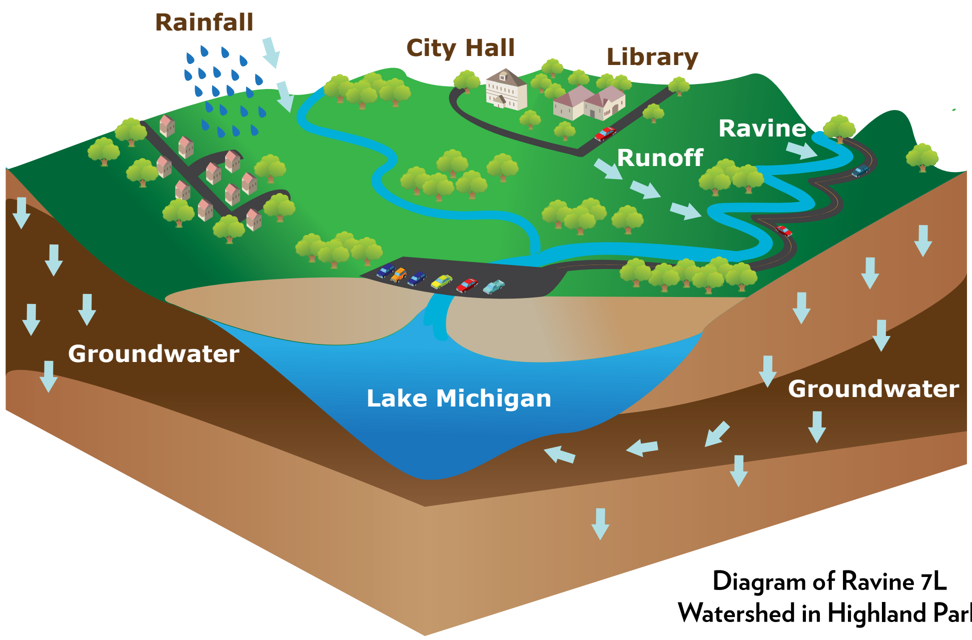


Diagram of Ravine 7L Watershed in Highland Park

WATERSHED MODELING

3. Students should sit in groups. Each student should have two white pieces of paper, a pencil, and a marker or pen. Each group should have a full spray bottle.

4. Modeling: To build the watershed model, each student should crumple up their white paper into a ball and then carefully unfold the paper without ripping it. Wrinkled paper simulates a watershed, one that has been carved by, wind, water, and ice over time. Students use the sides of their pencils to mark the high points of the watershed. Students may also add a lakeshore to their watershed, using the pencil to draw a boundary between land and water.

5. Making predictions: Ask students to analyze their watershed. Where will the water go when it rains? Is there any place where it will soak into the ground? They might make pencil marks on their papers to show where they think most of the water will end up.

WATERSHEDS ARE LIKE WATER PARKS

Consider this analogy of a watershed:

"Think of a watershed like an enormous water park. Raise your hands if you have been to a water park. [hands] What is one feature found in every water park? [target answer is water slide] A waterslide! Which way does water flow on a waterslide? [downhill] Watersheds are like hundreds of waterslides. When water falls onto one of these pretend waterslides it flows downhill. The water might travel through the ground (**groundwater**), over the land (runoff), or through pipes (stormwater).

What is at the bottom of a normal waterslide? [a pool] Yes – the bottom of a watershed is like a pool. All the waterslides in the water park bring the water together into one place – it might be a lake, a river, a wetlands, or even an ocean. If water falls into another watershed, or, another water park, it drains into a different pool. Everyone lives in a watershed, so you could say that we all have a water park!"

6. Each student should spray five times to simulate precipitation on their watershed. Students can sketch or record where the water goes.

7. Class discussion: What happens to the rain water when it falls on the watershed?

EXPLORING THE LOCAL WATERSHED

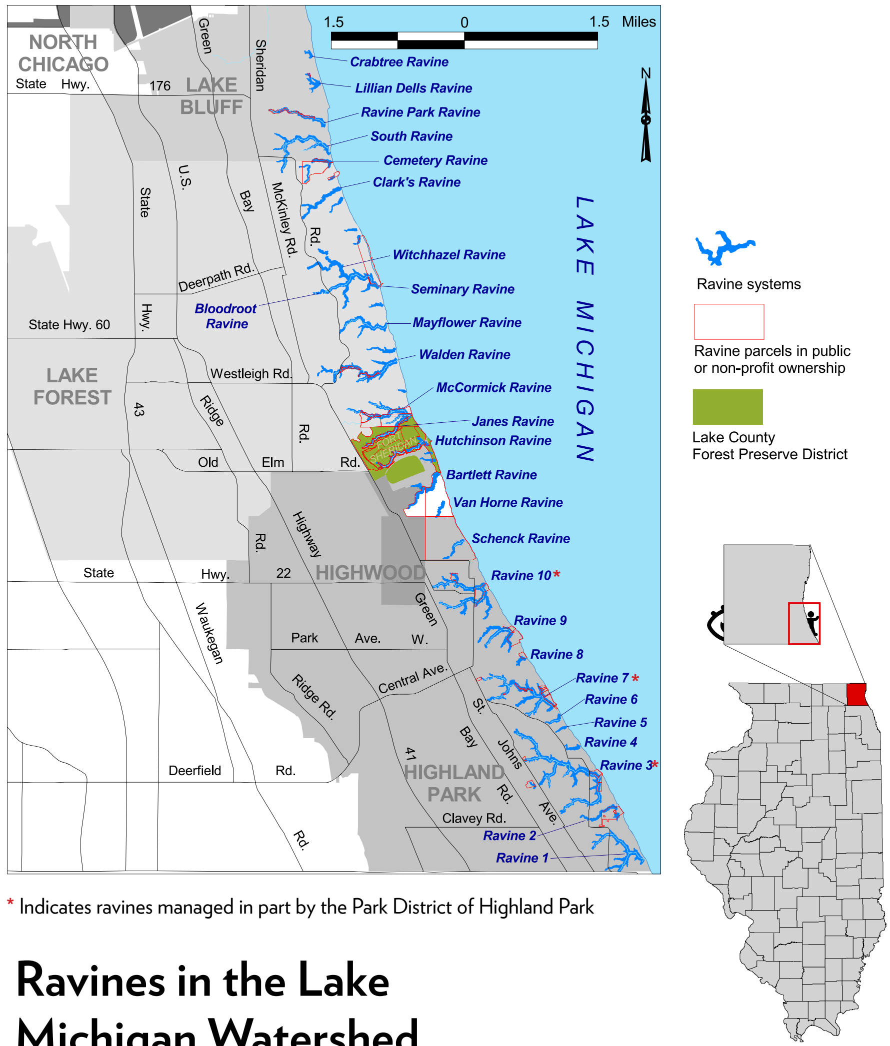
8. Each group should have one bucket with about one gallon of water, one compass, and a clipboard with the "Your Local Watershed" student page.

9. Take students outdoors in their groups. Pick three different locations around the school to empty the buckets. Students should complete the data table on the student page as each bucket is emptied. How much water soaked into the ground? 25%? 50%? 100%? How much water stayed in place, and how much flowed to another location? Use compasses to determine the direction of water flow. Where did the moving water stop? Consider what this data means about the local watershed.

HOW MUCH IS A GALLON?

1 gallon = **3.79** liters or **0.13** cubic feet.

A gallon is a volumetric measurement of a liquid.



* Indicates ravines managed in part by the Park District of Highland Park

Ravines in the Lake Michigan Watershed, Lake County, Illinois (Southern)

DATA SOURCES: Lake County Stormwater Management Commission; Lake County Department of Information and Technology, GIS & Mapping Division; Illinois State Geological Survey; Lake County Forest Preserve District; Openlands Project; Lake Forest College; City of Highland Park; Village of Lake Bluff

Source: Lake Country Stormwater Management Commission

WATERSHED MODELING WITH POLLUTION

10. Students return to their groups indoors and follow steps 2-4 with their second piece of paper. This time, they should use the marker to draw lines and dots on their papers before spraying precipitation.

The ink represents pollution in their watershed. The pollution could be **sediment**, oil, pesticides, herbicides, chemicals, road salt, fertilizer, lawn waste, or garbage. How will the pollution behave when it rains? Will it move? If so, where will it be taken?

CLASS DISCUSSION

11. Discuss the following:

- When pollution was added, how did the watershed change?
- Is the watershed healthier or less healthy after it rained?
- What solutions might eliminate or decrease the amount of pollution in the watershed?
- What are the model's limitations?
- How could we make the models more realistic?

ASSESSMENT

Check student page for completion.

EXTENSIONS

STORM DRAINS LEAD TO WATERWAYS

Storm drains are everywhere in our community. When streets flood after a storm, these drains quickly transport rain to a nearby waterway. Many storm drains have prompts.

Identify the prompts on your local storm drain (i.e., "dump no waste" or a small fish made of steel). Tell students to look for these clues outside, without telling them that they can be found on a storm drain.

Safety tip: DO NOT lift the storm drain covers.

After the exploration, direct students to create their own signs (like those on the storm drains) and put them in a visible place.

POLLUTION AWARENESS

Students complete "Watershed Words" page, a word search adapted from a United States Environmental Protection Agency (USEPA) activity.

Go here to see the original word search puzzle.

RESOURCES

EPA Nonpoint Source Pollution Activities for Students: http://www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-kids

SOURCES

Alliance for the Great Lakes Strategic Subwatershed Identification Process.

Ravine Erosion Control -Sediment/ Nutrient Transport Reduction Through Vegetative Stabilization, Charles W. Shabica, Draft Report to the Great Lakes Commission, Dept. of Public Works, City of Highland Park, IL 1996. http://projects.glc.org/basin/pubs/projects/ILravine.pdf

STANDARDS

SCIENCE (NGSS)

4-ESS2-1, 4-ESS2-2, 5-ESS2-1, 5-ESS3-1, MS-LS2-3, MS-ESS2-2, MS-ESS2-4, MS-ESS3-1, MS-ESS3-3

ENGLISH LANGUAGE ARTS (CCSS)

RST.6-8.4, WHST.6-8.2d, WHST.6-8.9

MATHEMATICS (CCSS)

4.MD.A.2

Storm drain with visible prompts

Your Local Watershed

Student Page

NAME: ____________________

DIRECTIONS

Record the results from your test of the local watershed. Remember that each bucket contains approximately one gallon of water.

LOCATION	How much water soaked into the ground?	Where did the rest of the water go?	Where did the water stop? How much was there?
GARDEN	About 50%, or a 1/2 gallon	Toward the sidewalk (south)	About 50% (1/2 gallon) stopped at a low point in the sidewalk.
1.			
2.			
3.			

WRAP-UP

Answer the questions below:

1. List the possible sources of pollution that could affect your watershed.

____

____

2. What could be done to prevent this pollution from entering the watershed?

____

____

Student Page

Watershed Words

NAME: ____________________

DIRECTIONS

Circle each word in the word search below.

Water	Erosion	Pollution	Sediment	Nonpoint Source	Runoff
Watershed	Conservation	Nutrients	Pesticide	Fertilizer	Environment

A	N	O	N	P	O	I	N	T	S	O	U	R	C	E
N	P	U	L	O	W	I	M	P	A	C	T	I	O	P
L	T	S	T	N	E	M	I	D	E	S	W	P	R	A
O	W	A	T	R	N	B	K	C	M	L	E	A	A	C
N	A	F	D	U	I	Y	F	F	O	N	U	R	I	S
O	T	E	W	O	T	E	R	B	W	T	N	I	N	I
I	E	R	Y	L	P	M	N	R	G	C	D	A	G	R
T	R	T	P	O	L	L	U	T	I	O	N	N	A	E
A	S	I	E	M	S	T	D	W	S	R	I	F	R	X
V	H	L	S	K	B	W	K	J	U	R	S	L	D	N
R	E	I	T	C	T	U	A	S	O	I	M	R	E	O
E	D	Z	I	P	L	V	O	T	A	W	Z	H	N	I
S	E	E	C	M	F	H	I	R	E	D	L	M	S	S
N	E	R	I	A	N	N	K	G	P	R	H	P	M	O
O	D	I	D	V	O	C	M	D	J	T	J	E	G	R
C	T	N	E	M	N	O	R	I	V	N	E	T	R	E

Source: http://www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-pollution-awareness-word-search-puzzle

BONUS

Match the words with their definitions.

_____ Watershed
_____ Permeable
_____ Stormwater
_____ Runoff

A. Water that is not absorbed by the ground
B. The area of land where all water drains to one place.
C. Able to let a substance, like water, through
D. Water that falls on the land during a storm.

Hydrology of the Watershed

Know Your Watershed

TIME: 30-45 minutes

GRADES: 5-8

LOCATION: Indoors

KEYWORDS:

Watershed, gallon, mile, ton, acre, square mile, cubic feet, cubic feet per second

MATERIALS:

- ❑ Paper
- ❑ Pencils
- ❑ Question and Answer Cards
- ❑ Student Worksheets
- ❑ Calculators (optional)

SUMMARY

In this activity, students use math skills to uncover new information about the watersheds of Highland Park.

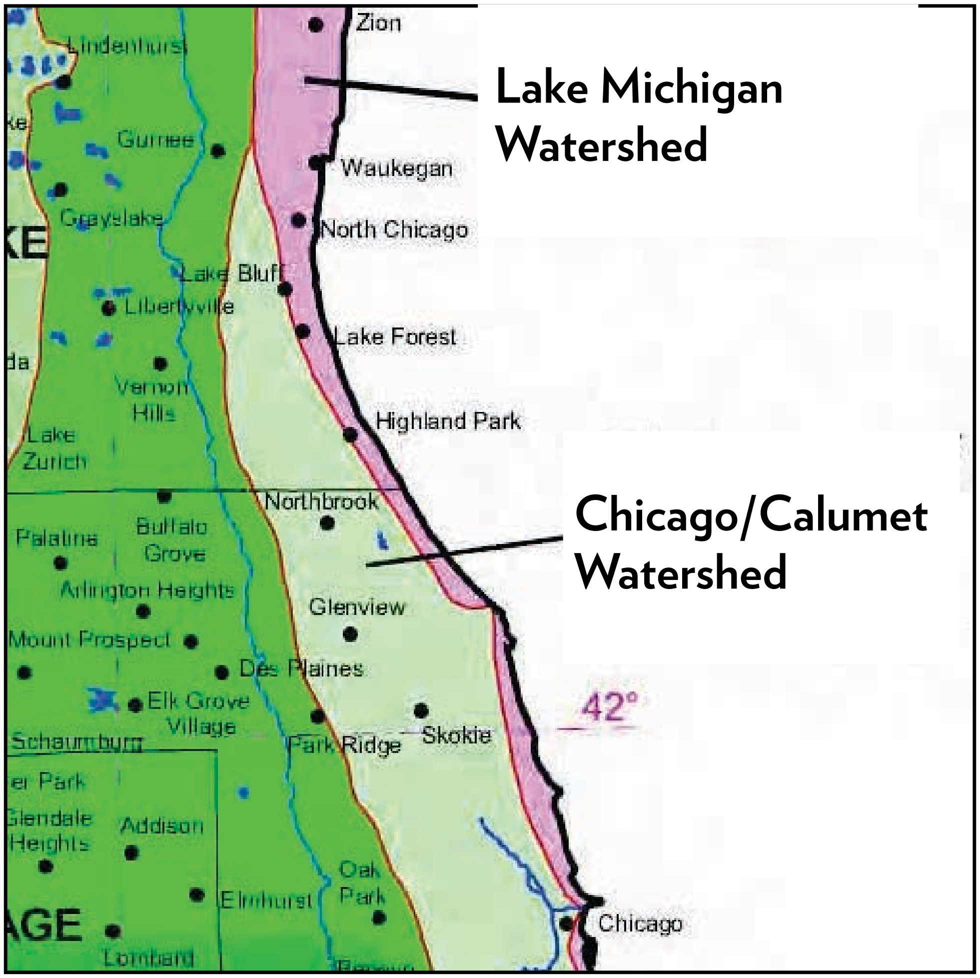
OBJECTIVES

Students are able to:

1. Use arithmetic to solve for real-world numbers;
2. Identify units used to measure length, area, volume, and flow rates;
3. Identify facts that makes their watershed unique;
4. Explain how water flows through a watershed; and
5. 6-8th grade students should practice researching their watershed and properly citing the sources of those facts.

BACKGROUND

Highland Park's Lake Michigan watershed actually represents a subcontinental divide. All water east of Green Bay road flows through Highland Park's Ravine system and into Lake Michigan. All water west of Green Bay road flows to the Chicago River, through the Mississippi River, all the way to the Gulf of Mexico.



The Lake Michigan Watershed in Illinois is very narrow. *Source: Illinois State Water Survey Watershed Map.*

AMAZING LAKE MICHIGAN

Watershed boundaries are created by features on the land, especially topography. They cross city, county and even state lines.

Watersheds can be divided into subwatersheds from a very large scale (the Mississippi River Watershed) to a very small scale (the drainage area of your own driveway at home). The section (or sub watershed) of the Lake Michigan watershed that includes the ravines is called the Pike Root Watershed. The other large scale watershed that includes Highland Park is called the Chicago/Calumet.

The Lake Michigan watershed in Illinois is very narrow -- about one mile wide in many places. While this land is mostly built up with houses, roads and businesses, there are still many areas that have been protected as open space for us all to enjoy. In fact while 30 percent of the land is urbanized, the National Heritage Inventory documented 16 endangered, 20 threatened plant and animal species and 17 rare aquatic and terrestrial species in the Pike Root.

In this activity students solve math problems to discover the following facts about watersheds in Highland Park:

- 200 fish species live in Illinois.
- Lake Michigan has 79 native fish species.
- Highland Park's water plant serves approximately 60,000 people with water from Lake Michigan.
- 26% percent of Highland Park is covered with impervious surfaces.
- If you lined up all of Highland Park's ravines, they would extend 11 miles.
- One of Highland Park's largest ravines, Ravine 7L, has a 375 acre watershed.
- Five fish species have been documented in Ravine 7L.
- Ravine 7L's flow rate has been recorded between 0 and 95 cubic feet per second.
- 3,290 tons of sediment flow through Highland Park's ravines every year.
- The Lake Michigan coastline is 63 miles long in Illinois.
- The maximum depth in Lake Michigan is 925 feet.

- 8,500,000 people in Illinois get their drinking water from Lake Michigan.
- Illinois' Lake Michigan watershed is 100 square miles.
- The entire Great Lakes watershed is 295,000 square miles.
- There are four states in the Lake Michigan Watershed.
- The Great Lakes contains 20% of the world's fresh water.
- 31 states are in the Mississippi River Watershed.
- The Mississippi watershed is 1,245,000 square miles.
- 450,000 cubic feet of water flows through the Mississippi River every second.
- 254,842,000 tons of sediment flow through the Mississippi River each year.

HOW MUCH IS...

One gallon (volume)	One gallon is 4 quarts, 8 pints, or 128 fluid ounces
One acre (area)	One football field without end zones
One mile (distance)	5280 feet, or 1,609 meters
One ton (mass)	2,000 lbs, or 907 kilograms. An average car weighs about one ton.
One square mile (area)	A square with each side measuring one mile in length. 640 acres.
Cubic foot (volume)	A square box with each side measuring one foot (12inches) in length. 7.5 gallons.
One cubic foot per second (flow rate)	A measurement of a liquid's rate of flow. For example if a bucket is filled with one cubic foot of water (7.5 gallons), and the bucket is emptied in 1 second, it is emptied at a rate of 1 cubic foot per second.

PREPARATION

Copy the "Watershed Number Cards" (Set 1 or 2) for this activity. Before class begins, hide the answer cards around the room. Also, be prepared to discuss the measurements of the following units: gallons, acres, miles, tons, square miles, cubic feet, and cubic feet per second (CFS).

PROCEDURE

EXPLORE

1. Ask students to define a watershed. Ideally students have prior knowledge of a watershed from previous activities. Ask what they know about their local watershed. Explain that this activity involves learning numerical facts about the local watershed. Each of the facts reveals a clue to a secret message that explains how all watersheds work.

2. Show students question and answer card #1, and read the question: "How many fish species live in Illinois? Any guesses?" [answers will vary]

3. Read the clue: "The answer is 4 x 50."

4. Next, show students the answer card [200 fish species]. Point out the clue on the answer card: WA.

INVESTIGATE

5. Break students into groups. Provide each student with a "Secrets of the Watershed" student page. Students will complete the table by answering each question card.

6. Explain that for every answer students should also note the units, especially unfamiliar units. At the end, students can ask what different units mean.

7. Tell students that there are nine question cards and nine answer cards. By solving the cards, they will discover the secret message.

8. When students are finished, they should return to their desks and answer the questions at the bottom of the student page.

9. With 6th-8th graders, instructor may consider providing students with paper copies of the sources of this information or additional facts about the watershed.

WRAP-UP

10. Ask students what the secret message is. [Set 1: Water flows down; Set 2: Groundwater trickles into streams which create habitat for aquatic organisms] Ask what the secret message means. [Answers will vary, but should emphasize that the force of gravity causes water to always flow downhill]

11. Ask students if there were any units they did not understand. If so, refer to the "How Much Is..." table earlier in this activity.

12. Ask students to share one fact about the watershed that surprised them.

ASSESSMENT

Check student page for completion.

VISUALIZING FLOW

The *average* flow rate of the Mississippi River is 450,000 cubic feet per second (CFS). At this rate, the Willis Tower would fill with water in less than two minutes. Willis Tower's volume is 53.4 million cubic feet. With the *maximum* recorded flow in Ravine 7L (95 CFS), it would take nearly a week!

EXTENSIONS

SPREAD THE WORD

Decorate a bulletin board in the school with facts about the local watershed.

RESEARCH THE WATERSHED

Students research a watershed topic using library resources and practice citing their sources.

RESOURCES

Great Lakes Information Network Facts and Figures: www.great-lakes.net/lakes/ref/lakefact.html

Mississippi River Anatomy: www.americaswetlandresources.com/background_facts/detailedstory/MississippiRiverAnatomy.html

Illinois EPA Lake Michigan Monitoring Program: www.epa.illinois.gov/topics/water-quality/monitoring/lake-michigan/indexl

SOURCES

Bailey and Smith in Eshenroder et al, 1995. Fish Community Objectives for Lake Michigan. Great Lakes Fisheries Commission SP 95-3 63 pp.

Bosanko, D. 2009. Fish of Illinois. Adventure Publications Cambridge MN 208 pp.

Great Lakes Facts and Figures. Great Lakes Information Network. www.great-lakes.net/lakes/ref/lakefact.html. Accessed April 8, 2013.

Illinois State Water Survey Watershed Map.

Joe Pasquesi, City of Highland Park Public Works. Personal communication, 2013.

Lake Michigan Monitoring Program. Illinois EPA. www.epa.illinois.gov/topics/water-quality/monitoring/lake-michigan/index Accessed April 8, 2013.

Mississippi River Anatomy. America's Wetland Foundation. www.americaswetlandresources.com/background_facts/detailedstory/MississippiRiverAnatomy.html. Accessed April 8, 2013.

Shabica, Charles 1999. Ravine Erosion Control-Sediment Nutrient Transport Reduction Through Vegetative Stabilization. Great Lakes Commission. http://projects.glc.org/basin/pubs/projects/ILravine.pdf. Accessed April 8, 2013.

STANDARDS

SCIENCE (NGSS)

4-ESS2-2, 5-PS2-1, 5-ESS2-2, 5-ESS3-1, MS-ESS2-1, MS-ESS2-2, MS-ESS2-4, MS-ESS3-1

ENGLISH LANGUAGE ARTS (CCSS)

RST.6-8.4, WHST.6-8.2d,

MATHEMATICS (CCSS)

4.MD.A.1, 4.MD.A.2, 4.MD.A.3, 5.MD.A.1, 7.EE.B.3, 6.NS.A.1, 6.NS.B.2, 6.NS.B.3, 6.NS.C.5, 6.SP.B.5

Knowing the Watershed

Watershed Number Cards: Set 1

Question Cards	Answer Cards
1. How many fish species live in Illinois? Hint: 100 x 2 = _______	ANSWER: 200 fish species CLUE: WA
2. How many native fish species are in Lake Michigan? Hint: 200 – 121 = _______	ANSWER: 79 native fish species CLUE: TE
3. How many people does Highland Park's water plant serve? Hint: 300 x 200 = _______	ANSWER: 60,000 people CLUE: R
4. Ravine 7L has one of the largest watersheds of the Highland Park ravines. How big is Ravine 7L's watershed? (in acres) Hint: 75 x 5 = _______	ANSWER: 375 Acres CLUE: FL
5. How many states are in the Lake Michigan Watershed? Hint: (23 + 17) / 10 = _______	ANSWER: 4 states CLUE: OW

LESSON MATERIALS

Knowing the Watershed

Watershed Number Cards: Set 1

Question Cards	Answer Cards
6. If you put all of Highland Park's ravines in a line, how long would that line be? (in miles) Hint: 65 – 54 = _______	**ANSWER**: 11 Miles **CLUE**: S
7. What percentage of the world's fresh water is contained in the Great Lakes? Hint: 100% / 5 = _______	**ANSWER**: 20% of the world's fresh water **CLUE**: D
8. How many tons of sediment flow through all of Highland Park's ravines each year? Hint: 658 x 5 = _______	**ANSWER**: 3,290 tons of sediment **CLUE**: O
9. How many states are in the Mississippi River watershed? Hint: (7 x 3) + 10 = _______	**ANSWER**: 31 states **CLUE**: W
10. How big is the Mississippi River watershed? (in square miles) Hint: 6,225,000 / 5 = _______	**ANSWER**: 1,245,000 square miles **CLUE**: N

LESSON MATERIALS

Knowing the Watershed

Watershed Number Cards: Set 2

Question Cards	Answer Cards
1. How many fish species live in Illinois? Hint: 100 x 2 = _______	ANSWER: 200 fish species CLUE: Groundwater
2. What percentage of Highland Park is covered with impervious surfaces? Hint: 2 x 13% = _______	ANSWER: 26% impervious surfaces CLUE: trickles
3. What is the average amount of water that flows through the Mississippi River every second? (in cubic feet per second)? Hint: 75 x 6000 = _______	ANSWER: 450,000 cubic feet per second CLUE: into
4. How much water flows through Ravine 7L every second? Guess: _______	ANSWER: Ravine 7L's flow rate has been recorded at 0-95 cubic feet per second CLUE: streams
5. How deep is the deepest part of Lake Michigan? Hint: 37 x 25 = _______	ANSWER: 925 feet CLUE: which

Knowing the Watershed
Watershed Number Cards: Set 2

Question Cards	Answer Cards
6. How many tons of sediment flow through the Mississippi River every year? Hint: 300,000,000 – 45,158,000 = _______	ANSWER: 254,842,000 tons of sediment CLUE: create
7. What is the length of the Lake Michigan coastline in Illinois? (in miles) Hint: 3 x 3 x 7 = _______	ANSWER: 63 miles CLUE: habitat
8. How many people in Illinois get their drinking water from Lake Michigan? Hint: 10,000,000 – 1,500,000 = _______	ANSWER: 8,500,000 people CLUE: for
9. How big is the Illinois' Lake Michigan watershed? (in square miles) Hint: 10^2 = _______	ANSWER: 100 square miles CLUE: aquatic
10. How many square miles is the entire Great Lakes watershed? Hint: 7,375 x 40 = _______	ANSWER: 295,000 square miles CLUE: organisms.

Student Page Secrets of the Watershed

NAME: ______________________

DIRECTIONS

What is the secret message of the watershed? Fill in the blanks below to find out. Your instructor will provide you with question cards. Each question card has a math problem which will provide you with a number. Find the answer card with that number and a clue to the secret message. The first question is completed for you.

QUESTION	MATH PROBLEM	ANSWER (with units)	CLUE
1. How many fish species live in Illinois?	4 x 50 = 200	200 fish species	
2. .			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

SECRET MESSAGE: ____

What do you think the secret message means?

____

____

RAVINE Education Program

A. Hydrology of the Watershed

Map Your Watershed

TIME: 45-60 minutes

GRADES: 4-8

LOCATION: Indoors

KEYWORDS:

Topographic maps, cartography, Geographic Information System (GIS)

MATERIALS:

- ❑ "Watershed Scavenger Hunt" student page
- ❑ "Watershed Maps" student page


Topography Map of Ravine 7L

Source: Lake Michigan Watershed Ecosystem Partnership

SUMMARY

In this activity, students explore various maps at different scales. Students consider the intersection of watersheds, and how some are divided, but many are connected.

OBJECTIVES

Students are able to:

1. Indentify which watershed their community is a part of;
2. Calculate the distance between their school and the closest ravine;
3. Understand that watersheds have natural boundaries not drawn by people;
4. Understand watersheds can be divided OR connected; and
5. Gain skills using a Geographic Information System (GIS).

BACKGROUND

There are many types of maps that are useful when studying watersheds. **Topographic maps** have contour lines which express changes in elevation, which helps planners determine which direction water moves in a particular area. Even the average street map can be useful in determining distances across an area. Small scale maps are useful for analyzing watersheds in a local area while large scale maps can be used when studying a state or region.

With the enormous amount of data available in today's world, **cartography**, or map making, has become more computer-based and accessible. Planners around the world can use computer mapping programs called **Geographic Information Systems** (GIS) to create maps at the local, state, national, and global scales. The Park District of Highland Park has used a GIS to create maps of the Highland Park ravines, which are used in this activity.

PREPARATION

Read through the procedure in advance and explore the online map resources. "Watershed Maps" may be printed off or viewed on a projector. If the technology is available the instructor may choose to have students explore the interactive maps at individual computer stations. Print "Watershed Scavenger Hunt" student pages for each student.

PROCEDURE

1. Ask students what they know about maps. Ask students to explain what a map is. Brainstorm various types and uses of maps.

2. Explain that today's activity involves using several types of maps at different scales to learn about the watersheds. Review the meaning of the word "watershed" with students. [an area of land where all the water drains to the same place]

3. Explain that topographic maps are useful when studying watersheds. Topography is the study of the surface of the earth, and topographic maps have contour lines that mark changes in elevation.

4. Pass out "Watershed Scavenger Hunt" student pages to all students. Work as a class or in small groups to complete the Scavenger Hunt using the Watershed Maps Pages.

ASSESSMENT

Collect "Watershed Scavenger Hunt" pages and check for accuracy.

Answers:

1. Ravine 1L, Ravine 3L (at Rosewood Park), Ravine 7L (at Millard Park), Ravine 9L (at Central Park), and Ravine 10L (at Moraine Park and Port Clinton Park.

2. Answers will vary

3. Answers will vary

4. Smallest scale map is of Indian Trail and Elm Place Schools. Largest scale map is of Braeside, Red Oak, and Sherwood Schools.

5. 680 ft. – 580 ft. = 100 ft. of difference in elevation.

6. The ravine slopes are steeper than slopes elsewhere.

7. Ravine Drive

8. Compass, legend, scales, or labels (i.e., Lake Michigan)

9. Lake Michigan watershed and Chicago-Calumet Watershed

10. Three. Chicago-Calumet Watershed, Des Plaines Watershed, Illinois Watershed

11. Lake Michigan Watershed

12. Answers vary

13. Gulf of Mexico

14. Atlantic Ocean, through the Saint Lawrence River.

15. Both answers are correct. Naturally, the two major watersheds in Highland Park are connected, since the Chicago River fed Lake Michigan before the River was reversed in 1900. Today, we might consider the watersheds separate because water in the Chicago-Calumet Watershed flows south toward the Gulf of Mexico, while water flowing into the Great Lakes naturally moves east towards the Saint Lawrence River. Since the Chicago River is fed by Lake Michigan water from the Lake Michigan Watershed some of this water ends up in the Chicago River.

EXTENSIONS

VISIT THE RAVINES!

Now that students see how close the ravines can be, encourage them to visit and report back to the class what they find. Consider using the "You Can Help" student page in the "Are You Fish Friendly" section of this guide or go to www.pdhp.org/ravines-project/

GET INTERACTIVE!

There are numerous GIS tools varying in complexity from Google Maps to ArcGIS.

Google Earth is a GIS many students may know. Google Earth has thousands of data layers to explore. Users can also zoom in to a particular area to experience a three dimensional portrayal of that area's terrain.

Download Google Earth at: www.google.com/earth/.

Consider using the National Geographic Map Maker Interactive with 4-8th grade audience. In this GIS students can use several interfaces (including satellite, topography, street maps) to map the world. Users can also view spatial data on dozens of themes, including population density, land cover, and climate zones. http://mapmaker.education.nationalgeographic.org/?ls=000000000000

LEARN ABOUT LAKE LEVELS

The Great Lakes have shaped the topography of the North Shore region and beyond over the past tens of thousands of years. Records show that Lake Michigan and Lake Huron water levels have been as much as 59 feet higher and 200 feet lower than they are today. Use the Great Lakes Water Level Dashboard from the National Oceanic and Atmospheric Administration (NOAA) to track monthly changes in the water levels of all five Great Lakes. The Dashboard combines Lake Michigan and Lake Huron because they are combined, and always have the same water level. http://www.glerl.noaa.gov/data/wlevels/

SOURCES

Chrzastowski, M. J., & Thompson, T. A. (1992). Late Wisconsinan and Holocene coastal evolution of the southern shore of Lake Michigan. SPECIAL PUBLICATION-SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS, 48, 397-397.

STANDARDS

SCIENCE (NGSS)

4-ESS1-1, 4-ESS2-1, 4-ESS2-2, 5-PS2-1, 5-ESS2-2, 5-ESS3-1, MS-ESS2-2, MS-ESS3-1

ENGLISH LANGUAGE ARTS (CCSS)

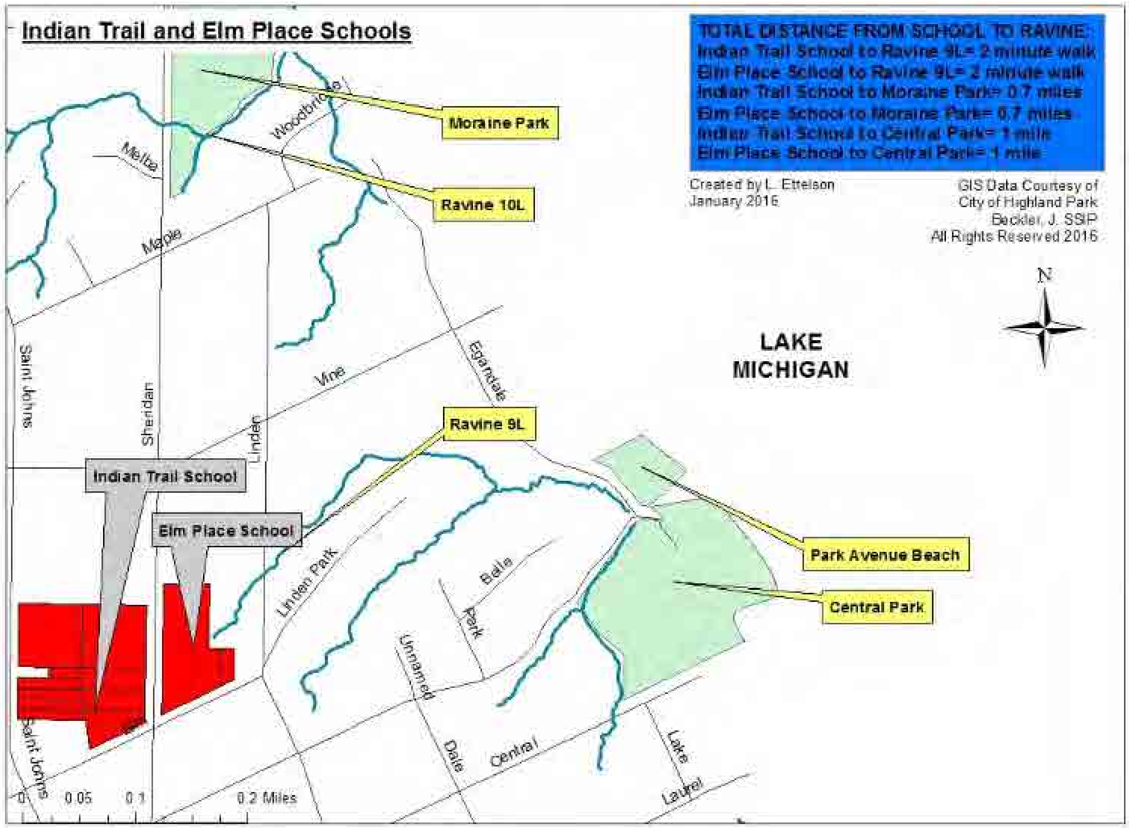
CCRA.R.7, CCRA.W.2, CCRA.W.4, RHA.6-8.7, RST.6-8.4, WHST.6-8.2d

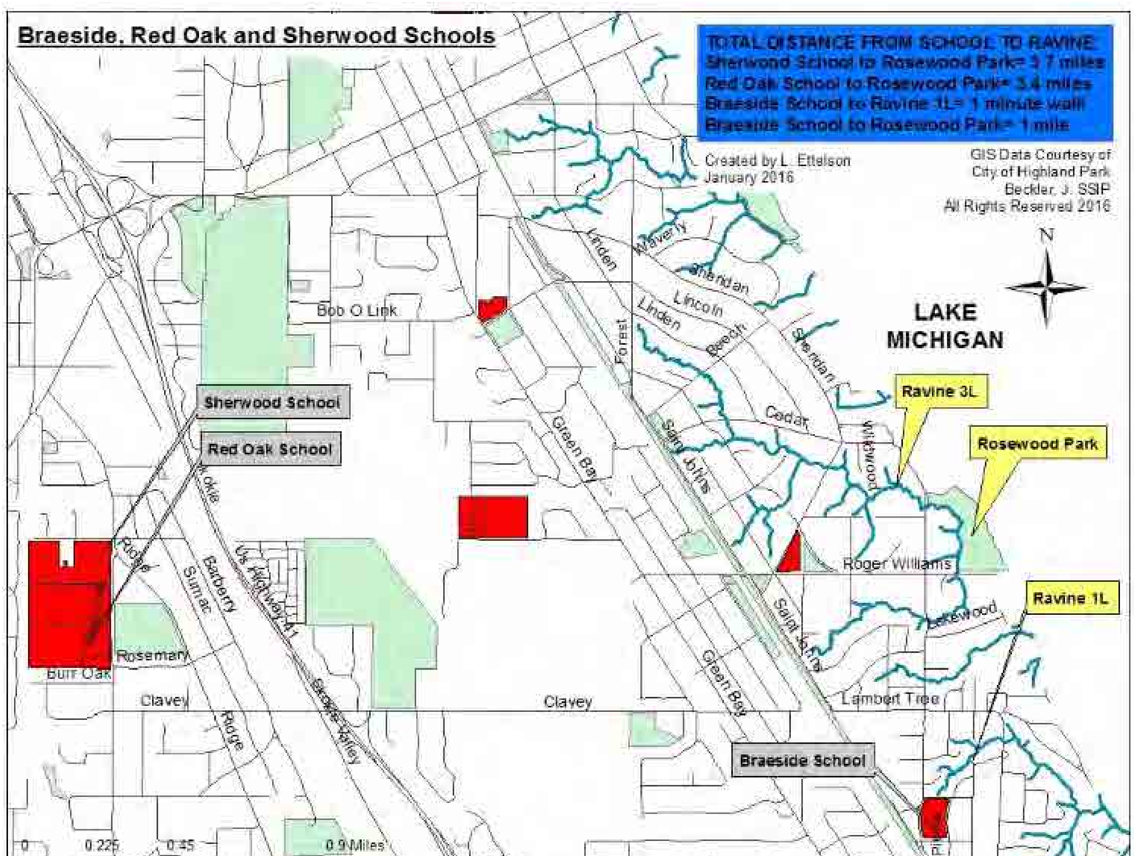
MATHEMATICS (CCSS)

4.MD.A.1, 4.MD.A.2

Teacher Page

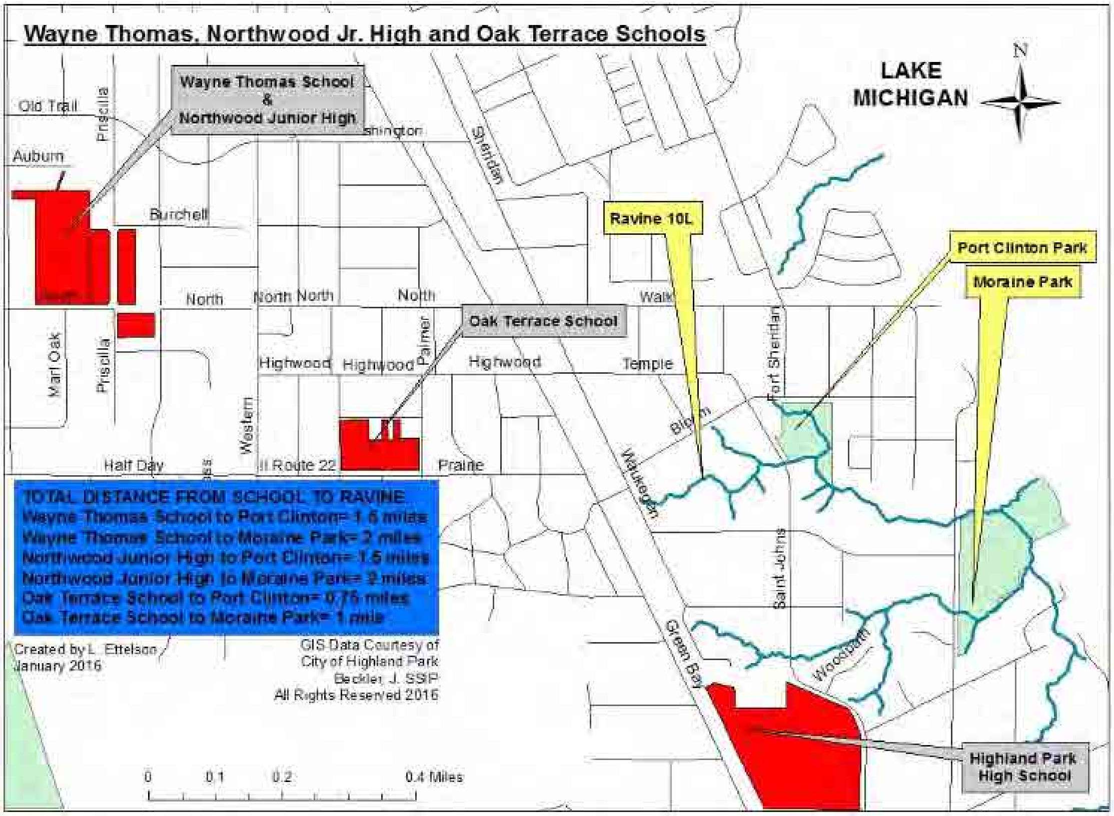
Map Your Watershed
Watershed Maps: Ravines & Schools of Highland Park

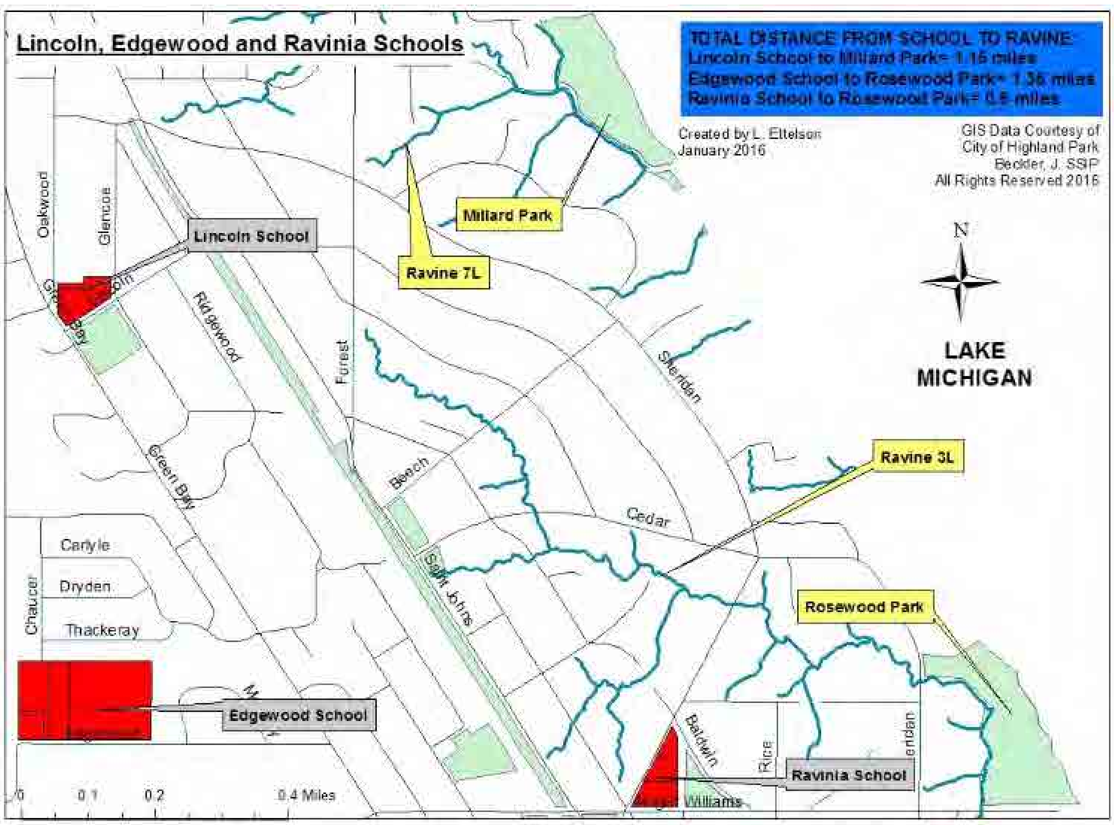




Teacher Page

Map Your Watershed
Watershed Maps: Ravines & Schools of Highland Park

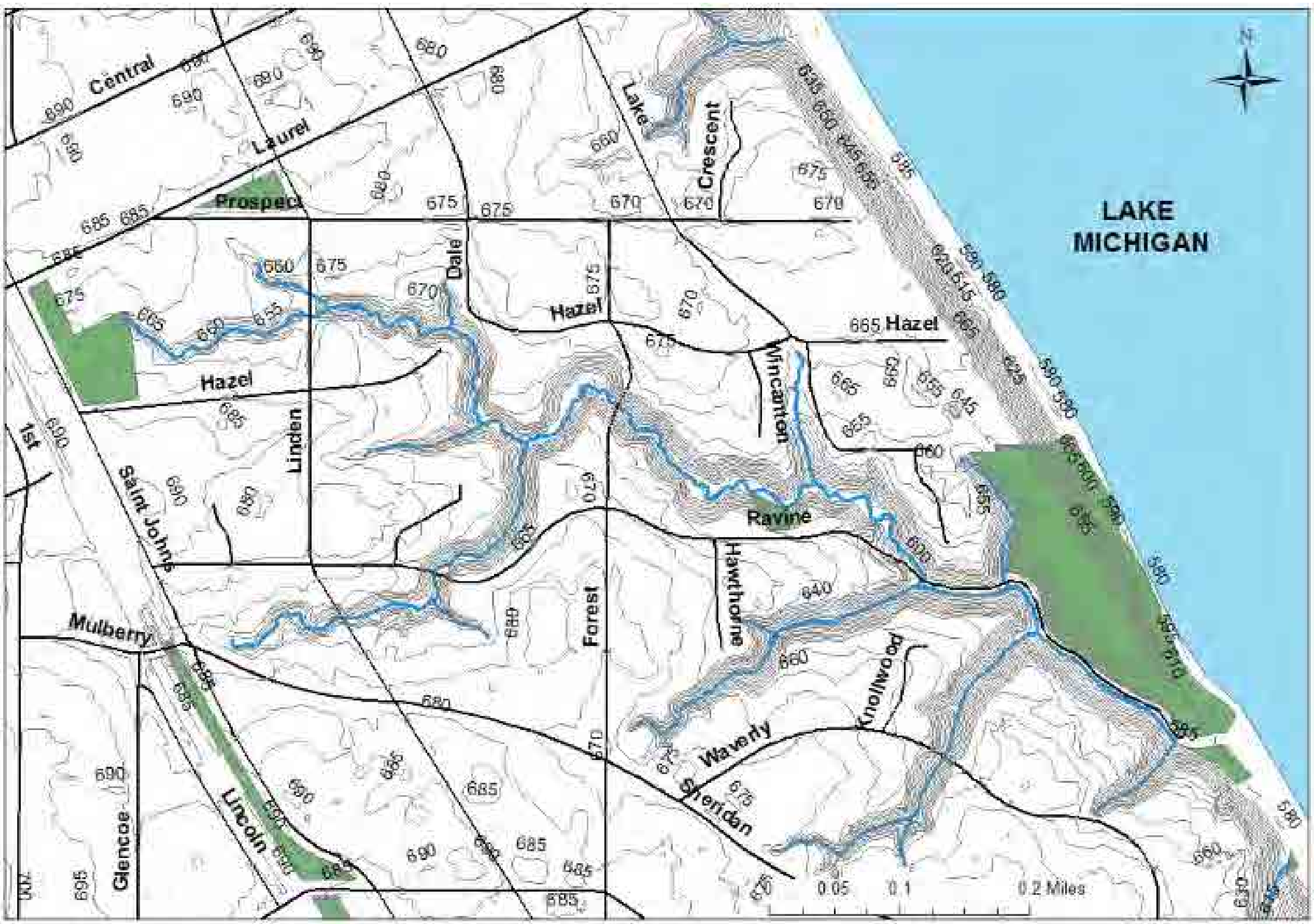




Teacher Page

Map Your Watershed

Watershed Maps: Ravine 7L Topography

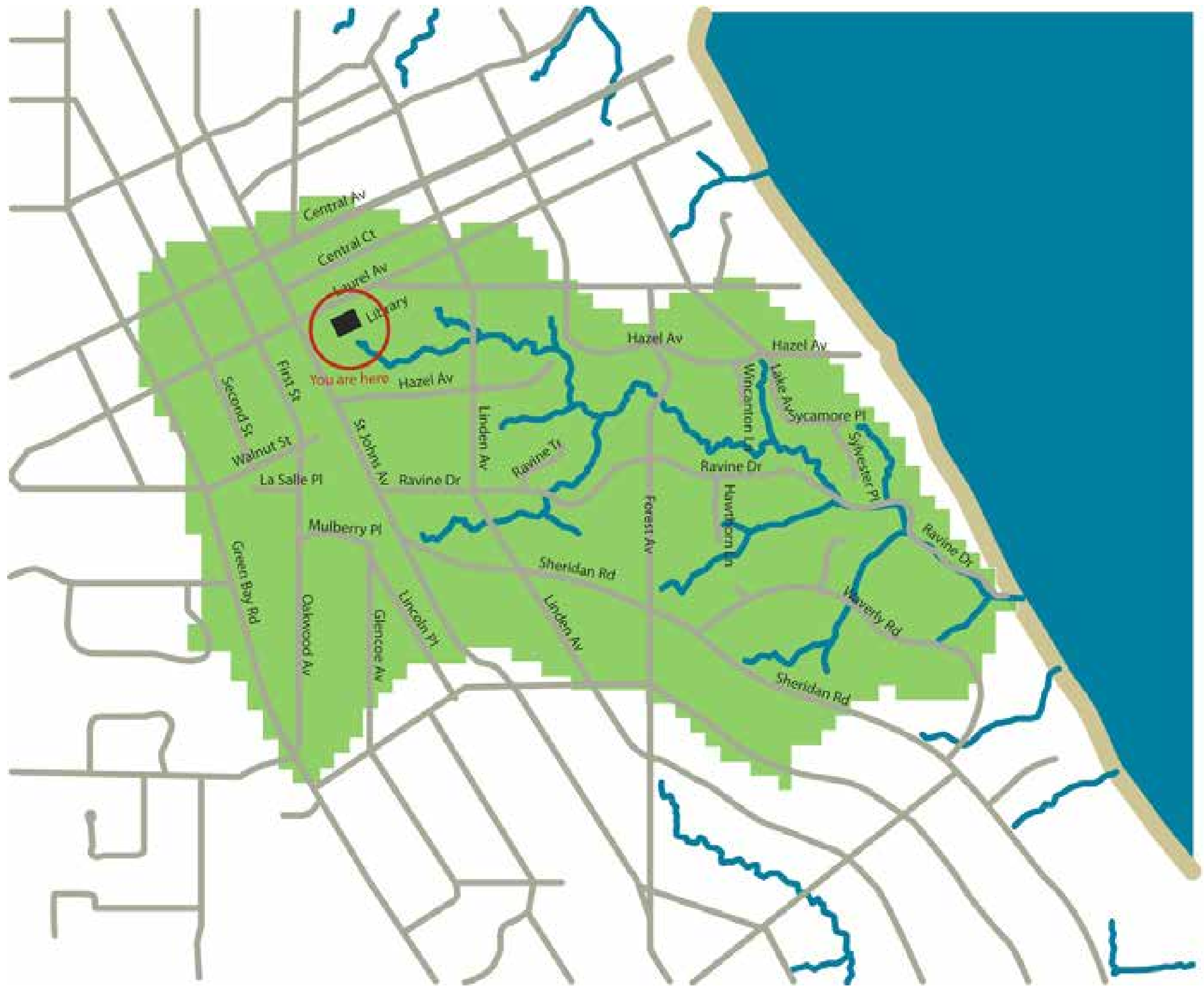


Created by L. Ettelson
January 2016

RAVINE 7L WATERSHED

GIS Data Courtesy of
City of Highland Park
Lake County GIS Mapping Division

Map Your Watershed
Watershed Maps: Ravine 7L Watershed



GIS data courtesy of the City of Highland Park and Alliance for the Great Lakes Strategic Subwatershed Identification Process. Watershed mapping was provided through the Park District of Highland Park using ESRI ArcHydro.

Teacher Page

Map Your Watershed
Major Watersheds of Illinois & the United States

ILLINOIS WATERSHEDS

From the Illinois River Decision Support System
http://www.isws.illinois.edu/data/maps/watershed.pdf

This map displays the major watersheds of Illinois. Note that this map refers to the Pike-Root Watershed of the Northshore as the Lake Michigan Watershed.

To learn more about the individual watersheds of Illinois, use this clickable map:

http://ilrdss.isws.illinois.edu/links/watersheds_all.asp

UNITED STATES WATERSHEDS

From the United States Geologic Survey
http://nhd.usgs.gov/wbd.html

This map shows the major watersheds of the United States. Like most of the major watersheds of Illinois, many of the biggest watersheds in the United States flow into the Mississippi River. These watersheds include the Missouri, Upper Mississippi, the Arkansas White Red, Ohio, Tennessee, and the Lower Mississippi.

Student Page Watershed Scavenger Hunt

NAME: ______________________

DIRECTIONS

Use the maps provided by your instructor to complete the questions in each of the four parts.

Part I: Ravines and Schools of Highland Park

1. List all five ravines on the maps: ______________ ______________

______________ ______________ ______________

2. Which ravine is closest to your school, and how far away is it (in minutes and/or miles)? ______________

3. Which ravine is closest to your home, and how far away is it (in minutes and/or miles)? ______________

4. Which of the four maps has the largest scale, and which has the smallest scale? (Hint: scales are usually at the bottom of the map)

Largest: ______________ Smallest: ______________

Part II: Topographic Map of Ravine 7L

5. One of Ravine 7L's fingers begins near the intersection of St. Johns Road and Sheridan Road, at 680 ft. above sea level. The ravine ends at Lake Michigan. Calculate (in feet) the difference in elevation between the beginning and the end of Ravine 7L. Show your work.

____

6. Why are the contour lines closer together near the ravine than they are in other areas? ______________

____

7. What road goes through Ravine 7L? ______________________________

8. Name at least one map element (something all maps have) that this map is missing. ______________

Watershed Scavenger Hunt

Student Page

Part III: Major Watersheds of Illinois

9. Find Highland Park on the map. Which two watersheds are in Highland Park?

1) ______________________ 2) ______________________

10. If rain falls into the Chicago-Calumet Watershed and reaches the Chicago River, how many watersheds must if flow through before it reaches the Mississippi River? ___

List them: ____

11. All major watersheds of Illinois are connected to the Mississippi River EXCEPT ONE. Which watershed do you think that is?

____

12. Watersheds of Illinois have funny sounding names for many different reasons. Which is your favorite and why?

____

____

Part IV: Major Watersheds of the United States

13. Which body of water does the Mississippi River flow into? ______________

14. Critical thinking: What body of water do the Great Lakes eventually flow into?

____

15. Critical thinking: Some watersheds are connected because they are drained in the same direction. Some watersheds are divided, meaning they drain in different directions. Think about the two watersheds of Highland Park - are they connected or divided, and how do you know?

____

____

Hydrology of the Watershed

Soaking in the Ravines

TIME: 40-60 minutes

GRADES: 4-8

LOCATION: Indoors or outdoors

SAFETY: Students should wear gloves when handling lab materials

KEYWORDS: Absorbent, pervious, impervious, erosion, sediment, runoff, groundwater

MATERIALS:
- ❑ Student pages
- ❑ 100 mL beaker
- ❑ Measuring cups
- ❑ Small rock
- ❑ Sponge
- ❑ Access to running water
- ❑ Paper cups
- ❑ Dishes
- ❑ Filter paper
- ❑ Thumbtacks
- ❑ Water
- ❑ Stopwatch
- ❑ Three trays
- ❑ At least three material samples (e.g., sponge, sand, moss, gravel, soil, clay, turf grass)

GREEN TIP

After the lab, return natural materials to their habitat.

Sedimentation in Ravine 7L

SUMMARY

Students will test absorbency and perviousness of different soils and other surfaces found in nature and urban areas.

OBJECTIVES

Students are able to:
1. Describe the difference between pervious and impervious surfaces;
2. Identify the impacts of impervious surfaces and sedimentation on the ravine ecosystem;
3. Rank materials in order of their ability to hold moisture; and
4. Evaluate several options to find a solution.

BACKGROUND

This activity explores how different surfaces affect the hydrologic cycle in the ravines. Ideally, rainfall slowly infiltrates the **absorbent** soil and moves slowly underground to the stream channel. Soil is a **pervious**, or penetrable surface, allowing water to flow through and absorbing it for a period of time. Like a giant water purifier, the ground cleans and cools water. Additionally, pervious surfaces help to recharge the water supply. Historically, these steady supplies of cold, clean **groundwater** fed ravine streams, resulting in a healthy and balanced ecosystem.

When rainwater falls on **impervious**, or impenetrable, surfaces such as pavement, it can't soak into the ground and instead rushes away as **runoff**.

Runoff causes **erosion**, where soil particles are washed away. This material, called **sediment**, is carried away by moving water as a form of pollution that can alter an ecosystem.

In east Highland Park, sediment and other substances like road salts, lawn chemicals and trash are carried by runoff into ravine streams. When the rain flows all at once into the ravines, it is not available to replenish the stream during drier times.

PREPARATION

Print student pages. Place the following materials at each lab station: scissors, filter paper, three paper cups, dish (to catch water), material samples, measuring cup, and stopwatch. Lastly, place three trays in the back of the classroom for used lab materials. Allow materials to dry overnight instead of discarding them in the garbage.

PROCEDURE

INTRODUCTION: WHAT IS ABSORPTION?

1. Ask students what it means to absorb. If they need a hint, hold up the sponge and remind students of a sponge's purpose [soaking up liquids]. Pour water on the sponge to demonstrate its ability to soak up liquids.

DRAINAGE IN HIGHLAND PARK

In Highland Park, rainfall flows in two directions. West of Green Bay Road, water flows into the Chicago River, on its journey to the Gulf of Mexico through the Mississippi River. East of Green Bay Road, water flows into the ravines, on the way to Lake Michigan. Since many areas of Highland Park are impervious (impenetrable), storms frequently result in the sudden flooding of these waterways due to runoff.

2. Ask students to brainstorm examples of absorbency in nature [e.g., soil, plants, amphibian skin, plant and animal cells].

DEMONSTRATING PERVIOUS AND IMPERVIOUS SURFACES

3. Explain to students that they will explore the ground's ability to soak up water.

4. Hold up the sponge and rock, and ask students to imagine that they are part of the earth's surface. Pretend that the sponge is a forest and the rock is a street.

5. Pour a small amount of water on the sponge, then pour water on the rock. Ask students what happened to the water. Was it absorbed by the forest? Was it absorbed by the street?


Sediment visible in Lake Michigan during a rainstorm

6.Explain that the sponge is a pervious surface that absorbed the water, and the rock is an impervious surface that lets the water run off.

7. Ask students: What does this have to do with nature? Explain that perviousness in nature is very important. Pervious surfaces (like forests, prairies, or gardens) allow water to soak into the ground. This recharges the groundwater supply and purifies the water. Then, over time the groundwater will slowly trickle into rivers and streams. Impervious surfaces cause runoff which leads to erosion, sedimentation and pollution of waterways.

LAB EXPERIMENT: TESTING PERVIOUSNESS OF MATERIALS FOR A PARKING LOT

8. Break students into lab groups (three to four students per group). Distribute the "Soaking in the Ravines" student page and provide them with the follow scenario: The City of Highland Park has a flooding problem on one of their parking lots, and they want to rebuild it. Each group will test the perviousness of three potential parking lot materials.

9. Students begin by setting up lab materials:

- One student uses a thumbtack to poke eight holes in the bottom of each cup. All the holes should be about the same size.
- Another student cuts filter paper into three circles that fit in the bottom of the cups.
- After filter paper and holes are in place, add a material sample to each cup.

10. Collect measurements:

- One student sets the stopwatch for two minutes.
- Another student measures 100 mL of water.
- Hold the first cup over the dish, start the stopwatch and add the water.

11. After five minutes, students measure how much water dripped into the dish and record results.

12. Students repeat steps 10 and 11 with all samples.

13. Students rank the samples in order of perviousness (1=most pervious, 3=least pervious).

14. To check for absorbancy, students press down on the sample to squeeze any remaining water out of the cup, and measure how much water remains.

15. When students finish, discard samples on trays to dry over night. While waiting for other groups to finish, students can begin assessment questions.

SEEING SEDIMENT

Sediment is material that is carried away by water. When moving water erodes soil from one area it carries that soil until the water slows down and settles. We call this process sedimentation. Demonstrate sedimentation by filling a jar with soil and water, and shaking the jar for several seconds. After you stop shaking the jar, sediment will settle out at the bottom of the jar. This is what sedimentation looks like at the bottom of a river or lake. Sedimentation changes the ecosystem. In order to survive these changes organisms living in an area that experiences sedimentation must move or adapt.

CLASS DISCUSSION

16. Discuss the results as a class:
- Which was the most impervious surface?
- How much water flowed through this surface in two minutes?
- Which was the most pervious surface?
- How much water flowed through this surface in two minutes?
- Did any surface continue to hold water after the test was over?

17. Which of these surfaces would help support the health of ravine systems? Why?

ASSESSMENT

Ask students the following:
- What is the difference between pervious and impervious surfaces?
- Which of the surfaces you measured during the lab would create the most runoff after a rainstorm?
- Name two negative impacts of runoff in your community.
- List three areas in Highland Park or near your home that are pervious surfaces, and three that are impervious.
- Pick one of these impervious areas. How could these be changed to be more pervious?

Check student pages for completion.

EXTENSIONS

SIMULATION: LET THE WATER SOAK!

In the Lake Michigan Watershed, the ravines drain land that is between 20-48% impervious. In the Ravine 7L drainage, 26% of the land is covered by impervious surfaces. The City of Highland Park appreciated the students' parking lot assessments and now needs innovative solutions that would improve stormwater management in Highland Park. Use the list of resources to identify possible techniques.

HOW MUCH IS PERVIOUS?

Distribute the "How Much is Pervious?" student page. Direct students to use colored pencils and a ruler to measure the area of pervious and impervious surfaces.

ORCHESTRATING A SOLUTION

Refer to the "Orchestrating a Solution" section later in this guide to learn about an innovative stormwater management techniques in Highland Park.

RESOURCES

Chicago Sustainable Backyards Program (native plants, trees and shrubs, compost, rain barrels): Accessed May 8, 2013.

Overview of different pervious surfaces (Permeable pavements, cisterns, and green roofs): www.bae.ncsu.edu/stormwater/PublicationFiles/BMPs4LID.pdf Accessed May 8, 2013.

Description of Rain Gardens: www.kidsgardening.org/node/76298 Accessed May 8, 2013.

SOURCES

Ravine Erosion Control - Sediment/Nutrient Transport Reduction Through Vegetative Stabilization, Charles W. Shabica, Draft Report to the Great Lakes Commission, Dept. of Public Works, City of Highland Park, IL 1996. http://projects.glc.org/basin/pubs/projects/ILravine.pdf

United States Geological Survey. National Water Information System. Skokie River Near Highland Park, IL. http://waterdata.usgs.gov/nwis/ Accessed May 8, 2013.

STANDARDS

SCIENCE (NGSS)
4-ESS2-1, 4-ESS3-2, 5-PS1-3, 5-ESS2-1, 5-ESS3-1, 3-5-ETS1-2, 3-5-ETS1-3, MS-LS2-5, MS-ESS2-2, MS-ESS2-4, MS-ESS3-1, MS-ESS3-3, MS-ETS1-1, MS-ETS1-2

ENGLISH LANGUAGE ARTS (CCSS)
RST.6-8.3, RST.6-8.4, WHST.6-8.1, WHST.6-8.2d, WHST.6-8.4

MATHEMATICS (CCSS)
4.MD.A.1, 4.MD.A.2, 4.MD.A.3, 6.NS.A.1, 6.NS.B.3, 6.SP.B.5

Soaking in the Ravines

Student Page

NAME: ____________________

DIRECTIONS

The City of Highland Park needs your help! Complete the experiment procedure below to determine which of these materials would help decrease flooding of parking lots in Highland Park. Record your data in the spaces provided and answer discussion questions at the end of the procedure.

EXPERIMENT

1. Prepare materials:
   - One person uses a thumbtack to poke eight holes in the bottom of each cup. Try to make all the holes the same size.
   - One person uses scissors to cut filter paper into three circles that fit in the bottom of the cups.
   - Place filter circles in the bottom of the cups. After filter paper and holes are in place, add a material sample to each cup.

2. Collect measurements:
   - One student should set the stopwatch for two minutes.
   - Another student should measure 100 mL of water.
   - Hold the first cup over the dish, start the stopwatch and add the water.
   - Stop the stop watch after water stops dripping, or after two minutes.

3. After five minutes has passed, measure how much water dripped into the dish, by pouring it back into the beaker. Record results.

4. Repeat steps 2 and 3 with all samples.

5. Rank the samples in order of perviousness (1= most pervious, 3=least pervious).

DATA TABLE ONE

Sample	How much water soaked through?	How long did it take to soak through?	Perviousness Ranking
1.			
2.			
3.			

Soaking in the Ravines

Student Page

NAME: ______________________

6. To check for absorbance, press down on the sample to squeeze any remaining water out of the cup, and measure how much water remained.

DATA TABLE TWO			
Sample	**Was there any water remaining?**	**How much water remained?**	**Absorbency Ranking**
1.			
2.			
3.			

When you are finished, discard samples on trays to dry over night. While other groups finish, begin responses to discussion questions.

1. Which sample was:

    the most pervious? ______________________

    the least pervious? ______________________

    the most absorbent? ______________________

    the least absorbent? ______________________

2. Which sample, or samples, should be used to build a new parking lot, and why?

____

____

3. What might be some of the challenges of using this material?

____

____

4. Are there other materials that you think the City could test?

____

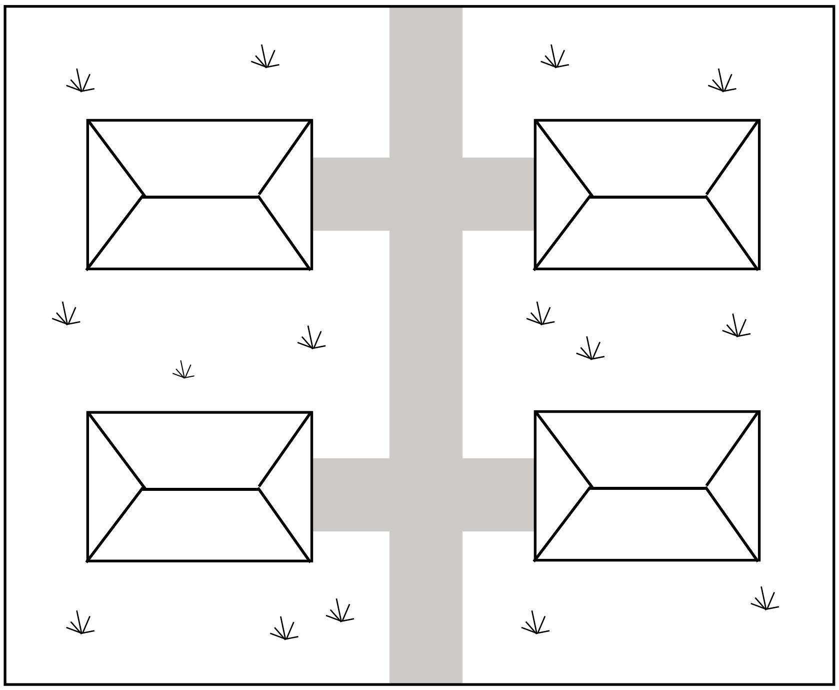
Student Page

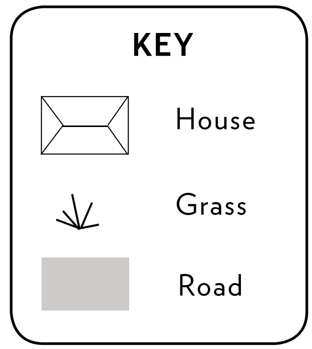
How Much is Pervious?

NAME: ______________________

DIRECTIONS

Use a green colored pencil to color all the pervious surfaces in this neighborhood. Use a gray colored pencil to color all the impervious surfaces. Use a ruler to measure the area, in square centimeters, of the surfaces to answer the questions below.





1. What percent of the neighborhood is pervious? ____ %

2. What percent of the neighborhood is impervious? ____ %

3. How could more pervious surfaces be created?

____

____

____

RAVINE Education Program

Measuring Stream and Biotic Health

Let's Be Clear

TIME: 30-45 minutes

GRADES: 4-6

LOCATION: Indoors with Park District of Highland Park Educator

SAFETY: Remind students that under no condition are lab supplies fit for consumption.

KEYWORDS: Transparent, translucent, opaque, turbidity, tolerance, suspended solids, benthic, macroinvertebrates

MATERIALS:

- ❑ Big sediment stick
- ❑ 2-liter pop bottle sediment sticks or graduated cylinders
- ❑ TSS conversion table
- ❑ Sports drink
- ❑ Chocolate milk
- ❑ Water


Measuring turbidity in Ravine 7L

Note: This lesson plan should be taught by guest instructors from the Park District of Highland Park.

SUMMARY

In this activity, students explore the concept of turbidity and how it impacts aquatic organisms. Students measure turbidity in several fictitious water samples and come to conclusions about how these turbidity levels would impact different organisms.

OBJECTIVES

Students are able to:

1. Measure the turbidity of several liquids;
2. Understand conditions and actions that change turbidity levels; and the amount of total suspended solids; and
3. Understand that turbidity is one of several water quality factors that determine whether or not certain species of fish will live in certain rivers, streams, and lakes,

BACKGROUND

High **turbidity** in a body of water can impair water quality and decrease its visual appeal to recreation users. The more turbid a water body, the more **suspended solids** it contains. Suspended solids absorb more heat, thus higher turbidity leads to warmer water temperatures. High turbidity reduces dissolved oxygen (DO) concentrations because warmer water holds less DO than cold water.

TEST	WHAT IS MEASURED?	TESTING METHOD	UNITS OF MEASUREMENT
Turbidity	Light passing through the water column (i.e., relative clarity)	For streams: Sediment stick For lakes: Secchi disk	Inches, feet, or meters of visibility
Total Suspended Solids	Includes silt and clay particles, plankton, algae, fine organic debris, and other particulate matter within a volume of water	Use turbidity data in conversion table	Milligrams per liter (mg/L)

Because suspended solids reduce the clarity of water, aquatic plants at the bottom of rivers, lakes or streams receive less light. This leads to decreased photosynthesis and thus lowers production of DO.

Suspended solids directly affect some fish species by clogging gills, reducing disease resistance, lowering growth rates, and affecting egg and larval development. Several fish species, such as carp, are very tolerant of high turbidity, while other fish species, such as trout, have less **tolerance**.

In slow moving waters the suspended solids settle over time in the **benthic** (bottom) region. This reduces access to DO and can suffocate organisms that live in the benthic region, including fish eggs and **macroinvertebrates** (invertebrates large enough to be seen without a microscope). Many fish species rely on these macroinvertebrates for food.

Sources of stream turbidity include:

- Soil erosion
- Waste discharge
- Urban runoff
- Large numbers of bottom feeders (such as carp), which stir up bottom sediments
- Phytoplankton/algae
- Re-suspended sediment, from wave action

The Turbidity Measurement Scale on the following page can be used to measure turbidity with elementary-aged students.

HOW MUCH TURBIDITY CAN THEY TAKE?

This chart shows the tolerances of several fish species found in the Great Lakes. Many of these species tolerate turbidity for short periods of time. This chart shows tolerances over an extended period of time (several days or more). Bold indicates that the species have been observed in a Highland Park ravine.

TOLERANT	MODERATELY TOLERANT	MODERATELY INTOLERANT	INTOLERANT
Alewife Goldfish Common carp Yellow perch	Northern pike Walleye Bluegill Largemouth bass Smallmouth bass Round goby **White sucker**	**Threespine stickleback** Tadpole madtom **Longnose dace** Brown trout	Brook stickleback Brook trout **Rainbow trout**

From Trebitz et. al, 2007. Classification of all trout and Longnose dace from Lyons, 2013.

PREPARATION

Secure supplies. Upon arrival into the classroom, draw the Turbidity Measurement Scale on a chalkboard or whiteboard. Fill turbidity tubes with liquids, until the dots are barely visible. Label the tubes Liquid 1, Liquid 2, and Liquid 3.

PROCEDURE

EXPLORE TURBIDITY

1. Ask students if they like to go fishing or eat fish *or drink water*. If they do, this will be important to them because this activity involes measuring something that impacts fish. Explain that there are several tools that scientists use to measure water quality in lakes and streams. These tools help determine what organisms will survive in an area.

2. Explain to the students that they will learn a new word: turbidity. Ask if anyone has heard this word. Explain that turbidity is how clear or cloudy the water is.

3. Ask students why cloudy water could harm fish. [clogs gills, buries eggs, makes water warmer, and holds less oxygen, which fish need to breathe] Could cloudy water be good for fish? [Yes! Some species of fish filter nutrients out of water. Sometimes cloudy water means that nutrients are present.]

4. Ask students to guess what causes turbidity in a stream. [target answers include dirt, sand, mud, sediment, algae]

MEASURING TURBIDITY

5. Explain that it is important to monitor turbidity in the streams and along the shoreline of Lake Michigan because this is where many small fish live. If sediment levels are high, it can harm the fish, their young and their food.

6. Tell students that the Park District of Highland Park measures turbidity in streams, because these streams carry sediment to Lake Michigan.

TURBIDITY MEASUREMENT SCALE	
Turbidity	**Water clarity**
26 inches or more	**Transparent – excellent water quality**
4-26 inches	**Translucent – good to moderately impaired water quality**
4 inches or less	**Opaque – poor, severely impacted water quality**

Adapted from the Lake County, Ohio, Sediment Stick Field Sheet.

Secchi disk in Lake Michigan

TURBIDITY MEASUREMENT TOOLS

Scientists often measure turbidity with expensive meters that provide data instantaneously but there are two other measurement tools that anyone can use!

1) A **sediment stick** is demonstrated in this lesson. Sediment sticks are used to measure turbidity in small streams.

2) Another measurement tool is the **Secchi disk**, which is generally used to measure turbidity in lakes or other large bodies of water.

Sediment Stick

Show students the sediment stick, which is one tool used to measure turbidity.

- Show the students the dot on the bottom of the empty sediment stick and the markings on the side.
- Pour a sample liquid very slowly into the sediment stick, stopping occasionally to check the dot, until it is no longer visible.
- The higher the liquid (more inches of liquid) in the stick, the clearer the water is.

7. Ask students if they have heard the words **transparent, translucent**, and **opaque**. If so, ask what these words mean. Explain that they can be used to describe different levels of turbidity. If a stream's water is opaque, it is highly turbid and only turbidity tolerant fish can survive in it for an extended period of time. If it is transparent, fish that don't like turbidity could live in the stream. Fish eggs are more vulnerable during short periods of high turbidity (i.e., after a flood) because, unlike adult fish, they cannot swim to other areas.

INVESTIGATE TURBIDITY

8. Explain to students that they will test the turbidity of several liquids, pretending that they are water samples from different streams.

9. Pass out "How Turbid is the Water?" student pages to each student. Direct students to measure the three samples in turbidity tubes.

10. After students measure the three samples, show the transparent water sample in the sediment stick, where more accurate readings can be made.

11. When students finish the investigation they should begin to answer student page questions.

WRAP-UP

12. Ask students to discuss the following wrap-up questions:

- Could fish survive in any of these samples? [High turbidity tolerant fish might tolerate the impacted samples, low turbidity tolerant fish might be able to tolerate the water sample.]
- Do you think fish could survive in the clear water? [Maybe, maybe not]
- Could there still be pollution that cannot be seen? [yes] We would have to test other aspects of water quality to be sure. [temperature, pH, dissolved oxygen, dissolved solids, and salinity] Also, in nature crystal clear water isn't always a good thing for fish, because it means there is not much plankton in the water, so there is a smaller base for the food chain.
- What do you think the water samples are actually made of? [Once they guess have students vote as to whether or not the fish would survive.]

FILTER FEEDERS

The zebra mussel and the quagga mussel have disrupted lake ecosystems by filter feeding and eating all the phytoplankton in the water. These invasive mussels make the water clearer and prettier, but decrease the available food and nutrients for other species.

We can prevent these mussels and other invasive species from spreading to new areas in the Great Lakes region by washing our boats. The Illinois-Indiana Seagrant education programs spread the word about invasive species to recreational boaters. They even have have volunteers to wash boats! To learn more about this work visit: www.iiseagrant.org/ais/transportzero.php

EXTENSIONS

CREATE A SEDIMENT STICK

Supplies: Pop bottle, permanent marker, ruler

1. Remove packaging and label from pop bottle
2. Using the permanent marker, draw a dot on the bottom of the pop bottle.
3. Cut off the top of the bottle, creating a cylinder with an open end.
4. Using the ruler, make a mark for every inch starting at the bottom.
5. At this point, your pop bottle has transitioned into a sediment stick! Go collect samples and test for turbidity.

CONVERT TO TOTAL SUSPENDED SOLIDS (TSS)

For 6-8th grade

Use the "Turbidity to Total Suspended Solids Conversion Chart" to convert the results to Total Suspended Solids (TSS).

Then, use the "Water Quality & TSS" chart to determine how samples' water quality.

WATER QUALITY & TSS	
EXCELLENT water quality	TSS < 10 mg/L
NORMAL water quality	TSS 10-28 mg/L
IMPAIRED stream quality	TSS 29-133 mg/L
SEVERLY IMPACTED stream quality	TSS > 133 mg/L

TURBIDITY TO TOTAL SUSPENDED SOLIDS CONVERSION CHART

Stick(inches)= TSS(mg/L)	Stick(inches)= TSS(mg/L)	Stick(inches)= TSS(mg/L)
0.5=1751	10=34	24=11
1=702	11=30	25=20
1.5=411	12=27	26=10
2=282	13=24	27=9
2.5=210	14=22	28=9
3=165	15=20	29=8
3.5=135	16=18	30=8
4=113	17=17	31=8
4.5=97	18=16	32=7
5=84	19=14	33=7
6=66	20=14	34=7
7=54	21=13	35=6
8=45	22=12	≥36=<6
9=39	23=11	

VISIT THE FIELD!

Visit one of the Park District of Highland Park's ravine locations. Using a sediment stick or a Secchi disk, compare turbidity levels in the ravine to the turbidity of Lake Michigan. For locations, visit www.pdhp.org/ravines-project/.

ASSESSMENT

Check student page for completion.

RESOURCES

Read about how scientists measure turbidity in the field on the websites for the U.S. Environmental Protection Agency and the U.S. Geological Survey.

- EPA: www.epa.gov/national-aquatic-resource-surveys/indicators-water-clarity
- USGS: http://water.usgs.gov/edu/turbidity.html

SOURCES

Fieldsheet for the Ohio sediment stick. Ohio DNR Division of Soil and Water Conservation. http://www.raingardeninitiative.org/images/ohio_sediment_stick.pdf Accessed June 24, 2013.

John Lyons, Wisconsin Department of Natural Resources. Personal communication, 2013.

Trebitz, A.S., J.C. Brazner, V.J. Brady, R. Axler, and D.K. Tanner. (2007). Turbidity tolerances of Great Lakes coastal wetland fishes. *North American Journal of Fisheries Management.* 27:619-633.

Water Monitoring and Assessment: 5.5 Turbidity. U.S. Environmental Protection Agency. www.epa.gov/national-aquatic-resource-surveys/indicators-water-clarity Accessed May 8th, 2013.

STANDARDS

SCIENCE (NGSS)

4-ESS2-1, 4-ESS3-2, 5-PS1-3, 5-ESS3-1, 3-5-ETS1-3, MS-LS1-5, MS-LS2-4, MS-LS2-5, MS-ESS3-3

ENGLISH LANGUAGE ARTS (CCSS)

CCRA.R.7, CCRA.W.2, RST.6-8.3, RST.6-8.4, WHST.6-8.2d

MATHEMATICS (CCSS)

4.MD.A.1, 5.MD.A.1, 6.EE.C.9, 7.EE.B.3, 6.SP.B.5

How Turbid is the Water?

Student Page

NAME: ____________________

DIRECTIONS

Use the table below to decide how cloudy the water samples are. How many inches does it take until you can no longer see the black dot at the bottom of the sediment stick?

TURBIDITY	WATER QUALITY
26 inches or more	Transparent
4-26 inches	Translucent
4 inches or less	Opaque

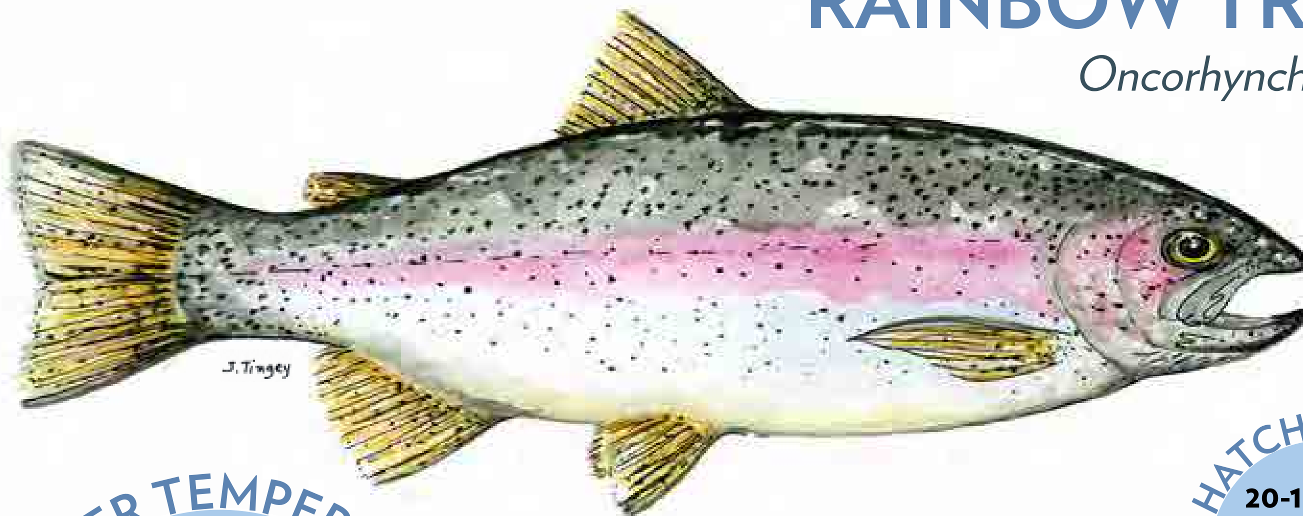
WATER SAMPLE	TURBIDITY *(How many inches?)*	WATER QUALITY *(How healthy is the water?)*
Example Liquid	*7 inches*	*Translucent*
Liquid 1		
Liquid 2		
Liquid 3		

Fish Habitat Preferences

Visual Aid

RAINBOW TROUT

Oncorhynchus mykiss



SUMMER TEMPERATURE

Rainbow trout

12-18 °C / 53-64 °F (adult)
10-15.5 °C / 50-60 °F (spawning)

White sucker

18-25 °C / 64-77 °F (adult)
12-16 °C / 54-61 °F (spawning)

pH

6.0-8.5
Rainbow trout

White sucker
6.0-9.0

TURBIDITY*

Intolerant
Rainbow trout

White sucker
Moderately tolerant

HATCHING TIME

20-100 days
Rainbow trout

White sucker
5-7 days

DISSOLVED OXYGEN

Rainbow trout

5-6 mg/L (normal activities)
7 mg/L (spawning)
11 mg/L (eggs and larva)

White sucker
≥6 mg/L
(normal activities)

WHITE SUCKER

Catostomus commersonii

* Turbidity tolerance is in reference to turbidity levels encountered over several days or more

Information from:
John Lyons, Wisconsin Department of Natural Resources. Personal communication, 2013.
Raleigh, R. F., T. Hickman, R. C. Solomon, and P.C. Nelson. 1984. Habitat Suitability information: Rainbow Trout. U.S. Fish Wildl. Serv. FWS/OBS-82/10.60. 64 pp
Twomey, K., K. Williamson, P.C. Nelson. 1984. Habitat suitability index models and instream flow suitability curves: White Sucker. U.S. Fish Wildl. Serv. FWS/OBS-82/10.64. 70 pp.

Park District of Highland Park

RAVINE Education Program

Measuring Stream and Biotic Health

Take a Deep Breath

TIME: 40-60 minutes

GRADES: 6-8

LOCATION: Indoors with Park District of Highland Park Educator

SAFETY: Handle PCSTesters and DO meter with great care

KEYWORDS: Dissolved oxygen (DO), solution, solute and solvent

MATERIALS:

- ❑ Oxygen bubble machine
- ❑ DO meter
- ❑ Straws
- ❑ Stir sticks
- ❑ Seltzer tablets
- ❑ Water samples
- ❑ Containers for water samples (at least 4.5 inches in height)
- ❑ Towel
- ❑ Thermos (or access to microwave)
- ❑ Student sheets

Note: This lesson plan should be taught by guest instructors from the Park District of Highland Park.

SUMMARY

In this lesson, educators from the Park District of Highland Park lead students through an exploration of dissolved oxygen (DO). Students will learn how oxygen becomes dissolved in water, how dissolved oxygen is measured, and how it impacts animals that live under water.

OBJECTIVES

Students are able to:

1. Explain how fish breathe;
2. Explain how water takes up dissolved oxygen;
3. Measure dissolved oxygen and temperature in several water samples; and
4. Demonstrate an understanding of situations that increase or decrease dissolved oxygen in water, including the relationship between dissolved oxygen and temperature.

TEST	WHAT IS MEASURED?	TESTING METHOD	UNITS OF MEASUREMENT
Dissolved Oxygen	Oxygen is measured in its dissolved form as dissolved oxygen (DO). The stream ecosystem produces and consumes oxygen.	Optical Dissolved Oxygen Meter	Milligrams per liter (mg/L) Parts per million (ppm)
Temperature	Temperature affects rates of chemical and biological processes	Optical Dissolved Oxygen Meter or Thermometer	Degrees Celsius (°C) Degrees Fahrenheit (°F)

BACKGROUND

The air we breathe is 21% oxygen, but water contains less than 1% dissolved oxygen, so little that it is measured in parts per million. A stream ecosystem both produces and consumes **dissolved oxygen** (DO). DO is an example of a gas (oxygen) dissolved in a liquid (water). There are several ways in which this happens.

The primary source of DO in water comes from the atmosphere. Oxygen in the air is attracted to empty spaces in water molecules at the surface. Because water movement (e.g., wind, waves, riffles, falling water) mixes water and exposes more water to the air, moving water such as streams and large lakes have higher concentrations of DO than stagnant water bodies like small ponds. Within streams, areas in and below riffles or waterfalls generally have higher DO than pools and slower moving stretches.

Water also gains oxygen from aquatic plants as they conduct photosynthesis.

DO is consumed primarily through animal and plant respiration and decomposition of organic matter (e.g., leaves, dead plants or animals, animal droppings, dead algae) by bacteria and fungi in the stream.

Temperature also plays an important role in water's ability to retain oxygen. Since higher temperature excites molecules, oxygen will more readily escape into the atmosphere from warm water than from cold water.

Oxygen also dissolves more easily in water without dissolved solids (like salt) or suspended solids (like sediment). For example, waters with high salinity have lower DO concentrations than freshwater bodies. However, runoff can carry salt and sediment into freshwater bodies and lower DO levels.

In Highland Park ravines, DO is measured where fish are likely to take shelter. Rainbow trout and White suckers both require about 5-6 mg/L DO for normal activity.

DEAD ZONES

Hypoxic zones are areas of water where little to no dissolved oxygen is present. Scientists often call these areas "dead zones" because they cannot support respiring organisms. Dead zones very rarely occur in rivers and streams, but have been documented in lakes, reservoirs, and oceans. They are a common occurrence in the Gulf of Mexico because of the vast amount of fertilizer, sewage, and soil nutrients draining from the Mississippi River. Over the past decade Lake Erie has also experienced dead zones in the summer months.

For more information on hypoxic zones, visit: http://water.epa.gov/type/watersheds/named/msbasin/hypoxia101.cfm.

PREPARATION

Print enough "Measuring DO" student pages for all students.

Before the lesson, select two tables in the back of the classroom. At one table, set up the Oxygen Bubble Machine. To reduce tripping hazards, this table should be near a wall. At a second table, place water sample containers, and label containers. Add ice cubes to cold water samples, and microwave the warm water sample. Stir sticks should be available for the agitation samples. Finally, ensure that the DO meter is in a safe place.

PROCEDURE

EXPLORATION: DISSOLVED OXYGEN

1. Explain to students that they will be learning about water today. Ask students:

- What do you know about water? [answers will range]
- What is water made of? [Hydrogen and oxygen]
- Is water a solution? [usually]

2. Define vocabulary words on chalkboard or whiteboard:

- What is a **solution**? [a homogenous mixture of two or more substances; a solution is made up of a solute and a solvent]
- What is a **solute**? [a substance that is dissolved by another substance]
- What is a **solvent**? [a substance that dissolves another substance]
- Examples? [salt or sugar in water, oxygen in water]

3. Instructor explains that today the class will learn about how a gas (oxygen), dissolves in a liquid (water) forming a solution called dissolved oxygen (DO). DO is very important for aquatic organisms.

4. Write the following equation on the board: **H2O +O2 + X**. O is oxygen, and X is a variable representing any other solute. Ask students to name other substances that might be dissolved in water [carbon dioxide, nitrogen, salt and chlorine].

5. Ask students why oxygen is so important to animals like fish. [They need oxygen to breathe.] Explain that animals breathe oxygen to help their cells produce energy to survive.

6. Ask students how fish breathe. Specifically, do they breathe the O in H2O? [No! Fish do not separate the oxygen atoms from water molecules, instead they take up oxygen that is dissolved in water. Fish open their mouths to fill them with water. When they close their mouths it pushes water out through their gills. As the water passes over the gills, the dissolved oxygen is absorbed by the many blood vessels in the gills, and oxygen moves through the fish's body.]

7. Explain how DO can change in water. Encourage students to brainstorm with their neighbors.

Answers should include:

- Photosynthesis increases DO. (Hint: What makes oxygen? DO has a daily cycle. It is usually lowest right before sunrise because plants respire at night and there is no photosynthesis.)
- Moving water increases DO. (Hint: Oxygen from the air can mix into water.)
- Rising temperatures decrease DO while falling temperatures increase DO. (Hint: boiling water)
- Decomposition uses up oxygen, and decrease DO. (Hint: Fertilizer that drains from farms into the Mississippi River and then the Gulf of Mexico creates "dead zones.")
- Ice cover decreases DO. (Hint: Wind and waves mix oxygen into the water at the surface.)

8. Ask students what they think happens when there is no DO in the water. [Animals must move to a new area.

If they don't, they will not survive.]

9. Each animal has a tolerance level. Show students the "Fish Habitat Preferences" visual aid with tolerance levels of the *Catostomus commersonii* (White sucker) and *Oncorhynchus mykiss* (Rainbow trout).

INVESTIGATION: TESTING DO IN WATER SAMPLES

10. Explain to students that they will test the temperature, and DO of five water samples: 1) cold water, 2) cold and shaken water, 3) heated water, 4) seltzer water, and 5) water in the Oxygen Bubble Machine. For the 6th trial, instructor may consider taking students outside to collect another sample OR having students blow bubbles through straws while measuring a sample with the DO meter.

11. While assigning groups, instructor should heat warm water samples in microwave. Also, pick a volunteer agitator – someone who is good at agitating things!

12. Distribute the "Measuring DO" student page and conduct the first trial as a class. Students should record results on the student sheet.
13. In small groups, student rotate through stations to complete the following activities:

- Station 1: Use the DO meter to measure the DO and temperature of the five samples.
- Station 2: Study the Oxygen Bubble Machine and create a sketch of it on the back of student sheet. Label bubbles breaking above the surface and bubbles breaking below the surface. Students should not touch the machine unless otherwise directed.
- Station 3: Sit at desks and work on student worksheet or another short assignment.

WRAPPING UP

14. Ask students whether their results were the same or different. [Answers may differ between groups depending on amount of agitation and cooling of warm water samples.]
15. Review answers to the student page. Ask what other tests should be conducted to ensure that the fish could survive in these samples. [turbidity, pH, conductivity, etc.]

EXTENSIONS

FIELD STUDY: DISSOLVED OXYGEN

Take the DO meter into the field to test water near your school or nature center. Add these water samples to the study.

INVESTIGATE DEAD ZONES

Instruct students to research hypoxia. What types of problems might hypoxia cause for plants and animals in a region? What about the people living in that region?

ADOPT THE OXYGEN BUBBLE MACHINE!

This machine can be used in your classroom over time to perform additional experiments on dissolved oxygen. Upon


The Oxygen Bubble Machine, available at the Park District of Highland Park

request, the Park District of Highland Park can point you in the direction of inexpensive dissolved oxygen testing materials.

ASSESSMENT

Students should complete the student page.

RESOURCES

Measuring Dissolved Oxygen
For information on dissolved oxygen, visit the U.S. EPA's website on dissolved oxygen: www.epa.gov/national-aquatic-resource-surveys/indicators-dissolved-oxygen

Hypoxia
For maps, charts, and more information on hypoxia, visit: http://www.epa.gov/ms-htf/hypoxia-101

Temperature Tolerance
For more information on temperature tolerances: www.water.ncsu.edu/watershedss/info/aqlife.html#suckertemp

Factsheet on Dissolved Oxygen
www.pca.state.mn.us/sites/default/files/wq-iw3-24.pdf

Visualizing the Dissolved Oxygen Cycle:
This website provides a diagram of processes that increase or decrease DO in a body of water.
http://omp.gso.uri.edu/ompweb/doee/science/physical/choxy1.htm

Exploring Dissolved Oxygen and Temperature
This website provides additional information on DO, including a graph of temperature and DO fluctuations throughout one year at a study site in New Jersey.
http://water.usgs.gov/edu/dissolvedoxygen.html

How do Fish Breathe?
Take a closer look at fish gills and learn about one of the differences between fish and sharks.http://tpwd.texas.gov/kids/wild_things/fish/howdofishbreathe.phtml

SOURCES

Water Monitoring and Assessment: Dissolved Oxygen . U.S. Environmental Protection Agency. www.epa.gov/national-aquatic-resource-surveys/indicators-dissolved-oxygen.

Accessed May 8th, 2013.

Twomey, K., K. Williamson, P.C. Nelson. 1984. Habitat suitability index models and in stream flow suitability curves: White sucker. U.S. Fish Wildl. Serv. FWS/OBS-82/10.64. 70 pp.

Raleigh, R. F., T. Hickman, R. C. Solomon, and P. C. Nelson. 1984. Habitat suitability information: Rainbow trout. U.S. Fish Wildl. Serv. FWS/OBS-82/10.60. 64 pp.

STANDARDS

SCIENCE (NGSS)
4-ESS3-2, 5-PS1-3, 5-PS1-4, 5-ESS3-1, 3-5-ETS1-3, MS-PS1-2, MS-PS1-4, MS-LS1-5, MS-LS2-4, MS-LS2-5, MS-ESS3-3

ENGLISH LANGUAGE ARTS (CCSS)
CCRA.R.7, CCRA.W.2, CCRA.W.4, RH.6-8.7, RST.6-8.3, RST.6-8.4, WHST.6-8.1, WHST.6-8.2d, WHST.6-8.4

MATHEMATICS (CCSS)
4.MD.A.1, 5.MD.A.1, 6.EE.6.9, 6.SP.B.5

Measuring DO

Student Page

NAME: ______________________

DIRECTIONS

In your group, complete the data table below. Your instructor will assist as you use the dissolved oxygen (DO) meter. PLEASE HANDLE THE METER WITH GREAT CARE.

- Submerge the tester probe to mid-depth in the water
- Allow the reading to stabilize
- Read and record the temperature measurement while the meter remains in the water

Sample	Temperature (°C or °F)	Dissolved Oxygen (mg/L or ppm)
1. Cold water		
2. Warm water		
3. Cold & agitated water		
4. Seltzer Water		
5. Oxygen Bubble Machine		
6.		

1. Which sample had the highest level of dissolved oxygen? Why?

____

____

2. Which samples had a suitable level of dissolved oxygen for White suckers and Rainbow trout to spawn?

____

____

3. Do you observe a relationship between temperature and dissolved oxygen? If so, explain.

____

____

4. Do you expect that White suckers and Rainbow trout could survive in these water samples? Why or why not?

____

____

A Matter of Balance

TIME: 10-20 minutes at ravine, 20-30 minutes in class, 2-4 days of daily observations

GRADES: 4-8

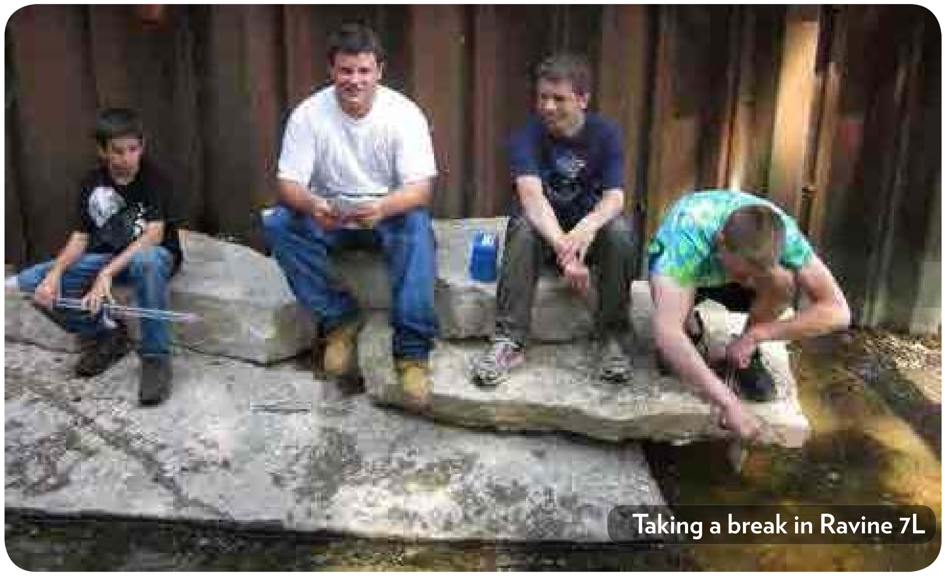
LOCATION: Ravine and Indoors

SAFETY: Use gloves and other appropriate lab equipment when measuring pH of liquids.

KEYWORDS: pH, alkalinity, acidity, neutral

MATERIALS:

- ❑ Ravine map (a topographic map of Ravine 7L at Millard Park is available on page 24)
- ❑ pH strips with color key
- ❑ Various liquids for pH measurement (vinegar, orange juice, lemon juice, tap water, baking soda & water, window cleaner, milk, olive oil, etc.)
- ❑ Three small potted plants
- ❑ Three beakers or pint jars


Taking a break in Ravine 7L

SUMMARY

In this lesson students explore the concept of pH, testing local water samples as well as common household substances. Students also model the impact of acid rain on plants.

OBJECTIVES

Students are able to:

1. Measure pH at several sites within the ravine;
2. Understand conditions in nature that change pH; and
3. Model the effect of acid rain on plants.

BACKGROUND

pH indicates the **alkalinity** or **acidity** of a substance. pH is measured on a scale of 0 to 14, where acidity increases as the pH gets lower and alkalinity increases as pH gets higher. What does this scale actually mean?

pH measures the concentration of hydrogen ions (H+) and hydroxide ions (OH-). When these two types of ion have equal concentration, the substance is **neutral**, with a pH of 7.0. Pure water is a neutral substance, since it has the same number of

TYPE OF SUBSTANCE	HYDROGEN IONS (H+)	HYDROXIDE IONS (OH-)	pH
Acidic	More than 50% of ions	Less than 50% of ions	Less than 6
Neutral	About 50% of ions	About 50% of ions	6-8
Alkaline (basic)	Less than 50% of ions	More than 50% of ions	More than 8

hydroxide ions and hydrogen ions. The pH scale is logarithmic, so dropping the pH of a substance by 1.0 makes the new substance 10 times more acidic. For example, a substance with a pH of 5 is 1,000 times more acidic that a substance with a pH of 8.

In nature, pH affects many chemical and biological processes, especially in water. Different organisms have different preferred levels of pH. For example, many aquatic animals can withstand pH within a range of 6.5-8.0. If an organism experiences pH outside its range of tolerance for an extended period of time it can cause harm to the organism and possibly reduce reproduction. pH can be impacted by several factors, including acid rain, runoff, wastewater discharge, and even surrounding rocks.

PREPARATION

Instructors may collect water samples before implementing the lesson, though instructors are encouraged to involve students in the sample collection process. If students are able to accompany instructors to the ravines, the pH test can be completed on site without collecting samples.

When completing the inside portion, instructor should set up stations with six different substances for students to test pH. Label each substance "Substance 1," "Substance 2," "Substance 3," etc.

PROCEDURE

WATER SAMPLE COLLECTION

1. Using a ravine map, select four locations to collect samples. One sample should be taken from the lake. Mark sample locations on ravine map. Select locations where samples can be collected with minimal impact on the plants growing near the stream.

2. Collect samples in clean water bottles or jars.

MEASURING pH

3. Explain that pH is a measurement that helps determine whether certain plants and animals can live in a habitat. Specifically, pH is a way to measure the ratio of ions in a chemical compound.

4. Distribute "A Matter of Balance" student pages. Students should measure pH of the samples and additional substances at each station.
- Immerse pH strip in water for 10-15 seconds.
- Remove pH strip, match to the pH color chart, and record the reading on the Student Page.
- Rotate to another station.

5. Review pH findings with students. What was the pH and what does this mean about the stream's health? [Hint: Optimal pH range is 6.0-8.0.]

6. Discuss these questions:
- Would the pH of these samples be ideal for a healthy aquatic ecosystem?
- If yes, would they meet the other criteria for a healthy ecosystem? (e.g., temperature, total suspended solids, dissolved oxygen, conductivity, and total dissolved solids)

TEST	WHAT IS MEASURED?	TESTING METHOD	UNITS OF MEASUREMENT
pH	The relative concentration of hydrogen (H+) ions and hydroxide ions (OH-) in a solution	pH strips	pH

HOW ACIDIC IS RAIN?

Normal rainwater has a pH of between 5.0-5.5. Acid rain can have a pH between 4-4.5. This may not seem like a big difference, but a pH of 4.0 is actually 10 times more acidic than a pH of 5.0.

http://www.epa.gov/acidrain/education/site_students/phscale.html

DAILY OBSERVATIONS: MODELING ACID RAIN

Adapted from Kids Ecology Corps

7. Explain to students that over the next four days the class will measure the effects of acid rain on three plants.

8. To set up the model, label each of the plants as Plant 1, Plant 2, and Plant 3. Place the plants in an area where they will receive equal sunlight.

9. Fill each of the three jars with a solution to water the class' three plants.

- Fill the first beaker with 1/4 cup of vinegar or lemon juice. Fill the rest with water. Measure pH, label the jar "Weaker Acid," and screw the lid onto the jar.
- Fill another beaker with 1 cup of vinegar or lemon juice. Fill the rest with water. Measure pH, label the jar "Stronger Acid," and screw the lid onto the jar.
- Fill the last beaker with just water. Measure pH, label the jar "Water" and screw the lid onto the jar.

10. Each day, water Plant 1 with the "Weaker Acid," Plant 2 with the "Stronger Acid," and Plant 3 with the "Water". When beakers are empty, refill using directions from Step 9.

11. Consider having each student sketch the same plant at the beginning of the experiment and at the end.

12. Observe the changes in the plants. How do the three plants change as they are watered more? Which plants change the most? What does this tell us about the effects of acid rain?

ASSESSMENT

Check student pages for completion.

EXTENSIONS

BECOME CITIZEN SCIENTISTS!

Contact the Park District of Highland Park to share your data online. The Park District will post your data on the Highland Park Ravines Blog (www.hpravines.blogspot.com) and their online database of stream health measurements.

RESOURCES

pH Scale from U.S. Environmental Protection Agency

This webpage visualizes the pH scale, provides examples of substances with different pH values, and describes environmental effects of changes in pH.

http://www3.epa.gov/acidrain/measure/ph.html

SOURCES

U.S. Environmental Protection Agency. Effects of Acid Rain: Surface Water and Aquatic Animals. www3.epa.gov/acidrain/measure/ph.html Accessed March 22, 2013.

U.S. Environmental Protection Agency. Water Monitoring and Assessment: pH. www.epa.gov/national-aquatic-resource-surveys/indicators-acidification Accessed March 22, 2013.

Kids Ecology Corps. "Create Acid Rain in Your Own Kitchen!" www.kidsecologycorps.org/kid-power/activities/create-acid-rain-in-your-own-kitchen Accessed March 22, 2013.

STANDARDS

SCIENCE (NGSS)

4-ESS3-2, 5-PS1-3, 5-ESS3-1, 3-5-ETS1-3, MS-LS1-5, MS-LS2-4, MS-LS2-5, MS-ESS3-3

ENGLISH LANGUAGE ARTS (CCSS)

CCRA.W.2, CCRA.W.4, RH.6-8.7, RST.6-8.3, RST.6-8.4, WHST.6-8.1, WHST.6-8.2d

MATHEMATICS (CCSS)

4.MD.A.1, 6.EE.C.9, 6.SP.B.5

A Matter of Balance

Student Page

NAME: ______________________

DIRECTIONS

Measure the pH of samples from a ravine stream and Lake Michigan. Compare the pH of these samples to the pH of other substances we use in our daily lives. Complete the data table:

Samples	pH	Acidic, basic, or neutral?
Example Substance: Rain	*5.0-5.5*	*Acidic*
Lake Michigan		
Ravine Sample 1		
Ravine Sample 2		
Ravine Sample 3		
Substance 1:		
Substance 2:		
Substance 3:		
Substance 4:		
Substance 5:		
Substance 6:		

1. Which of the samples you tested is the most acidic?

____

2. Which of the samples is the most basic? ______________________

3. List the samples that you decided were neutral:

____

4. Do you think the samples from Lake Michigan and the ravine would support a healthy ecosystem? Why or why not?

____

____

RAVINE Education Program

Measuring Stream and Biotic Health

Living with Limits

TIME: 45-60 minutes

GRADES: 4-6

LOCATION: Indoors or outdoors

KEYWORDS: Tolerance, preference, nearshore ecosystem, stream ecosystem, open water, ecotones, substrate, pelagic

MATERIALS:

- ❑ Labels for stations
- ❑ Fish Habitat Preferences Visual aid (from "How Turbid is the Water?")

SUMMARY

Students explore how animals respond to changes in our world. Beginning with a discussion of human tolerance and preference, students then model how fish migrate between ecosystems throughout the year in order to find the most preferred habitat. The model is based on known fish tolerances and preferences of certain conditions.

OBJECTIVES

Students are able to:

1. Model how aquatic organisms respond to changes in their environment;
2. Provide evidence that different species of animals have different tolerances and preferences; and
3. Identify reasons why fish migrate.

BACKGROUND

Along the north shore, there are several distinct ecosystems that are a part of Lake Michigan: tributary streams, nearshore, and the offshore ecosystem. **Stream ecosystems** that flow toward the lake exist in several ravines along the North Shore. Flow in these streams is largely dependent on storm events (though groundwater contributes to their volume as well) and varies by season. Thus, they are classified as intermittent, or seasonal, streams. Though small, some of these streams provide adequate food, water quality and temperature to support important fish species during certain times of the year and their lifecycle. For example, Lake chub fry and Longnose dace were found in a ravine stream in 2011 by scientists from the US Army Corps of Engineers. Rainbow trout parr (young fish) have been observed in the mouths of the ravines in early summer, presumably seeking food and shelter, and White suckers have been observed using the ravine stream to lay eggs.

The **nearshore ecosystem** is the area with water depth up to 33 feet deep (10 meters) and extends as much as a mile or more from the shoreline. The relatively plentiful amount of food in the nearshore habitat supports numerous fish species of the Great Lakes during some portion of their life cycle, such as spawning or rearing. The nearshore bottom **substrate** along Highland Park tends to be very rocky compared to the primarily sand substrate along the border between Illinois and Wisconsin.

Popular fish for anglers, such as Yellow perch, Smallmouth bass, and Walleye use nearshore habitats for most of the summer. Important prey fish like Alewife, shiners, darters, dace and suckers also take advantage of nearshore areas for spawning or shelter. Even trout and salmon will come into nearshore waters when the temperature is cool enough or they are on their way from offshore waters to streams to spawn.

The **offshore ecosystem** is more than a mile away from shore and deeper than 33 feet (Lake Michigan is over 900 feet at its deepest point). Because the offshore waters can be very deep, most fish that live in this area are considered **pelagic** and spend most of their time up in the water column rather than down on the bottom. There are exceptions such as Lake whitefish, Deepwater sculpin, and spawning Lake trout. Some large reef complexes (bedrock and boulder) in deep waters offshore of Highland Park were historical Lake trout spawning sites. Even fish that usually live in the open water offshore may take advantage of nearshore waters and tributary streams at some point. Fish associated with open water have also been found in the ravine and include salmonids, such as the Rainbow trout (which were introduced from the west coast), and forage fish (those which larger fish eat), like the Lake chub.

Scientists call the transitional zones between these ecosystems **ecotones**. Throughout the year as conditions in these areas change, so do the biological communities they support. Many organisms travel across ecotones in order to meet their basic needs year round. For example, temperature and food availability influence where fish are located at a given time. Additionally, some species of fish spawn in fast moving stretches of streams – this is the case with Rainbow trout and White suckers.

Humans impact our aquatic ecosystems. These ecosystems are multidimensional and include important features such as substrate, hydrology, chemistry and wave processes. By paving over areas of the ravine watershed, water flows into the ravines faster, causing more variable stream conditions and potential harm to fish habitat. Algal blooms in the nearshore ecosystems, which are often caused by fertilizer runoff, will decay and deplete oxygen. Chemicals and other waste spills can make areas of the lake uninhabitable. Man-made structures along the shoreline can impact sediment transport and wave dynamics. Our actions, both positive and negative, affect the organisms that live in these ecosystems.

PREPARATION

In the classroom or outdoors, label five Lake Michigan Ecosystem stations: "Nearshore Ecosystem 1," "Nearshore Ecosystem 2," "Ravine Ecosystem 1," "Ravine Ecosystem 2," and "Offshore Ecosystem."

PROCEDURE

INTRODUCTION TO TOLERANCE

1. Ask students what the word "tolerance" means to them. Perhaps they have heard their parents use this word. Explain that **tolerance** is our ability to deal with something difficult or painful.

2. For example, ask students to raise their hands if they don't like the sound a loud crying baby. Most of us **prefer** not to hear that sounds, but we can tolerate crying babies. Ask the students how long they could tolerate a crying baby before they would leave the room. Five seconds? 30 seconds? One minute? 10 minutes? These are all levels of tolerances.

MODELING HUMAN TOLERANCES

3. Read to students the stories in the tolerance situation box, then ask them 1) how long could they tolerate each scenario before taking action, 2) what actions would they prefer to take, and 3) what would happen if they didn't take any actions? Students should answer honestly. The scenarios may sounds silly, but encourage students to think critically about them. Consider splitting into small groups to consider the situations, then come back together as a group.

Situation example: It is 40°F in the classroom.

- Sam can tolerate the cold for 30 minutes. Joe can tolerate it for just 10 minutes.
- After 10 minutes in the classroom, Joe gets his winter coat from his locker. 20 minutes later, Sam puts on a sweatshirt.
- If either student is still cold, they might go home.
- If the students don't protect themselves, they might get sick.

4. Ask students what they think about the situations. Did anyone have different tolerance levels? What were the most dangerous situations, and what situations were least important for survival?

TOLERANCE SITUATIONS

- You are having a picnic with a friend and the sun is in your eyes.
- Your air conditioner is broken, and it is HOT! Each day the temperature creeps higher and higher. 77°... 78°... 79°...
- Everyday when you leave your house to go to school, your friendly neighbor greets you and as she passes, hits you on the back, HARD, in what appears to be a friendly greeting.
- Next door there is a karate class. People are talking loudly and making banging sounds.
- In class, a classmate is continuously bouncing a basketball while you are trying to listen to the instructor.
- The water fountains are all broken, so there is no drinking water in the building.
- The school cafeteria starts serving only peanut butter and jelly sandwiches... every day.
- You are hiking with friends. Your shoes get wet when you miss-step into a puddle. They are sloshing wet!
- The room begins to slowly fill with smoke and it is difficult to breathe.
- Ask students to come up with their own appropriate scenarios to share with the class.

MODELING TOLERANCE OF FISH SPECIES

5. Humans aren't the only animals that have tolerances. Ask students to brainstorm other examples of animals that respond when their environment changes. [E.g., migratory birds fly south for the winter, trees drop their leaves in autumn, many animals hibernate]

6. Fish respond to changes as well – explain to students that as a class they will be modeling changes to several different ecosystems in the Great Lakes.

If students are confused about the Great Lakes having multiple ecosystems, remind them that an ecosystem is a place where living and non-living things interact. An ecosystem can be as big as a lake or as small as a tree.

7. The instructor should point out the five Ecosystem stations:

- Nearshore Ecosystem 1
- Nearshore Ecosystem 2
- Ravine Ecosystem 1
- Ravine Ecosystem 2
- Offshore Ecosystem

Explain that the boundaries between these ecosystems are called **ecotones**.

8. Explain that there will be changes in the ecosystems each month, and students will react to those changes based on their fish's tolerances. Students should keep track of how many times they cross an ecotone.

Measuring the length of a Rainbow trout

9. Split the class into Rainbow trout (Rainbows) and White suckers (Suckers). Since Rainbow trout swim faster than White suckers, Rainbows may take normal-sized steps as they move from station to station. Suckers should take baby steps.

READ SITUATIONS

- In January, all fish start in either Nearshore Ecosystem 1 or 2. The lake surface is frozen and water temperatures are far below tolerance levels for both species. Fish stay mostly still, moving slowly every once in a while.
- In February, oxygen levels are depleted in Nearshore Ecosystem 1 because of ice cover. In Nearshore Ecosystem 2 there is open water, so the air is mixing much needed oxygen into the water. Fish from Nearshore Ecosystem 1 should migrate to Nearshore Ecosystem 2.
- In March, the ice has melted throughout the lake. Food is plentiful in both Nearshore Ecosystems 1 and 2. The temperature is warming and the fish have more energy to swim faster and more frequently. The lake's water temperature reaches 45 degrees, which is when some Suckers start spawning in the ravine. The three Suckers closest to the ravine enter the ravine stream. Rainbows travel long distances in search of a river for spawning.

- In early April, the lake's water temperature reaches 54 degrees, which is ideal for Suckers to start spawning in the ravines. BUT there hasn't been rain in the area, and the ravine steam level is too low for Suckers to enter! Instead, they stay in Nearshore Ecosystem 1 & 2.
- In the middle of April, a heavy rainstorm fills the ravines with water. The flow rate is fast and the water level is high. Perfect for White sucker spawning. The Suckers enter the Ravine Ecosystems while the Rainbows remain in Lake Michigan, cruising for insect larvae and fish to feed on.
- In May, another rainstorm allows the White suckers to move between the Ravine and Nearshore Ecosystems. Some Suckers exit toward the lake.
- In June and July, all adult fish are back in Nearshore Ecosystems 1 and 2. Some of the larger Rainbows explore the Offshore Ecosystem in search for a bigger meal.
- In August, a rainstorm washes fertilizer into the lake, causing an algal bloom in Nearshore Ecosystem 1. Soon the algae dies, reducing oxygen levels as it decomposes. To find water with more oxygen, Rainbows migrate to Nearshore Ecosystem 2. Some of the larger Rainbows may continue swimming through the Offshore Ecosystem. Since Suckers can tolerate lower levels of oxygen so they can stay in either ecosystem.
- In September, oxygen levels stabilize and fish all return to the Nearshore Ecosystems.
- In October a chemical spill from a passing ship makes Nearshore Ecosystem 2 and the Offshore Ecosystem uninhabitable for Suckers, Rainbows, and their prey. All fish crowd Nearshore Ecosystem 1. The Ravine Ecosystems have too low of a flow to enter.
- In November, Nearshore Ecosystem 2 is cleaner, but most fish remain in Nearshore Ecoysystem 1. As the temperature drops, fish begin to move more slowly again.
- In December, all Rainbows and Suckers are located in Nearshore Ecosystems 1 and 2. Temperature is below tolerance levels, so fish move slowly to conserve energy.

RECAP THE SIMULATIONS

10. Ask students to recap the situations that caused them to migrate across ecosystems. Discuss the following questions:

Rainbow trout release

- Do fish stay in one place? How many times did each fish cross an ecotone?
- What were the major factors that made your species act a certain way?
- What were the limitations of this model? What didn't it take into account?
- How could we improve the model?

ASSESSMENT

WRITING WITH SEQUENCE

Ask students to recall the modeling activity and write a story summarizing their activities as a fish in the model.

Depending on age level, require that a certain number of events from the model are included, and in order (i.e., 4th grade may write about 3-5 events, older students may write about all events).

Summaries should be in complete sentences and should include details about when fish moved, why, they moved, and where they went.

EXTENSIONS

CONDUCT A FISH SURVEY IN YOUR CLASS

How do scientists know where fish migrate to? Do they put on scuba gear and follow the fish around Lake Michigan? As fun as this might sounds, scientists use a system of tagging and recapturing fish to learn about fish movement and fish growth. In this lesson students simulate a population of bluegill (using beans) in a lake and practice tagging and recapturing the fish.
http://dnr.wi.gov/org/caer/ce/eek/teacher/fishactivity.htm

CREATE A FISH MONITORING PROTOCOL

Students will design and write protocols for monitoring trout released into their stream, detailing their ideas on containment, times to monitor, and tagging individual fish.

Students may use various types of graphs to illustrate fish movement and best practices for monitoring.

Learn more about fish in Ravine 7L: http://hpravines.blogspot.com/

RESOURCES

Fisheries Learning on the Web: Lesson 4: Fish Populations

In this activity, students in grades 4-8 learn how scientists use technology and GIS mapping to track fish populations in the Great Lakes.

www.miseagrant.umich.edu/lessons/lessons/by-broad-concept/life-science/searching-for-steelhead/

SOURCES

Becker, George C. "Fishes of Wisconsin." (1983).

Creque, S.M., K.M Stainbrook, D.C GLvoer, S.J. Szesny, and J.M. Dettmers. 2010. Mapping bottom substrate in Illinois waters of Lake Michigan: linking substrate and biology. J. Great Lakes Research 36:780-789.

Mackey, S.D and D.L. Liebenthal. 2005. Mapping changes in Great Lakes nearshore substrate distributions. J. Great Lakes Research. 31(SUppl.1): 75-89.

Wei, A., P. Chow-Fraser and D. Albert 2004. Influence of shoreline features on fish distribution in the Laurentian Great Lakes. Canadian Journal of Fisheries and Aquatic Science 61: 1113-1123.

STANDARDS

SCIENCE (NGSS)

4-LS1-2, 5-LS2-1, 5-ESS2-1, 5-ESS3-1, MS-LS1-4, MS-LS1-6, MS-LS1-8, MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4

ENGLISH LANGUAGE ARTS (CCSS)

CCRA.W.3, RST.6-8.4, WHST.6-8.2d

RAVINE Education Program

Aquatic Life in Streams and Nearshore

A Ravine's Web of Life

TIME: 40-60 minutes

GRADES: 5-8

LOCATION: Indoors or outdoors

SAFETY: When outside, stay in groups

KEYWORDS:

Food chain, food web, producer, primary consumer, secondary consumer, decomposer, herbivore, omnivore, carnivore, biotic, abiotic, trophic level

MATERIALS:

- ❑ Printed Food Web Cards
- ❑ Ball of yarn
- ❑ Permanent markers
- ❑ Hole punch
- ❑ 4x6 note cards

GREEN TIP

Laminate Food Web cards for future reuse.

Ebony jewelwing damselfly

© Carol Freeman

SUMMARY

Students learn about food chains and food webs in the context of their local community. After discussing the different aspects of a food web, students model the food web of a Highland Park ravine and learn how the food web changes following a disruption.

OBJECTIVES

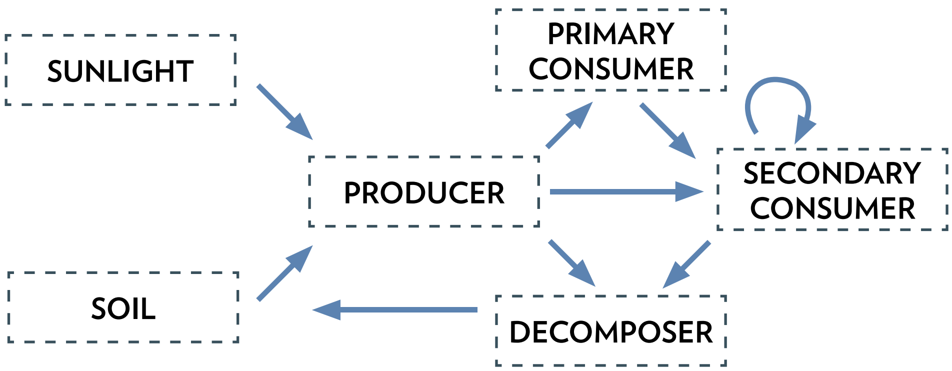
Students are able to:

1. Explain how energy and matter move through a food web;
2. Describe how a change in one section of a food web affects the rest of the web; and
3. Identify examples of producers, consumers, and decomposers in a ravine ecosystem.

BACKGROUND

Energy and matter naturally cycle through the **biotic** (living) and **abiotic** (non-living) parts of every ecosystem; this cycle is called a **food web**. Food webs can be divided into simple individual **food chains**, like the chain below. This example demonstrates four different feeding levels, also known as **trophic levels**, in the food chain.

DAMSELFLY → FROG → SNAKE → HAWK



In nature, many food chains fit together to create a complex food web. **Producers** (plants) use the energy and nutrients from sunlight and soil to create their own food. **Primary consumers** (also called herbivores) eat these plants (or particles of organic matter or detritus).

Secondary consumers (**carnivores** – flesh eaters) eat the primary consumers, or other secondary consumers. Some secondary consumers are omnivores, so they eat both producers and consumers. **Decomposers** break down dead plant and animal matter.

The chart above illustrates a simple food web. Food webs are important because plants and animals cannot create (or destroy) extra energy. They can only change energy from one form to another.

Every ecosystem has its own unique set of producers, primary consumers, secondary consumers, and decomposers. Below is a list of energy sources, organisms and groups of organisms that may inhabit ravines in Highland Park.

Using this list and the procedure below, students will create a food web exclusive to this ecosystem.

PREPARATION

There are two sets of Food Web Cards for this lesson. **Set A** includes the basic categories of a food web. **Set B** includes organisms that have been observed in the ravine ecosystems.

Select a set to print for this activity. Be sure to print cards double-sided.

Print enough cards so that each student receives one. If you print duplicate cards, be sure there is only one sunlight card per group.

Punch holes in the top left and right corners of the cards. Weave a piece of yarn through the holes in each card to make a necklace.

Note: Illustrations on food web cards are not to scale.

Energy Source	Producers	Primary Consumers (herbivores)	Secondary Consumers (omnivores and carnivores)	Decomposers
Sunlight Organic matter (suspended in water)	Leaf litter Phytoplankton Algae Blue-green algae (cyanobacteria)	Zooplankton (scuds daphnia, copepods) Bloodworm/Midge Mayfly Riffle beetle	Water strider Dragonfly Broadwing damselfly Rainbow trout Lake chub Longnose dace White sucker Mosquito Great blue heron	Bacteria

PROCEDURE

INTRODUCTION

1. Ask students:

- What do they know about food chains? [who eats who, energy transfer from one organism to another]
- What are the levels of a food chain called? [trophic levels]
- What do we call an animal that eats another animal? [predator]
- An animal that is eaten? [prey]
- How does a plant get its food? [they create their own food through photosynthesis]

2. As a class, define the following science words, and ask students for examples of these:

Producer: an organism that creates its own food

Consumer: an organism that eats other living things

Carnivore: an organism that eats animals (secondary consumer)

Omnivore: an organism that eats both plants and animals (secondary consumer)

Herbivore: an organism that eats only plants/producers (primary consumer)

Decomposer: an organism that eats dead things and breaks them down into nutrients


White suckers in ravine stream

3. Introduce the idea of a food web, where each living organism links to several food chains. Explain that while food chains may appear simple, in nature the transfer of energy between organisms is more complicated. Each plant or animal eats or is eaten by several others.

4. Define **food web**: many food chains linked together.

FOOD WEB MODELING

Note to instructors: If using Set A, divide class into groups of 10-12 students. If using Set B, do not split the class into groups.

5. Give each student a Food Web Card. After they receive a card, they "become" that organism or ecosystem component. They may be biotic or abiotic.

6. Sit or stand in a circle (or multiple circles based on groups if using Set A).

7. Instruct students to hold their cards facing outward and visible to the group. Hand the ball of yarn to the students with the Sunlight Card.

8. Direct students to hold onto the yarn with one hand and toss the ball of yarn to whomever they think is the next step of the food web. For example, the student with the sunlight card should pass the yarn to a producer, showing the transfer of energy between them. If the group disagrees with their selection then the person should try again. Students should not toss the ball of yarn to the same person every time.

9. After five minutes, ask student to count how many other organisms they are connected to (i.e., their food web connections). Some students may not receive the ball of yarn.

10. Ask a student to roll up the yarn, hand it to the student with The Sun, and start again. After a couple minutes, remove a primary consumer from the food web by asking him or her to step out of the circle. Before they step out have them tug on their part of the yarn. Anyone else who feels the tug should step out as well.

11. Explain that this is an exaggerated model of the ripple effect of changes made to an ecosystem. Changes in the food web could be caused by numerous factors, including changes in weather or climate, disease, pollution, overharvesting by people, and introduction of exotic species.

12. Repeat Step 9.

13. The person with the Decomposer Card should wrap up the yarn. The class can return inside.

DISCUSSION

14. Have a representative from each group explain the yarn's journey through their food web.

15. Consider the following questions as a class:

- How did the web differ after one person stepped out of the group? Was the food web more or less complicated?
- Is it healthier to have a complicated or a simple food web? [Complicated food webs are stronger]
- If using Set B of the Food Web Cards, ask students if they thought their food webs included every species in their ecosystem? [No, because land plants and animals, as well as species that live only in Lake Michigan, are not included]
- What are some of the limitations of this model?
- How might matter or energy leave the ravine ecosystem?

ASSESSMENT

FOOD WEB FLIP BOOKS

Using 4"x6" note cards, students create small books explaining the different elements of a food web - producers, primary consumers (herbivores), secondary consumers (carnivores and omnivores), and decomposers.

After the definitions are written, encourage students to draw examples on each card. Students should label the drawings and list the plants and animals that eat or are eaten by this organism.

PRESENTING FOOD WEBS

Students create a short skit or multimedia presentation that reenacts an aquatic food web. The story should include producers, primary consumers (herbivores), secondary consumers (carnivores and omnivores), and decomposers.

Students should include a situation where their food web goes out of balance. Encourage students to be creative and have fun with this activity!

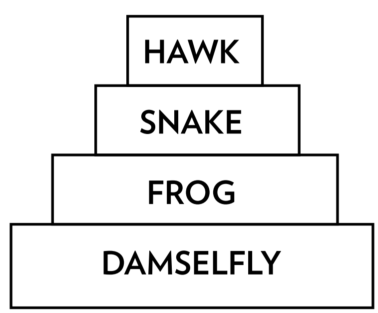
VOCABULARY QUIZ

Quiz students on the meaning and spelling of vocabulary words,

EXENSIONS

TROPHIC PYRAMIDS (Grades 6-8)

Explore an alternative visualization of a food web: the trophic pyramid.



TERRESTRIAL FOOD WEBS

Encourage students to create a terrestrial food web which occures on land. Compare the similarities and differences between the aquatic and terrestrial food webs.

To learn more, visit:

Food Chain Game (4th and 5th grade) www.sheppardsoftware.com/content/animals/kidscorner/games/foodchaingame.htm

Food Web (6-8th grade) – when all arrows are clicked into place the activity is completed. http://teacher.scholastic.com/activities/explorer/ecosystems/be_an_explorer/map/foodweb_play.htm

RESOURCES

Fisheries Learning on the Web (FLOW): Food Web

This set of five lesson plans explores food chains and food webs of a freshwater ecosystem, and the impacts of invasive species on these food webs. www.miseagrant.umich.edu/lessons/lessons/by-broad-concept/life-science/food-chains-and-webs/

SOURCES

Background information adapted from Michigan Sea Grant Fisheries Learning on the Web (FLOW), Lesson 1: Make the Connection. www.miseagrant.umich.edu/lessons/lessons/all-lessons/

Adult Mayfly found in Highland Park

D.S. White and W.U. Brigham. 1996. Aquatic Coleoptera. pp 399-473 in An Introduction to the Aquatic Invertebrates of North America. Eds. R.W. Merritt and K.W. Cummins. Kendall/Hunt Publishing Company, Dubuque, Iowa.

Diana, J. S. 1995. Biology and ecology of fishes. BIOLOGICAL SCIENCES PRESS, CARMEL, IN(USA).

Diet and predation information was gathered from the following sources: (accessed April, 2013)

Water strider life history: http://texasinsects.tamu.edu/aimg41.html

Dragonfly life history: http://texasinsects.tamu.edu/aimg5.html

Broad-winged damselfly life history: http://texasinsects.tamu.edu/aimg7.html

Rainbow trout life history: http://animaldiversity.org/accounts/Oncorhynchus_mykiss/

Lake chub life history: www.mass.gov/eea/docs/dfg/nhesp/species-and-conservation/nhfacts/couesius-plumbeus.pdf

Longnose dace life history: http://animaldiversity.org/accounts/Rhinichthys_cataractae/

White sucker life history: http://wildlife.ohiodnr.gov/species-and-habitats/species-guide-index/fish/white-suckerf

Great blue heron life history: http://animaldiversity.org/accounts/Ardea_herodias/

Midge life history: http://animaldiversity.org/accounts/Chironomidae--Chironomidae/

Mayfly life history: http://texasinsects.tamu.edu/aimg3.html

Riffle beetle: http://animaldiversity.org/accounts/Elmidae/

Mosquito: http://texasinsects.tamu.edu/bimg220.html

STANDARDS

SCIENCE (NGSS)

4-LS1-1, 5-PS3-1, 5-LS1-1, 5-LS2-1, 5-ESS2-1, MS-LS1-4, MS-LS1-5, MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4, MS-ESS2-1

ENGLISH LANGUAGE ARTS (CCSS)

CCRA.W.3, RST.6-8.4, WHST.6-8.2d

A Ravine's Web of Life

FOOD WEB CARDS: SET A (Front)

Sunlight	Organic Matter
Producer	Primary Consumer
Secondary Consumer	Decomposer

LESSON MATERIALS

A Ravine's Web of Life

FOOD WEB CARDS: SET A (Back)

Organic Matter

I get my energy and matter from:

- Decomposers

My energy and matter flows to:

- Producers

Sunlight

I get my energy and matter from:

- Self-produced

My energy and matter flows to:

- Producers

Primary Consumer

I get my energy and matter from eating:

- Producers

My energy and matter flows to:

- Secondary consumers
- Decomposers

Producer

I get my energy and matter from:

- Sunlight
- Organic matter

My energy and matter flows to:

- Primary consumers
- Secondary consumers
- Decomposers

Decomposer

I get my energy and matter from eating dead:

- Producers
- Primary consumers
- Secondary consumers

My energy and matter flows to:

- Organic matter

Secondary Consumer

I get my energy and matter from eating:

- Producers
- Primary consumers

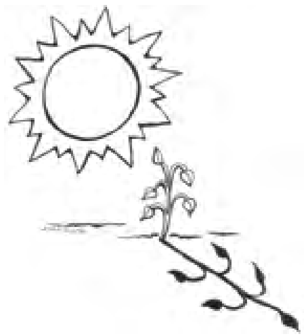
My energy and matter flows to:

- Decomposers
- Other secondary consumers

LESSON MATERIALS

A Ravine's Web of Life

FOOD WEB CARDS: SET B (Front)



Sunlight

Energy Source

Organic Matter

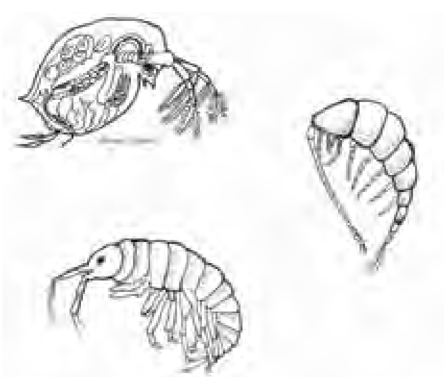
Energy Source

Algae and Phytoplankton

Producer

Leaf Litter

Producer



Zooplankton

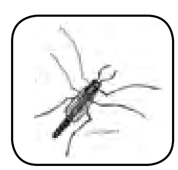
(Scuds, Daphnia, Copepods)

Primary Consumer

Bloodworm

(Larva)

Primary Consumer



Midge
(Adult)

LESSON MATERIALS

A Ravine's Web of Life

FOOD WEB CARDS: SET B (Back)

Organic Matter

I get my energy and matter from:

- Dead plants and animals

My energy and matter flows to:

- Zooplankton
- Bloodworms
- Mayfly nymphs
- Riffle beetles
- Mosquito larvae
- White suckers

Sunlight

I get my energy and matter from:

- Self-produced

My energy and matter flows to:

- Plants
- Phytoplankton
- Algae

Leaf Litter

I get my energy and matter from:

- Producers

My energy and matter flows to:

- Secondary consumers
- Decomposers

Algae and Phytoplankton

I get my energy and matter from:

- Sunlight (and nutrients)

My energy and matter flows to:

- Zooplankton
- Mayfly nymph
- Riffle beetle
- Rainbow trout
- Longnose dace
- White sucker
- Mosquito larvae

Bloodworm

I get my energy and matter from eating:

- Leaf litter
- Organic matter

My energy and matter flows to:

- Mayfly nymph
- Water strider
- Dragonfly nymph
- Broad-winged damselfly
- Rainbow trout
- Lake chub
- Longnose dace
- White sucker

Zooplankton

I get my energy and matter from eating:

- Phytoplankton
- Leaf litter
- Organic matter

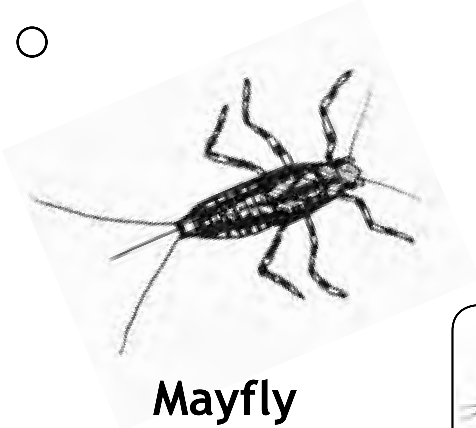
My energy and matter flows to:

- Rainbow trout
- Lake chub
- White sucker

LESSON MATERIALS

A Ravine's Web of Life

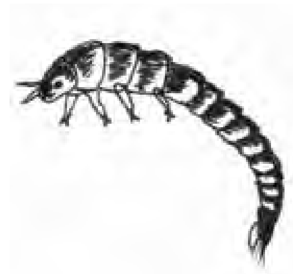
FOOD WEB CARDS: SET B (Front)



Mayfly
(Nymph)

Primary Consumer

Mayfl
(Adult)



Riffle Beetle
(Larva)

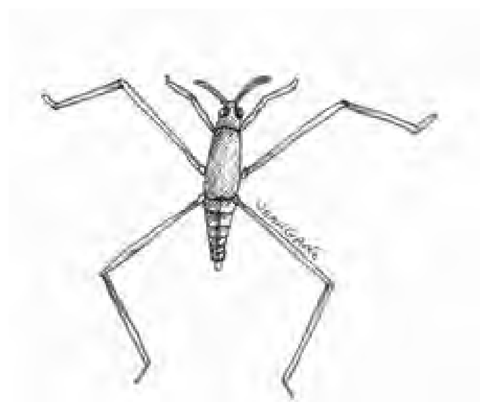
Primary Consumer

Riffle Beetl
(Adult)

Mosquito
(Larva)

Secondary Consumer

Mosquito
(Adult)



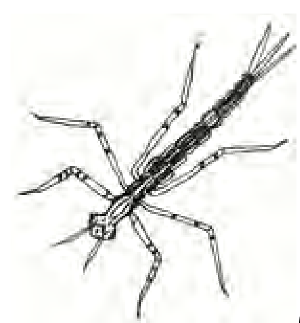
Water Strider

Secondary Consumer

Dragonfl
(Nymph)

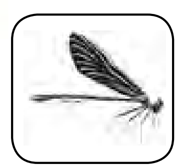
Secondary Consumer

Dragonfl
(Adult)



Broad-winged Damselfl
(Nymph)

Secondary Consumer



Broad-winged Damselfly (Adult)

LESSON MATERIALS

A Ravine's Web of Life

FOOD WEB CARDS: SET B (Back)

Riffle Beetle Larv

I get my energy and matter from eating:

- Leaf litter
- Organic matter
- Algae

My energy and matter flows to:

- Small Fish (like Longnose dace or Lake chub)

Mayfly Nymp

I get my energy and matter from eating:

- Algae
- Organic matter

My energy and matter flows to:

- Water strider
- Dragonfly nymph
- Broad-winged Damselfly nymph
- Lake chub
- Rainbow trout

Water Strider

I get my energy and matter from eating:

- Insects (which may include Midge, Mosquito, Mayfly, Dragonfly, and Broad-winged damselfly)

My energy and matter flows to:

- Rainbow trout
- Lake chub

Mosquito Larva

I get my energy and matter from eating:

- Bacteria
- Organic matter
- Phytoplankton

My energy and matter flows to:

- Water strider
- Dragonfly
- Broad-winged damselfly
- Mosquito
- Lake chub
- Rainbow trout

Broad-winged Damselfly Nym h

I get my energy and matter from eating:

- Mosquitoes
- Midges
- Other aquatic insects (which may include Mayfly nymphs)

My energy and matter flows to:

- Rainbow trout
- Lake chub
- White sucker
- Great Blue Heron

Dragonfly Nymp

I get my energy and matter from eating:

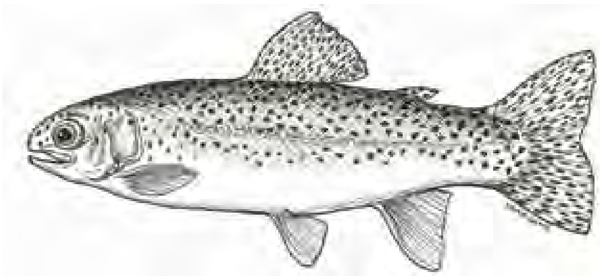
- Mosquitoes
- Midges
- Other aquatic insects (which may include Mayfly nymphs)

My energy and matter flows to:

- Rainbow trout
- Lake chub
- White sucker
- Great Blue Heron

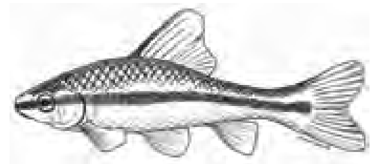
A Ravine's Web of Life

FOOD WEB CARDS: SET B (Front)



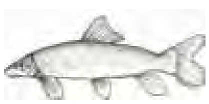
Rainbow Trout

Secondary Consumer



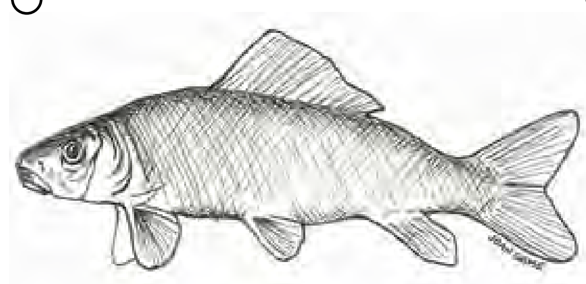
Lake Chub

Secondary Consumer



Longnose Dace

Secondary Consumer

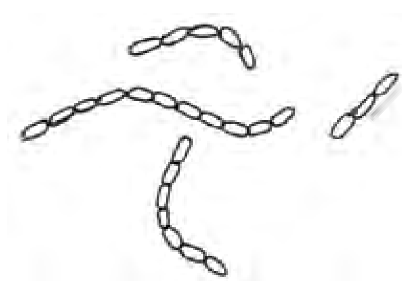


White Sucker

Secondary Consumer

Great Blue Heron

Secondary Consumer



Bacteria

Decomposer

A Ravine's Web of Life

FOOD WEB CARDS: SET B (Back)

Lake Chub

I get my energy and matter from eating:

- Zooplankton
- Aquatic insects (may include Mayfly nymph, Dragonfly, Midge, Damselfly)
- Smaller fish (may include Longnose dace)

My energy and matter flows to:

- Rainbow trout
- Longnose dace (consumes eggs)

Rainbow Trout

I get my energy and matter from eating:

- Algae
- Zooplankton
- Insect larvae (may include Midge, Mayfly nymphs, Dragonfly nymphs, Damselfly nymphs, Riffle beetle, Mosquito larvae, and Water strider)
- White sucker eggs
- Smaller fish (may include Longnose dace and Lake chub)

My energy and matter flows to:

- Great Blue Heron (consumes juvenile Rainbow trout)

White Sucker

I get my energy and matter from eating:

- Organic matter
- Algae
- Phytoplankton
- Zooplankton
- Aquatic insects (may include Midge, Mosquito, Dragonfly nymph, and Damselfly nymph)

My energy and matter flows to:

- Great Blue Heron (consumes juveniles)
- Rainbow trout (consumes eggs)

Longnose Dace

I get my energy and matter from eating:

- Algae and phytoplankton (consumed by juveniles)
- Midges
- Mayflies
- Eggs from other minnows (which may include Lake chub)

My energy and matter flows to:

- Rainbow trout
- Lake chub (consumes juveniles)

Bacteria

I get my energy and matter from:

- All dead plants and animals

My energy and matter flows to:

- Organic matter

Great Blue Heron

I get my energy and matter from eating:

- Dragonfly and Damselfly nymphs
- Minnows (Longnose dace and Lake chub)
- Juvenile White sucker
- Rainbow trout
- Frogs

My energy and matter flows to:

- Gulls (consume eggs)

Go Fish!

TIME: 30-45 minutes

GRADES: 4-6

LOCATION: Large indoor or outdoor space

SAFETY: Consider playing "Go Fish!" on grass or other soft surfaces to avoid injury

KEYWORDS:

Habitat, population, carrying capacity, limiting factors

MATERIALS:

- ❑ Flip chart or blank poster
- ❑ Student sheets
- ❑ Watercolor materials
- ❑ Markers
- ❑ Chalk

Electrofishing in Ravine 7L to collect samples

SUMMARY

As a class, students create a habitat model and explore the concept of carrying capacity as it relates to the number of habitat components available in an ecosystem.

OBJECTIVES

Students are able to:

1. Create a habitat model that reflects changes over time;
2. Construct an argument that changes to a species' habitat affects the population of that species; and
3. Create a species of fish that would camouflage in a local stream.

BACKGROUND

This activity models a **habitat**, an organism's home where it can find the four essential components for survival: food, water, shelter, and space (or territory). Every habitat has a **carrying capacity**, which is the balance between the availability of habitat components and the number of organisms that habitat can support. Carry capacity determines the maximum **population** (number of organisms of the same species) that a habitat can support.

In addition to the accessibility of food, water, shelter and space, there are **limiting factors** that prevent a population from exceeding carrying capacity. Disease, predator and prey relationships, variable weather (e.g., early freezing, heavy snows, flooding, drought), pollution, and habitat destruction are among these factors. When there are many of these limiting factors in a habitat the population can be threatened, endangered, and even eliminated.

Key points for this activity:

- Wildlife need quality habitat in order to survive and succeed.
- Populations will grow unless there are limiting factors.
- Even with limiting factors, fluctuations occur.

Wildlife populations continuously change in response to limiting factors and the availability components.

The above information and procedure steps three through eleven of this lesson were adapted from "Oh Deer!," a popular lesson from the curriculum guide Project Wild. To view the lesson plan for "Oh Deer!" visit: www.projectwild.org/documents/ohdeer.pdf.

PREPARATION

For "Go Fish," find a flat space at least 20'x40,' either indoors or outdoors. To minimize risk of injury, use a gymnasium or a grassy area outside. Clearly mark two parallel lines about 40 feet apart and large enough for the whole class to stand on.

PROCEDURE

INVESTIGATE: WHAT IS A HABITAT?

1. Ask students: What is a habitat? [Natural environment in which an organism lives] Brainstorm the major parts of a habitat with students. [food, water, shelter, space]

2. Compare habitats of different animals. What are the habitat needs for humans? Do all animals have the same habitat needs? What about animals that live under water? [some aquatic animals need fast-moving water, other need calm, slow water]

GO FISH!

3. Explain to students that in this game they will create a model of a fish habitat. It represents any fish that lives in the Great Lakes or another freshwater system.

4. All students should line up on one of the lines while the instructor explains the game. Students number off in fives. All the ones stand between the two lines, while everyone else remains on the line. Ones are the fish, and the rest of the students are fish habitat components. Twos are food, threes are water, fours are shelter, and fives are space.

5. Explain that in each round, habitat components will run from one line to the other. The fish will try to tag one person, depending on what they are looking for.

6. Students will use hand signals to communicate what habitat component they represent or need. Explain the hand signals:

- Food: rub stomach
- Water: hold hands in cup shape
- Shelter: make triangle over head with arms
- Space: stretch arms straight out
- Fish: make a fishy face

7. The first round begins with fish turning away from the other students and picking their choice of signs. When the instructor says "Go Fish!" the fish turn around and try to catch one of their matching components before they reach the other line.

8. If a fish catches what they need, they "multiply" – the person they tag becomes a fish as well. If a fish does not catch what they need, they go "belly up" and join the other habitat components.

9. Select a student or a group of students to graph each round's the fish population changes. X axis should read "Year," and Y axis should read "Number of fish." Plot the number of fish before each round.

10. Play 10-15 rounds, each representing one year, and ask students to observe how the fish population changes.

11. To simulate predation from other animals including humans, remove several habitat components from the game for 3-4 rounds, or until the fish population drops noticeably.

DISCUSSION & ASSESSMENT

12. At the end of the activity, ask students what happened to the population of fish as the years went on. Did it change, or did it remain constant? Refer to the chart to help students visualize these changes.

13. Introduce the idea of carrying capacity, where a habitat can only support a certain number of species, because of limiting factors.

14. Discuss the following questions:

- What factors limited the population of fish?
- How and why did these factors limit the number of fish in the habitat?
- How is this model realistic and unrealistic?
- What are some other limiting factors in a habitat?
- Think about the factors humans can help control. If we wanted to increase a habitat's carrying capacity for a certain species, what actions might we take?

EXTENSIONS

STEALTHY FISH

Ask students what characteristics freshwater stream fish have that allow them to hide more easily. Are they colorful? [not really]

Visit www.pdhp.org/ravines-project/ and show students pictures of the ravines.

Provide students with water colors, colored pencils, or markers, and ask them to color the fish in a way that they would easily camouflage in the Highland Park ravine streams.

Explain that some fish (such as Rainbow trout) can change colors depending on the coloring of their habitat and the clarity of the water. Also, trout change as they grow and enter new life stages. Young trout (parr) have distinct dark marks on their sides.

RESEARCH PROJECT

Study the habitat requirements of a local plant or animal species. How does that animal or plant obtain food, water, shelter and space? How do humans impact this species' ability to meet these needs? Write a one page paper in response to these questions.

RESOURCES

NATIONAL GEOGRAPHIC'S GEOGRAPHY ACTION: HABITAT HOME SWEET HOME

This page offers a variety of lesson plans related to habitats around the world, as well as the relationship between humans and natural habitats. http://education.nationalgeographic.org/activity/habitat-needs/

SOURCES

Oh Deer. Project Wild. www.projectwild.org/documents/projectwild.pdf. Accessed April, 2013.

STANDARDS

SCIENCE (NGSS)

4-LS1-1, 4-LS1-2, 5-LS2-1, MS-LS1-4, MS-LS1-5, MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4, MS-ESS2-1

ENGLISH LANGUAGE ARTS (CCSS)

RST.6-8.4, WHST.6-8.2d

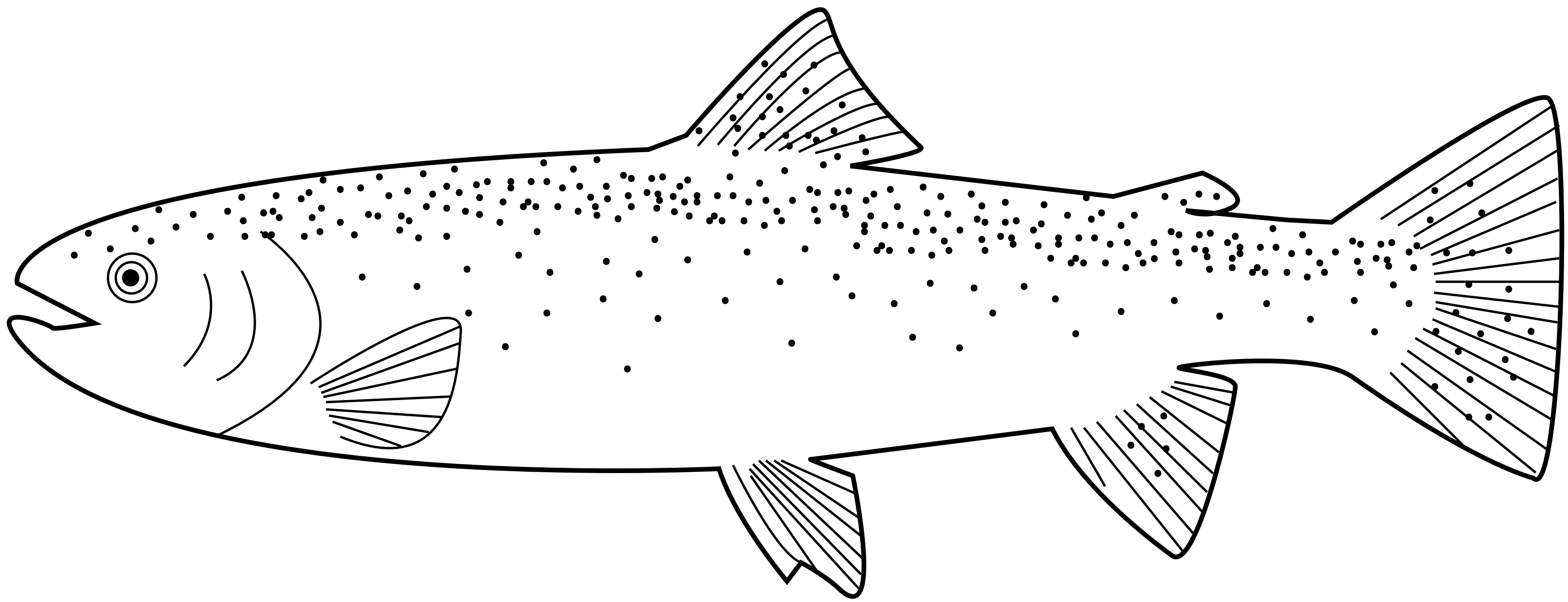
Student Page

Go Fish: Stealthy Fish

NAME: ____________________

DIRECTIONS

Using the images provided by your instructor, color or paint this fish with colors that would help it camouflage in its habitat.



Aquatic Life in Streams and Nearshore

Head to Tail

TIME: 35-40 minutes

GRADES: 4-8

LOCATION: Indoors or outdoors

KEYWORDS:

Operculum, lateral line, dorsal fin, adipose fin, tail fin (caudal fin), anal fin, vent, pelvic fin, scales, pectoral fin, terminal mouth, ventral mouth, adaptation

MATERIALS:

- ❑ "Fish Fins" and/or "Fish Adaptations" student pages

Rainbow trout (Oncorhynchus mykiss)

SUMMARY

In this activity students learn about the external structures of two freshwater fish found in the Great Lakes, and which are known to use the ravines of Highland Park at certain times of the year. Students learn about the function of these structures along with their similarities and differences from the human body.

OBJECTIVES

Students are able to:

1. Identify similarities and differences between human anatomy and fish anatomy;
2. Identify structural adaptations of fish that function to support their survival, growth, behavior, and reproduction; and
3. Describe the functions of these structures.

BACKGROUND

This activity compares the anatomy of two fish found in Lake Michigan – the White sucker (Catostomus commersonii) and the Rainbow trout (Oncorhynchus mykiss). White suckers are in the Catostomidae family and Rainbow trout are in the Salmonidae family.

For background on fish anatomy, please see the "Fins Table" and Adaptations Table" later in this lesson which explain the functions of the structures discussed in this lesson.

Technology Connections:

- Download Trout Unlimited's "Introduction to Trout for Smartboards:" www.troutintheclassroom.org/teachers/library/smart-board-presentation
- Use the below web pages to compare life histories of these two fish:

  Rainbow trout: www.biokids.umich.edu/critters/Oncorhynchus_mykiss/

  White sucker: www.dnr.state.mn.us/fish/whitesucker.html

PREPARATION

Print student pages and teacher pages in advance. Read content in the "Fins Table" and "Adaptations Table" before discussing with students. Also consider printing factsheets for White sucker and Rainbow trout.

PROCEDURE

INTRODUCTION

1. Begin by asking students to brainstorm as many parts of a fish as possible. [answers will vary] Also brainstorm similarities and differences between human parts and fish parts. [Important similarities are (1) both species are animals, thus bodies are made up of animal cells with different functions, (2) both species are vertebrates, so they each have backbones.]

2. Review with students that different species have different features that allow them to live in a certain environment. For example, fish have gills, which allow them to breathe underwater. This is an adaptation. Students may be asked to brainstorm other examples of adaptations found in different species.

3. Tell students that they will be labeling the external parts and structures of two fish that have been spotted spending time in the ravines of Highland Park – the Rainbow trout and the White sucker. Pass out "Fish Fins" and "Fish Adaptations" student pages. Together the class will label fish parts and discuss their functions.

FINS TABLE

#	Name	Human Connection
1T, 1S	Dorsal fin	"Dorsal" means the backside of an organism. In humans, the backbone is in the dorsal region. Individual organs also have dorsal areas (e.g., the back of the brain is referred to as the brain's dorsal region).
2T	Adipose fin (AD-uh-pohs) *Rainbow trout only, not White sucker*	Adipose cells in humans are the cells that store body fat.
3T, 2S	Tail fin, or caudal fin (KAWD-l)	Tail and caudal both refer to the posterior end of a body. Humans have a tailbone (called coccyx) located at the base of the spinal column.
4T, 3S	Anal fin	Anal fin is located behind the vent, which is an opening where waste is expelled. In many animals, including humans, this opening is called the anus.
5T, 4S	Pelvic fins (2)	Pelvic fins are related to the human pelvis structure. Legs are connected to the pelvis and are thought to have evolved from pelvic fins.
6T, 5S	Pectoral fins (2) (PEK-ter-uhl)	Humans have pectoral muscles, which are located in the chest region. Arms are thought to have evolved from pectoral fins of a species that lived in water over 300 million years ago.

ADAPTATIONS TABLE		
#	**Name**	**What does it do?**
1T, 1S	Operculum (oh-PUR-kya-lum)	This is the gill cover, which protects gills from damage.
2T	Lateral line *Rainbow trout image only*	This line of special scales with pore-like openings is a sensory organ that detects disturbances (pressure and sound) in the water. It helps fish identify movement of predators and prey.
2S	Scales *Sucker image only*	Scales provide protection for the fish. Rainbow trout have very small scales compared to the White sucker.
3T, 3S	Dorsal fin	Provides stability and some maneuverability. Prevent the fish from rolling over. Some fish have two dorsal fins (example is the Yellow perch, another fish found in the Great Lakes).
4T	Adipose fin (AD-uh-pohs) *Rainbow trout only, not White sucker*	We don't know! But some fish species like the Rainbow trout have this fin, while others like the White sucker do not. This fin is fleshy and has no rays or spines. Thus, this fin is often clipped by scientists at fish hatcheries to mark the fish so they know which fish are born in a hatchery and which are born in nature.
5T, 4S	Tail fin, or caudal fin (KAWD-l)	Provides propulsion through the water. Rainbow trout and White suckers both have forked tail fins, so they can swim faster than fish with rounded tail fins.
6T, 5S	Anal fin	Helps keep the fish stable in the water. Also used by female Rainbow trout to clear away sand or silt to build a nest.
7T, 6S	Vent	Solid and liquid waste disposal
8T, 7S	Pelvic fins(2)	Provides stability, helps fish swim upwards or downwards through the water column. These fins are in pairs.
9T, 8S	Pectoral fins (2) (PEK-ter-uhl)	Provides stability, helps fish turning directions, helps fish swim slowly. These fins are in pairs.
10T	Terminal mouth *Rainbow trout only, not White sucker*	Enables fish to feed on other fish that are swimming near them. This would be harder to do with a mouth pointing up or down.
9S	Ventral mouth *White sucker only, not Rainbow trout*	This downward pointing mouth is common on bottom feeders like the White sucker. The White sucker will use its ventral mouth to eat insects, algae, plankton, and other organisms at the bottom of a stream. Note that some fish have superior mouths, where the mouth opens closer to the top of the head. Fish with these types of mouths eat insects or other organisms at the surface of the water.

Spiny fins provide protection: *Fins on both fish are supported by soft rays, which are very flexible. Other fish like bass and bluegill have spines in their fins. These spiny fins are not flexible, but are very sharp, and protect the fish. Picking up a fish with spiny fins is difficult because their spines can poke you.*

ANATOMY WORKSHEETS

4. Using a projector, fill in the worksheet as a class, discussing the functions of each structure. Stop to pronounce difficult words together, and encourage students to ask questions (see "Fins Table").

Part 1: Fins Worksheet

5. Students write each term for both fish. For each fin, ask students why they think scientists gave it the name they did. Instructor should emphasize the connection between fins and human parts.

Part 2: Adaptation Worksheet

6. Students should label the structures for both fish. For each structure, ask students to guess the function. Emphasize that they are all adaptations that the species has evolved in order to survive in its habitat. Students should also take notes about the function of each structure discussed.

DISCUSSION

7. Consider the following:

- How are the White sucker and Rainbow trout different in appearance?
- What are the reasons this might this be? Use life history factsheets to compare (see background).
- How are they the same?

ASSESSMENT

Review students pages for completion.

EXTENSIONS

TROUT IN THE CLASSROOM ACTIVITIES

Explore Internal Anatomy

To expose students to internal anatomy of fish, consider the following lesson plan: www.troutintheclassroom.org/teachers/library/trout-guts-collage

Paper Bag Fish Models

Using what students have learned about fish anatomy, create models of a fish using paper bags. Trout in the Classroom's website provides directions for building these models: www.troutintheclassroom.org/teachers/library/paper-bag-trout

RESEARCH "LIVING FOSSILS"

The coelacanth (SEEL-uh-canth) is a fish that scientists describe as a "Living Fossil" because the species has been around for about 400 million years. Visit this website for more information: http://animals.nationalgeographic.com/animals/fish/coelacanth/?source=A-to-Z. To see a preserved coelacanth, visit The Field Museum of Natural History, in Chicago.

The lungfish is another fossil fish, with separate species found on several continents throughout the world. To see Australian lungfish, visit The Shedd Aquarium, in Chicago. To learn about the lungfish visit www.sheddaquarium.org/

Note the similarities and difference between the Rainbow trout and these living fossils. Do they look similar? Do they act similar? Why do you think this is? Also, which species is more in danger of extinction?

RESOURCES

TEXAS PARKS AND WILDLIFE FISH SCHOOL

This user-friendly website provides information on fish anatomy. Users can also learn how fish swim, breathe, see, smell, taste, sense, hear, and reproduce. https://tpwd.texas.gov/kids/wild_things/fish/fishparts.phtml

FISHERIES LEARNING ON THE WEB (FLOW) LESSON

Fins, Tails and Scales - Identifying Great Lakes Fish

This activity, designed for grades 4-8, teaches students how to identify the families of fish species based on their external features. www.miseagrant.umich.edu/lessons/lessons/by-broad-concept/life-science/fish-indentification/

FISH-SPECIFIC RESOURCES

Rainbow trout information: www.biokids.umich.edu/critters/Oncorhynchus_mykiss/

White sucker information: www.dnr.state.mn.us/fish/whitesucker.html

SOURCES

http://aquaticpath.phhp.ufl.edu/lesionguide/. Accessed May, 2013.

http://www.ncbi.nlm.nih.gov/pubmed/22913749. Accessed May, 2013.

http://evolution.berkeley.edu/evolibrary/article/evograms_04. Accessed May, 2013.

www.miseagrant.umich.edu/lessons/lessons/by-broad-concept/life-science/fish-indentification/ Accessed

May, 2013.

http://animaldiversity.org/accounts/Oncorhynchus_mykiss/. Accessed May, 2013.

STANDARDS

SCIENCE (NGSS)

4-LS1-1, 4-LS1-2, MS-LS1-2, MS-LS1-3, MS-LS1-4, MS-LS1-8, MS-LS4-1, MS-LS4-2

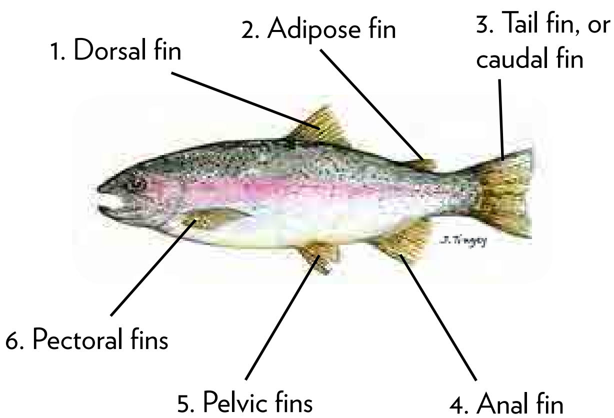
ENGLISH LANGUAGE ARTS (CCSS)

RST.6-8.4, WHST.6-8.2d

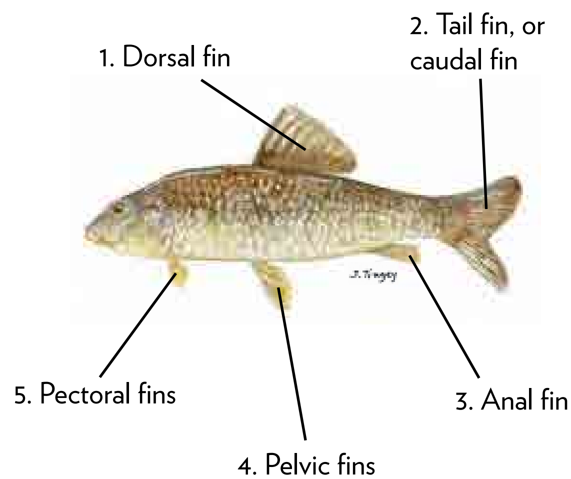
Teacher Page

From Head to Tail
Fish Anatomy Key for Student Pages

FINS PAGE

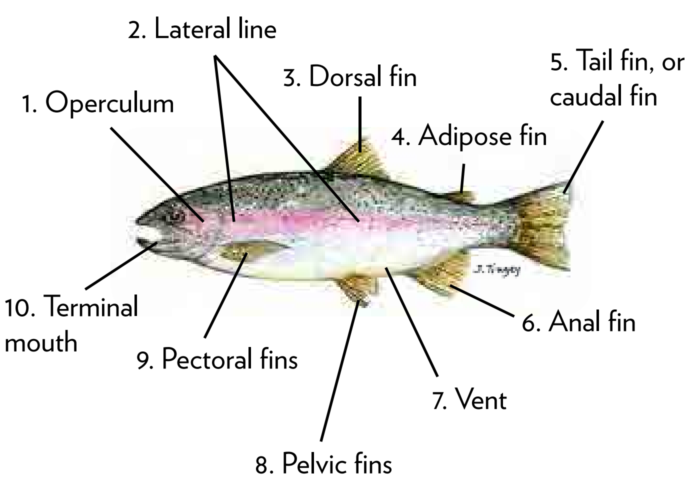


Rainbow trout

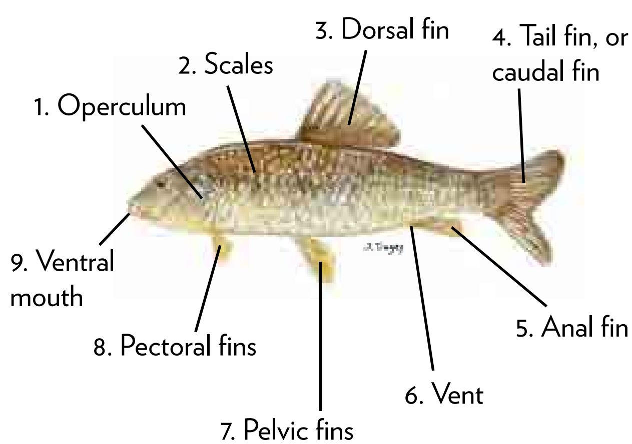


White sucker

ADAPTATIONS PAGE



Rainbow trout



White sucker

From Head to Tail:

Fish Fins

Student Page

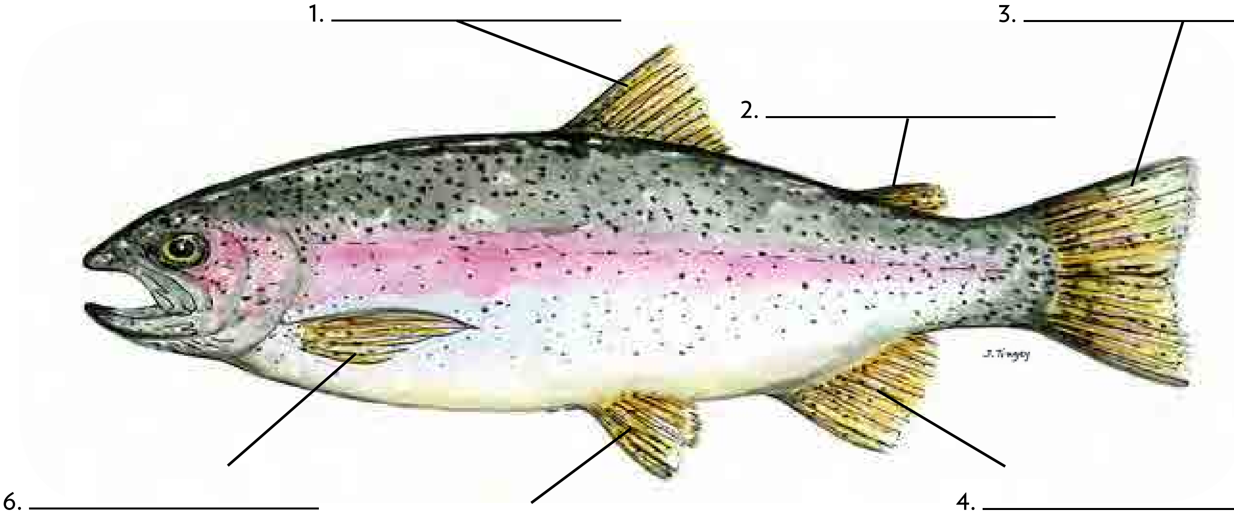
NAME: ______________________

DIRECTIONS

Label each fish's fins by completing the blank.

RAINBOW TROUT

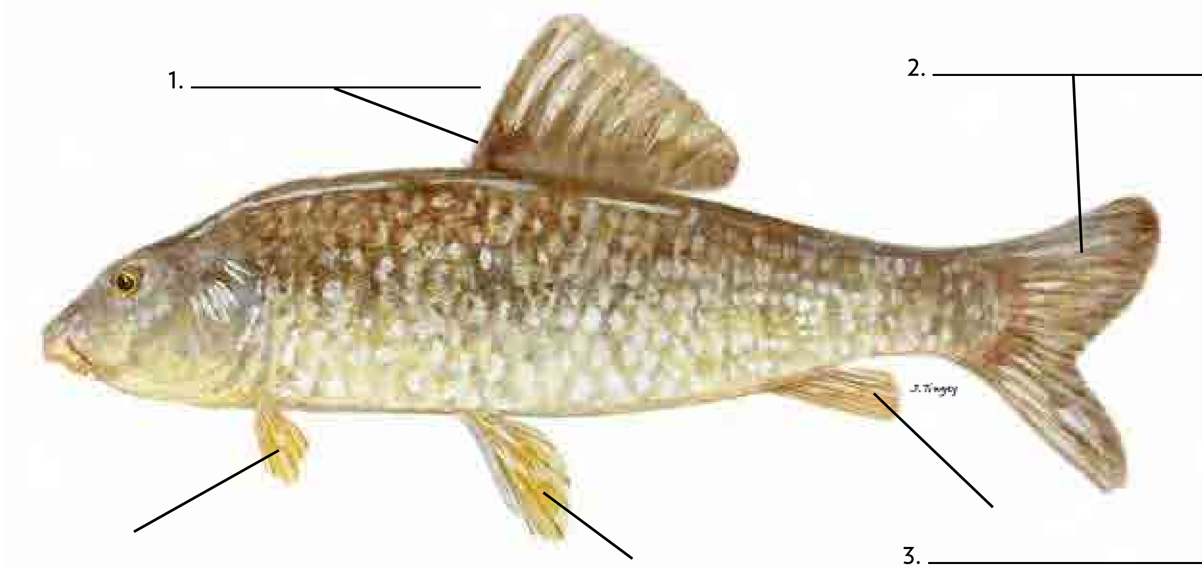
1. ______________________
2. ______________________
3. ______________________



4. ______________________
5. ______________________
6. ______________________

WHITE SUCKER

1. ______________________
2. ______________________



3. ______________________
4. ______________________
5. ______________________

Student Page

From Head to Tail:

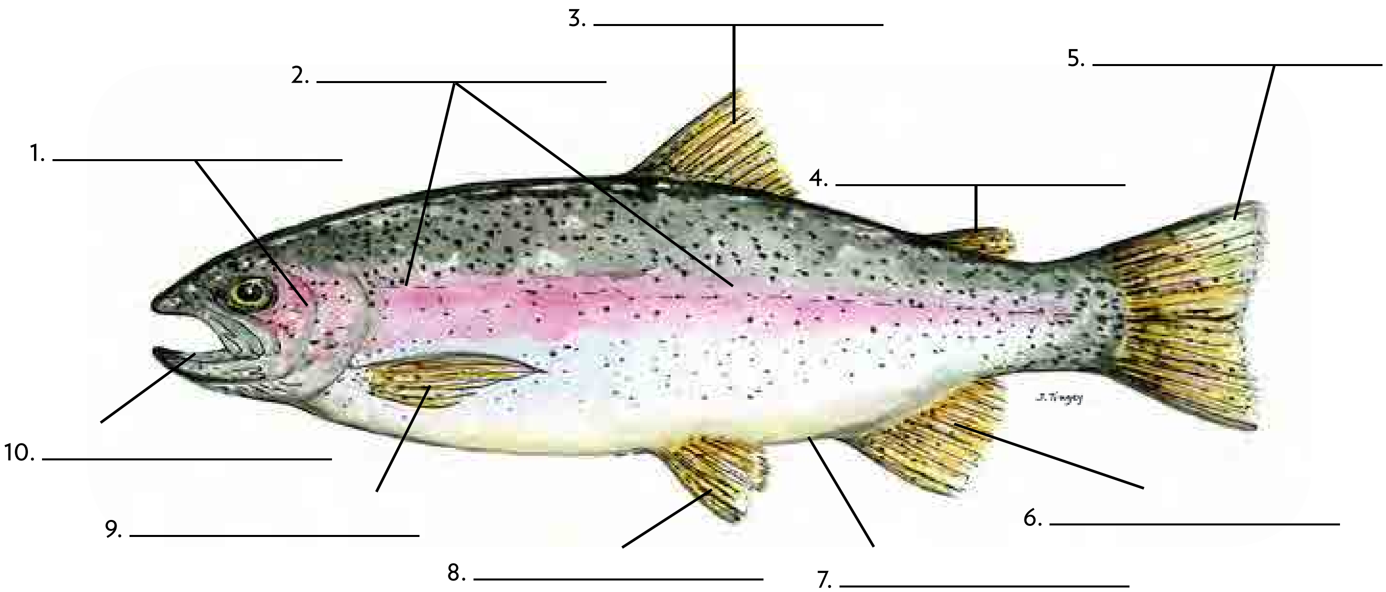
Fish Adaptations

NAME: ____________________

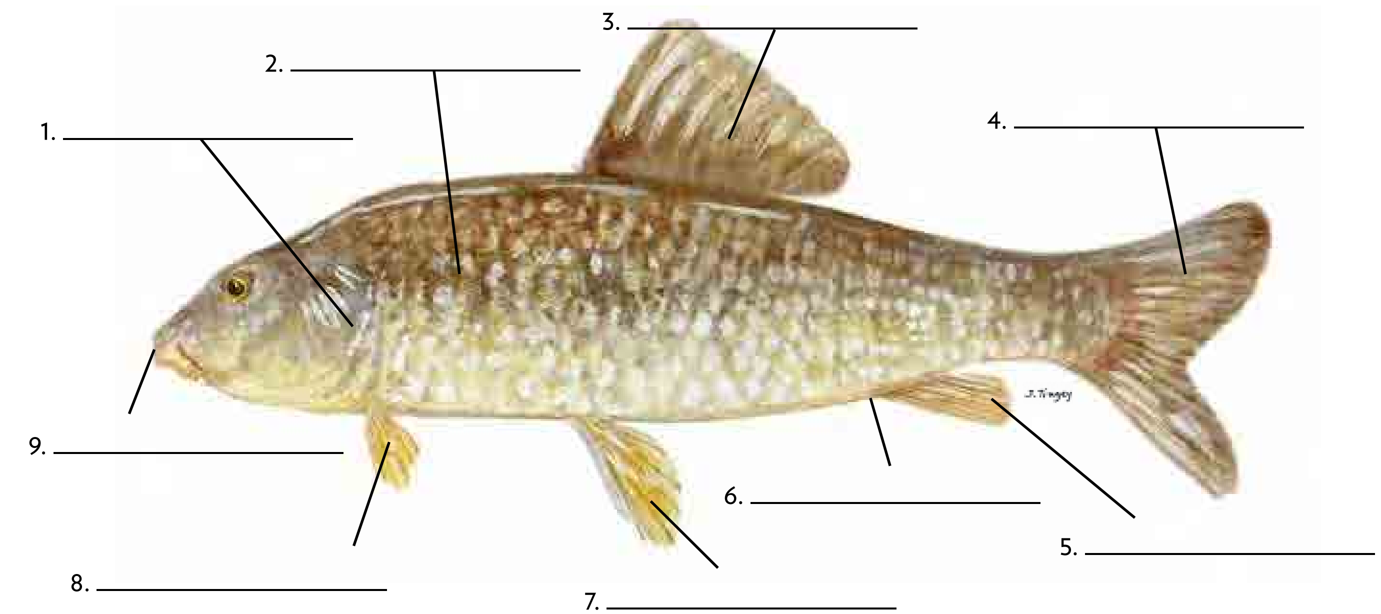
DIRECTIONS

Label each fish's adaptations by completing the blank.

RAINBOW TROUT



WHITE SUCKER



RAVINE Education Program

Aquatic Life in Streams and Nearshore

How Healthy is the Habitat?

TIME: 60-90 minutes at the ravine and 15-30 minutes indoors

GRADES: 6-8

LOCATION: Ravine (in fall or spring) and indoors

SAFETY: When exploring the ravine, step very carefully. Rocks may be unstable to stand on.

KEYWORDS:

Ecosystem, biotic, abiotic, habitat, turbidity, transparent, translucent, opaque, dissolved oxygen, pH, salinity, nearshore ecosystem, stream pools, riffles, substrate, indicator

MATERIALS:

- ❑ All water quality testing materials
- ❑ Four flags
- ❑ Stuffed animal trout
- ❑ Trout visual aid
- ❑ Clipboards
- ❑ Student sheets

Note: This field trip should be facilitated by the Park District of Highland Park.

SUMMARY

In this guided field trip to a ravine stream, students evaluate the habitat quality of the ecosystem. Visiting students are broken up into three groups to test the availability of food, healthy water, shelter, and physical habitat for Rainbow trout.

OBJECTIVES

Students are able to:

1. Provide and interpret empirical evidence about the health of a habitat for a specific species;
2. Consider actions that would increase or decrease the health of that habitat; and
3. Demonstrate the ability to describe the difference between an ecosystem and a habitat.

BACKGROUND and PREPARATION

Teachers: Before visiting the ravine, review proper field trip behavior with students. Divide students into three groups for the field trip and show them the habitat components worksheet they will complete on-site.

RAINBOW TROUT: AN INDICATOR

Did you know that rainbow trout are actually not native to the Great Lakes or the Midwest?

Humans brought the Rainbow trout from the western United States and have maintained populations by stocking the fish. Rainbow trout are a highly sought after sport fish, and when they are found in streams it is a good indication that the stream is a high quality cold or cool water stream. You may have a very healthy warm water stream with no trout – does that mean the water is unhealthy? No! Hopefully there are other organisms living in the water that prefer the temperature in the stream.

If necessary, introduce the concept of a **habitat** [the environment in which an animal lives and a place where a species has everything it needs to survive], and the four major habitat components, (1) food, (2) water, (3) shelter, and (4) space. Note that a habitat can be any size and vary by species. Habitat needs also change as individuals of a species grow and experience different parts of their life cycle.

The Rainbow trout is a good example—a native of the Pacific Ocean, it was introduced to the Great Lakes for recreational fishing in the late 1800s. In Lake Michigan, Rainbows (sometimes called Steelhead) spend most of their time in deep cold waters, but when they mature, they move into adjacent (tributary) streams to spawn in gravel found on the streambeds. When conditions are right, young Rainbow trout may stay a year or two in these sheltered streams until they grow big enough to go out to the lake. Here in the ravines, young Rainbows have been observed at the mouths of the streams in early summer coming to fill up on aquatic insects that are plentiful during that time. The Park District of Highland Park has released some Rainbow trout that have stayed over summer in the ravine stream, but conditions are hard as the streams get very dry in the hot months. That is why they have created pools and shelters to try to make it better for them and other fish using the stream.

Another large fish, the White sucker, which is native to the Great Lakes, uses tributary streams in the same way. However the White sucker is more tolerant of degraded conditions such as **turbidity** (suspended sediments in the water) and warmer temperatures. Here in the ravines, the White suckers come to the streams in April to spawn. Their eggs hatch and baby fish (fry) can be seen swimming the the streams. By July, they are usually gone, pushed out to the lake by summer storms.

On the field trip, students will observe the Rainbow trout's habitat components in a stream. Students will also have an opportunity to study habitat in a Great Lake.

Facilitators: Before students arrive, plant the four flags along the ravine (at 50 foot intervals) to mark study sites.

PROCEDURE

INTRODUCTION

1. Educators welcome students to the ravine ecosystem. Explain to students that they will be exploring this restored ravine ecosystem and decide how well it can serve as a habitat for Oncorhynchus mykiss, or the Rainbow trout [hold up picture of trout].

2. Ice breaker: Play "Pass the Trout" using the stuffed animal trout. Explain that there is no talking until you receive the

trout. When a student has the trout, they should say their name and something about themselves (facilitator decides the topic).

3. Ask students if they can explain what an **ecosystem** is. [a place where living and non-living things interact] Scientists call the living things **biotic**, and the non-living **abiotic**. Ask students to look around and brainstorm biotic and abiotic components that they observe in the ravine ecosystem.

4. Explain that one of the biotic parts of this ravine ecosystem is the fish, which is the focus of this field trip. One of the reasons we are focusing on fish is because some of the fish found in this ravine ecosystem, such as the Longnose dace, are rarely found in any other area in our state.

The Rainbow trout is another species of interest because it is particular about the quality of the water it lives in. Its presence is an **indicator** of relatively cool and clean water. If conditions are right, Rainbow trout will use streams adjacent to Lake Michigan to spawn or to find food to grow.

White suckers use the streams in the same way but they are more **tolerant** of conditions such as warmer temperatures and turbidity (suspended bits of soil which make the water cloudy). They have been successful in hatching eggs in the ravine streams. So far, Rainbow trout have not been seen doing this.

There are some important little fish (commonly called minnows) that live mostly in the **nearshore** waters of the Lake. These fish may come up the streams to lay eggs, seek shelter or find food. Lake chub and Longnose dace have both been spotted in the ravine streams. These fish vary in their tolerances for water quality.

5. Before splitting into groups to start filling out the "Ravine Habitats" student page, ask students to define habitat. [A place where an organism has everything it needs to survive.] Ask them to name the four habitat components that all species need to survive? [food, water, shelter, space] Ask if all species have the same habitat needs. [No – example: A penguin must live in a very different habitat from a zebra. A clownfish lives in a different habitat than a bass]

6. Break into three rotating groups. Explain the three stations and who will lead students through each station. Based on time constraints, spend between 10-20 minutes at each station.

STATIONS

Station 1: Water (2-3 instructors)

- Remind students to walk VERY cautiously on the rocks. Also, equipment is expensive. It should be handled with great care.
- Conduct water quality tests at one of the study sites to determine the habitat suitability of water. Students should complete results for **turbidity, temperature, dissolved oxygen (DO), pH,** and **salinity**.
    - *Note on turbidity*: For younger audiences, identifying whether the water is **turbid, translucent, or transparent** is sufficient. 6-8th graders should record numerical turbidity data.
    - *Note on salinity*: Explain that 1000 mg/L over a whole week is lethal to Rainbow trout. Ask students, what might cause salinity, or the amount of salt, to increase in the stream?
- If time remains, show students other tests as well (flow rate, conductivity).
- Explain how all of these tests help us to determine whether or not Rainbow trout can tolerate this ecosystem.

The water sample from Ravine 10L (left) is darker than Ravine 7L (right) because it has a higher turbidity level.

Station 2: Food, Shelter, and Space at Beach (1-2 instructors)

- Instructor should explain that the fish come up the stream against the current after rainstorms. Also, discuss the importance of nearshore and coastal habitats in the Great Lakes, where many small fish and several larger fish, like yellow perch, go to find food. Also, this is an area of Lake Michigan where humans can have the most impact.
- Point out areas of shelter and places where the fish can swim into the ravines (mouth or outfall of stream).
- Remind students to wait to complete their assessment of the habitat components until they have finished ALL stations.
- If time remains, introduce the game "Go Fish". Instructions can be found in the earlier lesson plan titled "Go Fish."

Station 3: Food, Shelter, and Space in Ravine (1-2 instructors)

- Guide students on a hike upstream, stopping at each of the four study sites to look for sources of food (look under rocks for invertebrates) and shelter.
- Instructor should point out the **stream pools, riffles,** cover, **and substrate** and explain their functions.
- This is a good location for students to create their sketches for question #4.

WRAP-UP

7. Ask students about the preliminary results of their assessment. Does this ecosystem have the habitat components to support a population of rainbow trout? What other tests or observations could we conduct? Do you think results might change if we were here during another season? How would they be different and why?

8. How do human actions affect this ecosystem? [1) physical destruction of habitat, 2) decreasing the water quality, and oxygen availability, and 3) introducing invasive species] **Explain what the Park District of Highland Park is doing to prevent these human impacts to this ecosystem and other natural areas in Highland Park.**

9. *If field trip was 60 minutes, take 15-30 minutes in class to ensure that all students have recorded data from the site visit.*

ASSESSMENT

1. Check student page for completion and accuracy.

2. Discuss the below questions, and have students write their own answers independently or in groups:

- What is the difference between an ecosystem and a habitat?
- Which of the habitat components are biotic factors?
- What of the habitat components are abiotic factors?
- How do human actions affect this ecosystem?

SOURCES

Staley, Kathryn. Mueller, John. Rainbow Trout (Oncorhynchus mykiss), Fish and Wildlife Habitat Management Leaflet: Number 13. May 2000. United States Department of Agriculture. Natural Resources Conservation Service. Wildlife Habitat Management Institute.

STANDARDS

SCIENCE (NGSS)

5-LS2-1, 5-ESS2-1, MS-LS1-5, MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4, MS-LS2-5, MS-ESS3-3

ENGLISH LANGUAGE ARTS (CCSS)

CCRA.W.2, CCRA.W.4, RH.6-8.7, RST.6-8.3, RST.6-8.4, WHST.6-8.1, WHST.6-8.2, WHST.6-8.2a, WHST.6-8.2b, WHST.6-8.2d, WHST.6-8.4, WHST.6-8.7

MATHEMATICS (CCSS)

4.MD.A.1, 4.MD.A.2, 5.MD.A.1, 6.EE.C.9, 7. EE.B.3, 6.SP.B.5, 6.NS.B.3, 6.NS.C.5

Student Page

Ravine Habitats

NAME: ____________________

DIRECTIONS

In your groups, complete this table to determine how well this ravine stream ecosystem could support a population of Rainbow trout. Add up your numbers in the assessment column to calculate your habitat assessment score.

HABITAT COMPONENT	WHAT TO LOOK FOR	ASSESSMENT
FOOD	Insect larvae, macroinvertebrates *What do you see?*	How many of the four sites have food present? (*Circle your answer*) 0 1 2 3 4
WATER	*Circle your answer:* Turbidity: Transparent *Yes or No* Temperature: 12-18°C *Yes or No* DO: ≥5mg/L *Yes or No* pH: 6-8.5 *Yes or No* Salinity: <1,000 mg/L *Yes or No*	How many "yeses"? 0 1 2 3 4 5
SHELTER	Overhanging rocks and tree roots Shade from trees *What do you see?*	How much of the four sites have shelter present? 0 1 2 3 4
SPACE	Pools, riffles, water level/flow *What do you see?*	How many of the four sites have physical habitat for the rainbow trout? 0 1 2 3 4

Trout-O-Meter

0-7	Unhealthy habitat
8-10	Moderately healthy habitat
11-17	Healthy habitat

My trout habitat assessment score: ______

Student Page Ravine Habitats (Continued)

1. Based on your assessment could this stream ecosystem provide healthy habitat for Rainbow trout? How might we help to make this stream healthier?

____

____

2. What other aspects of this ecosystem do you think could harm or support a population of Rainbow trout?

____

____

3. Do you think results would be different during another season? How would results differ?

____

____

4. In the box below, sketch a habitat components you observed today.

Staley, Kathryn. Mueller, John. Rainbow Trout (Oncorhynchus mykiss), Fish and Wildlife Habitat Management Leaflet: Number 13. May 2000. United States Department of Agriculture. Natural Resources Conservation Service. Wildlife Habitat Management Institute.

To Invade or Not to Invade

TIME: 40-60 minutes

GRADES: 6-8

LOCATION: Indoors

KEYWORDS:

Species, native species, non-native species, invasive species, naturalized species, terrestrial, ballast water

MATERIALS:

Print enough of the following printouts for each pair of students:
- ❑ Fish Stories
- ❑ To Invade or Not to Invade (Directions, Gameboard, Ecosystem situation cards)

Photo credit: Stock photo

SUMMARY

In this lesson students learn about the idea of invasive species. They compare characteristics of three Great Lakes fish and then play a board game modeling terrestrial invasive species in an Illinois forest.

OBJECTIVES

Students are able to:
1. Differentiate between native species and non-native or exotic species and identify whether or not a species is invasive;
2. Identify characteristics that make a species invasive;
3. Explore the social, ecological, and economic impacts of invasive species; and
4. Identify and critique solutions to control the spread of invasive species.

BACKGROUND

Since the late 19th century, humans have introduced approximately 180 **non-native species** to the Great Lakes region. About 10% of these are categorized as invasive species because of the harmful impacts they can have on their new ecosystems or on human activity.

VOCABULARY

Species: a group of organisms with common attributes and the ability to reproduce fertile offspring together.

Native species: a species that lives in a region or place without intervention from people.

Non-native species: a species (not in captivity) introduced by humans to a place outside of its historical native range.

Invasive species: a species that can be native or non-native to an ecosystem, and whose introduction can cause harm to the environment, native species, the economy, or human health. They usually have no natural predators in their new environment and reproduce rapidly.

Naturalized species: a non-native species that brings minimal negative impacts to a new ecosystem

Invasive species can impact new areas by:

- outcompeting native species for resources (food, habitat, spawning areas);
- changing the characteristics of natural areas;
- spreading diseases and parasites;
- damaging human equipment and infrastructure; and
- consuming native species.

ACCIDENTAL INTRODUCTIONS

One of the more recent invasive species in Lake Michigan is the Round goby, a bottom dwelling fish. In Illinois, the Round goby was first observed in the Grand Calumet River in 1993 and was then found in Lake Michigan near Chicago two years later. The goby outcompetes native species by spawning multiple times each year (about six times depending on temperatures) from April to September. Additionally, its advanced sensory system allows it to feed in the dark at nighttime, when other bottom dwelling fish like sculpins and darters are unable to locate food.

Round gobies are thought to have drastically reduced numbers of native Mottled sculpins through competition for food and breeding habitat. Round goby also eat the eggs of some native fish species. The Round goby is one example of a long history of accidental non-native species introductions in the Great Lakes that caused permanent changes to the ecosystem.

PREPARATION

Print "Fish Stories from Lake Michigan" student pages. Read and print directions for the invasive species modeling game. Become familiar with the invasive species information resources listed for student use. Prepare game materials by cutting out the Ecosystem Situation Cards.

PROCEDURE

INTRODUCTION: COMPARING THE IMPACTS OF SPECIES

1. Introduce the concept of an invasive species and review habitats and food webs. Students should have a foundational understanding of these concepts before participating in this exercise.

2. Introduce vocabulary terms: native species, non-native species, invasive species, and naturalized species (see "Vocabulary" box above).

3. Explore the differences and brainstorm examples of each of the above with students.

EXPLORATION: IS IT INVASIVE?

4. Instructor hands out "Fish Stories from Lake Michigan" student pages. Students work in pairs to read about each of the three species (White sucker, Rainbow trout, Round goby) and complete reading comprehension questions.

RECALL: RECAP FISH STORIES

5. After everyone has read "Fish Stories," ask students:

- Which of the three species are invasive? [Round goby]
- Where did this species come from? [ballast water from ships]
- Why is it invasive? [It outcompetes other species of fish by being aggressive and feeding at night; it can also consume zebra mussels, unlike many native fish, taking advantage of an additional food resource.]

6. Ask students if they think the White sucker and Rainbow trout are invasive in the Great Lakes [answers may vary].

7. Explain that while the Rainbow trout was brought into the Great Lakes and its streams by people, the Rainbow trout generally has minimal impact on its ecosystem. The Rainbow trout is an example of a species that has become naturalized, or has adapted to an ecosystem without causing major disruptions. Generally, naturalized species like the Rainbow trout aren't described as invasive species.

WHAT IS BALLAST WATER?

Ballast water is water held in a ship to increase its stability while floating. Ballast water is pumped into the ballast tank (at the bottom of the ship) from the surrounding the body of water. Ballast water is exchanged as a ship loads or empties cargo. For example, a freighter may fill its tank with ballast water at one port, and then release it in another port. Since that ballast water is used only for balance, most living organisms survive in the ballast tank and may also survive when the ballast water is released.

Demonstrate how ballast water keeps a ship from "keeling over" by taping the bottom of a funnel closed and placing it in a bowl of water. The funnel will tip over or sink unless the bottom of the funnel is partially filled with water.

TO INVADE OR NOT TO INVADE

8. Pass out board game materials to each pair of students, including directions, game board, game pieces, and ecosystem situation cards.

9. Game play should last approximately 15-20 minutes.

10. As students finish they should consider the discussion questions independently.

ASSESSMENT

Check student page for accuracy. Student page answers:

1. The White sucker is native. It has been in the Great Lakes for thousands of years.
2. Rainbow trout and Round gobies are non-native. They were introduced by humans.
3. Round goby is invasive. It disrupts the ecosystem by out-competing native species and reproducing rapidly.

4. Rainbow trout is naturalized. It has adjusted to living in the Great Lakes region with little impact on the ecosystem.

Instructor may also test students on their understanding of key terms (species, native species, non-native species, invasive species, naturalized species).

EXTENSIONS

INVASIVE SPECIES REMOVAL IN YOUR NEIGHBORHOOD

Every community is subject to invaders by land and water. Garlic Mustard, Buckthorn, Japanese Knotweed, and Goutweed are among the invasive plants commonly

found in or near Highland Park. See if any of these plants are growing at or near your school. To identify woodland invasive species, visit: wwx.inhs.illinois.edu/files/5513/4019/9798/WoodlandWeedsfinal.pdf

Want to work with the experts? The Park District of Highland Park has educated individuals specializing in natural area restoration and the removal of invasive species. If you are interested in setting up a work day for your student group, visit http://www.pdhp.org/ravines-project/.

INVASIVE SPECIES OUTREACH PROJECT

Students use what they have learned to create a product to educate the community about invasive species in Highland Park or in the Great Lakes.

FLOW LESSON 3: GREAT LAKES MOST UNWANTED

This lesson, designed for grades 4-8, provides fact cards, pictures, and other resources on many aquatic invasive species in the Great Lakes Region, and their impacts. www.miseagrant.umich.edu/lessons/lessons/by-broad-concept/life-science/invasive-species/

SOURCES

Becker, G. C. (1983). Fishes of Wisconsin.

City of Chicago Invasive Species Ordinance Brochure: www.cityofchicago.org/content/dam/city/depts/bacp/environmentdocs/landbasedinvasiveplantbrochure2011.pdf. Accessed July, 2013.

Mills, E. L., Leach, J. H., Carlton, J. T., & Secor, C. L. (1993). Exotic species in the Great Lakes: a history of biotic crises and anthropogenic introductions. *Journal of Great Lakes Research*, 19(1), 1-54.

Rainbow Trout and Steelheads. Wisconsin Department of Natural Resources. Environmental Education for Kids! http://dnr.wi.gov/topic/fishing/documents/species/rainbowtrout.pdf. Accessed July, 2013.

Steelhead. Michigan Department of Natural Resources. www.michigan.gov/dnr/0,1607,7-153-10364_18958-45692--,00.html. Accessed July,

2013.

Common White Sucker. Ohio Department of Natural Resources. Division of Wildlife. http://www.dnr.state.oh.us/portals/9/pdf/pub172.pdf. Accessed July, 2013.

Round Goby. Illinois Department of Natural Resources. www.in.gov/dnr/files/ROUND_GOBY.pdf. Accessed July, 2013.

STANDARDS

SCIENCE (NGSS)

4-ESS3-2, 5-LS2-1, MS-LS1-4, MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-4, MS-LS2-5, MS-ESS3-3

ENGLISH LANGUAGE ARTS (CCSS)

CCRA.R.6, CCRA.R.9, CCRA.SL.3, RH.6-8.5, RH.6-8.8, RST.6-8.2, RST.6-8.4, WHST.6-8.2d

Student Page

To Invade or Not to Invade:

Fish Stories from Lake Michigan

NAME: ____________________

DIRECTIONS

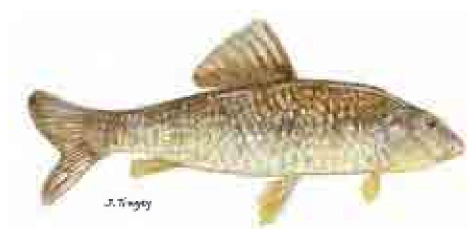
Read about three fish found in Lake Michigan and answer the following questions:

RAINBOW TROUT

WE first arrived in the Great Lakes in 1876, when humans brought a group of our ancestors from our native streams in the Western United States. We are often categorized in two groups – Rainbow trout ("landlocked") and Steelhead. If we spend our adult lives in streams, people call us Rainbow trout for our pretty colors. We tend to stay smaller (8 – 22 inches, up to 4 pounds) because we eat mostly insects and sometimes small fish. Others of us, the Steelhead, live in the Great Lakes. We are born in streams, but live our adult lives in the Great Lakes where prey fish are more abundant. As Steelhead, we swim up streams to spawn, or reproduce. Because we eat mostly fish when we live in the Great Lakes, we can grow larger (20 – 36", average 8-10 pounds, but can grow up to 20 pounds). The Illinois state record for steelhead from Lake Michigan is 31 pounds.

Both Rainbow trout and Steelhead usually spawn during the spring and fall. Fishermen really enjoy catching us, so scientists raise baby trout in a place called a hatchery, and then release us into the wild when we are big enough to find our own food. If hatcheries didn't do this, we probably wouldn't be able to sustain a population on our own. These Midwest streams are great, but they're not quite the same as the streams we are used to out west!

WHITE SUCKER



WE are suckers for Lake Michigan. Having lived here for thousands of years, this is our home. We are bottom feeders with a diversified diet, so we will eat almost anything on the bottom of the Lake Michigan, including algae, insect larvae, and crustaceans. Until we are about 8 inches in length, we can be eaten by walleye, bass, burbot, salmon and trout, and northern pike, as well as birds such as the Great Blue Heron. When we are adults, we weigh about two pounds and are 12-16", which is too large for most fish eating predators. The record White sucker caught in Michigan was 28 inches long and weighed 7 pounds.

In April and May we swim up streams to spawn. After our eggs hatch, baby suckers live in the stream for about one to two months until they are large enough to survive in the near shore habitat of Lake Michigan, which spans about 3/4 of a mile. We are generally more tolerant of a wide range of environmental conditions than other fish in the Great Lakes region.

To Invade or Not to Invade:

Fish Stories from Lake Michigan

NAME: ____________________

ROUND GOBY

WE are from the other side of the world. Our ancestors came from Europe, possibly the Black Sea or the Caspian Sea. In Illinois, we were first noticed in the Grand Calumet River in 1993. Scientists think we hitched a ride in the ballast water of a freighter that travelled to the Great Lakes and then dumped its ballast water. We are only about six inches long, but we have made Lake Michigan our home. You might even say we have taken over. Unlike almost all native fish in Lake Michigan, which spawn only once a year, we spawn multiple times between April and September. We will aggressively defend our nests from any intruder and scare native sculpins away from their preferred habitat, which is the same as ours.

A lot of people don't like us. Because we are so good at reproducing, we outcompete other bottom-dwelling fish for food. Additionally, we can feed at night and sometimes eat eggs of native fish. One of our favorite foods, both here and in our native countries, is the zebra mussel, which filters pollution (mercury, PCBs) out of the water. When a larger fish eats us, it also consumes all the pollution in our systems from dining on zebra mussels. This makes people that eat fish like trout and walleye from Lake Michigan nervous.

WHICH IS WHICH?

1. Which, if any, of these species are native to Lake Michigan? How do you know?

____

2. Which, if any, of these species are non-native to Lake Michigan? How do you know?

____

3. Which, if any, of these species are invasive in Lake Michigan? How do you know?

____

4. Which, if any, of these species are naturalized to life in Lake Michigan? How do you know?

____

LESSON MATERIALS

To Invade or Not to Invade
Invasive Species Modeling for 4-8th Graders

BACKGROUND

This is a learning game! By playing this game, students create a model that demonstrates the impact of invasive species in a fictitious forest in their community.

SUPPLIES

- ❑ Game board
- ❑ Dice (one per student group)
- ❑ Invasive species game pieces (suggestions include: beans, tokens, paper squares, etc.)
- ❑ Native species game pieces (should be different in color or shape from invasive pieces)
- ❑ Cut out game cards
- ❑ Cut out X-pieces

DIRECTIONS

Object of the game: to have as many pieces on the board at the end of the round

SET UP

- Students should work in groups of two. In each group, one student is an invasive species and one is a native species.
- In this game, a native and a non-native invasive plant species are competing in a Highland Park forest.
- Players take turns putting pieces down. For each turn, a player will roll the die. If they roll an odd number they place one piece on the space of their choice. If they roll an even they place two pieces.
- After each person takes two turns, draw one Ecosystem Situation Card and follow the directions on that card.
- After the board is filled, count your pieces and consider the discussion questions.

DISCUSSION QUESTIONS

1. What were the major ways that the invasive was able to succeed?

2. What were the main ways the invasive species was controlled?

3. What are the limitations of this game? How is it different in the real word?

4. How might this game be different if we were talking about aquatic invasive species?

LESSON MATERIALS

To Invade or Not to Invade
Invasive Species Modeling: Game Cards (Front)

VOLUNTEER WORK DAY! Remove 4 Invasive Pieces.	**BIRD CONSUMES BERRIES FROM INVASIVES** **They spread seeds around the forest.** Place 1 Invasive Piece in an available space in 5 columns of your choice.	**VOLUNTEER PLANTING DAY!** Place 3 Native Pieces in any available spaces.
VOLUNTEER WORK DAY! Remove 2 Invasive Pieces.	**FIRE!** **A large controlled burn in rows 9 and 10 destroys half of the Invasive species.** Remove half of the Invasive Pieces in rows 9 and 10.	**DROUGHT** **Plants struggle to grow.** Each player removes 3 Pieces.
BIRDS CONSUME BERRIES FROM INVASIVES **They spread seeds around the forest.** Place 1 Invasive Piece on an available space in every column.	**BIRDS CONSUME BERRIES FROM INVASIVES** **They spread seeds around the forest.** Place 1 Invasive Piece in an available space in 5 columns of your choice.	**HEALTHY GROWING SEASON** **The temperature and amount of precipitation are just right.** Each player places 3 Pieces on the board (Invasive goes first).
NEW INVASIVE ARRIVES! **This plant releases a toxin into the soil, so nothing else can grow where it grows.** Remove all Pieces from H7, H8, H9, P7, P8, P9, I7, I8 and I9. Replace with Xs. Remove Xs after three turns.	**HEALTHY GROWING SEASON** **This plant releases a toxin into the soil, so nothing else can grow where it grows.** Place 2 Natives Pieces on available spaces. Then place 3 Invasive Pieces on any available space.	**INVASIVE SPECIES REMOVAL FESTIVAL!** Remove 9 Invasive Pieces.
FOREST STEWARD **A caring individual adopts a small section of the forest.** Remove all Invasive Pieces from R1, R2, S1, and S2. For the rest of the game Invasive Pieces may not be placed on these squares	**NEW INVADER ARRIVES** **This plant brings a disease that affects the native species.** Remove all Native Pieces in N5, A5, V5, N6, A6, V6, N7, A7, and V7.	X X X X X X X X X

To Invade or Not to Invade

Invasive Species Modeling: Game Cards (Back)

ECOSYSTEM SITUATION CARD	ECOSYSTEM SITUATION CARD	ECOSYSTEM SITUATION CARD
ECOSYSTEM SITUATION CARD	ECOSYSTEM SITUATION CARD	ECOSYSTEM SITUATION CARD
ECOSYSTEM SITUATION CARD	ECOSYSTEM SITUATION CARD	ECOSYSTEM SITUATION CARD
ECOSYSTEM SITUATION CARD	ECOSYSTEM SITUATION CARD	ECOSYSTEM SITUATION CARD
Cut out X pieces on other side	ECOSYSTEM SITUATION CARD	ECOSYSTEM SITUATION CARD

LESSON MATERIALS

To Invade or Not to Invade

Invasive Species Modeling: Game Board

	H	P	I	N	V	A	D	E	R	S
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

RAVINE Education Program

Aquatic Life in Streams and Nearshore

Invasive Species Reports

TIME: Two to three 45 minute class periods

GRADES: 6-8

LOCATION: Indoors

KEYWORDS:

Species, native species, non-native species, invasive species, naturalized species, terrestrial, ballast water

MATERIALS:

- ❑ Resources
- ❑ “Invasive Species Report” student page

SUMMARY

In this activity, designed for a middle school grade level, students research, report, and present to their class on an invasive species found in the Great Lakes region.

OBJECTIVES

Students are able to:

1. Research and present information on an invasive species in the Midwest;
2. Explore the social, ecological, and economic impacts of invasive species; and
3. Identify and critique solutions to control the spread of invasive species.

BACKGROUND

Refer to the Background section in the previous lesson, “To Invade or Not to Invade.”

PREPARATION

Gather resources for student research. Consider reserving a library or computer lab for students to complete their research project.

PROCEDURE

INVASIVE SPECIES REPORT RESEARCH

1. Break students into groups of 3-4 for this activity, and provide students with student page. Groups should select one invader to research, and create a 2-3 minute presentation or video for the class with the following information:

- Common name
- How was it introduced to this area?
- What does it eat? Does it have predators?
- What makes this invader so successful?
- How does the invader affect the other plants and animals in its community? How might it affect people?
- How can we keep this invader from spreading?
- Encourage students to create their own innovative solutions to prevent their species from spreading.

Instructor should ask students to add an element of creativity to their presentations by creating a multimedia presentation (i.e., PowerPoint or Prezi), song, skit, narrative, or video.

2. Student groups (or instructor) determine which invasive species they will research. The side table contains a potential list of species for research.

Terrestrial (Land-dwelling) Invasive Species	Aquatic Invasive Species
Garlic Mustard	Sea lamprey
Common Buckthorn	Spiny water flea
Emerald ash borer	Zebra mussels and quagga mussels
Japanese beetle	Asian carp (Silver carp, big head carp)
Teasel	Purple Loosestrife
Kudzu	Eurasian Milfoil

Use the "Resources" section at the end of this lesson plan to guide students toward useful information.

3. Students should answer the research questions using the resources, and any other information sources they can locate with the instructor's guidance. For each answer students should document the source.

4. Students should prepare a 3-5 minute presentation for the class answering the research questions about their invasive species. Additionally, each group must turn in written answers to their instructor for assessment.

PRESENTATIONS & STEWARDSHIP

5. Students should present their findings to the class. Presentations should not exceed five minutes.

6. As a class discuss the implications of these invasive species.

Consider these questions:

- Which of these invaders are the most important for us to be thinking about, and why?
- What are some of the most promising solutions to controlling these invaders?
- Are there any species that we should be working harder to prevent from spreading?
- How can we help teach people about the importance of controlling our invaders?

ASSESSMENT

Collect written invasive species reports. Grade for completion and accuracy with the understanding that many invaders will have incomplete information because of the varying levels of scientific knowledge of a specific species.

Provide students with feedback on their presentations.

EXTENSIONS

INVASIVE SPECIES OUTREACH PROJECT

Students use what they have learned to create a product to educate the community about invasive species in Highland Park or in the Great Lakes.

RESOURCES

These government agencies and programs provide access to information on aquatic invasive species:

U.S. Environmental Protection Agency: www.epa.gov/greatlakes/invasive-species-great-lakes

Great Lakes Nonindigenous Species Information System: www.glerl.noaa.gov/res/Programs/glansis/glansis.html

Illinois-Indiana Seagrant: www.iiseagrant.org/nabinvader/Lakes/admin/factsheets.html

Northeastern Illinois Invasive Plants Partnership: www.niipp.net/general-information-about-invasive-plants

United States Geological Survey: http://nas.er.usgs.gov/queries/greatlakes/SpeciesList.aspx?Group=Fishes&HUCNumber=DGreatLakes&Genus=&Species=&ComName=&status=0&pathway=0&Sortb=1&SpeciesCategory=1

City of Chicago Invasive Species Ordinance Brochure: http://www.cityofchicago.org/content/dam/city/depts/bacp/environmentdocs/landbasedinvasiveplantbrochure2011.pdf

Below are terrestrial invasive species factsheets from the Illinois Natural History Survey:

Grasslands: wwx.inhs.illinois.edu/files/6313/4019/9800/GrasslandWeedsfinal.pdf

Woodlands: wwx.inhs.illinois.edu/files/5513/4019/9798/WoodlandWeedsfinal.pdf

Wetlands: wwx.inhs.illinois.edu/files/5213/4019/9798/WetlandWeedsfinal.pdf

SOURCES

Becker, G. C. (1983). Fishes of Wisconsin.

STANDARDS

SCIENCE (NGSS)

4-ESS3-2, MS-LS1-4, MS-LS2-1, MS-LS2-2, MS-LS2-4, MS-LS2-5, MS-ESS3-3

ENGLISH LANGUAGE ARTS (CCSS)

CCRA.R.7, CCRA.W.6, CCRA.W.7, CCRA.W.8, CCRA.W.9, CCRA.SL.1, CCRA.SL.2, CCRA.SL.3, CCRA.SL.4, CCRA.SL.5, RH.6-8.1, RST.6-8.1, RST.6-8.4, WHST.6-8.2d, WHST.6-8.7, WHST.6-8.9

Invasive Species Report

Student Page

NAME: ______________________

GROUP MEMBERS: ______________________

1. What is the common name of your invasive species? ______________________

2. How was it introduced to this area? ______________________

____

3. What does it eat? ______________________

____

4. Does it have predators? If so, what are they? ______________________

____

5. What makes this invader so successful? ______________________

____

____

6. How does the invader affect the other plants and animals in its community? How might it affect people?

____

____

7. How can we keep this invader from spreading? ______________________

____

____

RAVINE Education Program

Stories of Stewardship

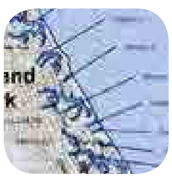
Are You Fish Friendly?

FISH FRIENDLY: STORIES FOR LEARNING

This section of the Ravine Education Program curriculum guide focuses on stewardship of the ravine habitats and other natural areas. These entertaining articles provide students with:

- Examples of people and places that protect these natural areas
- Critical thinking reflection questions
- Stewardship opportunities.

They include **six stories** designed for student reading with extension activities:



Our Ravines

Orchestrating a Solution

Working with Nature

Hatching Trout

A Love for Fish

You Can Help!

SUPPLEMENTING ACTIVITIES

Instructors may choose to use the Fish Friendly stories independently or in conjunction with activities from the previous three sections. Suggestions are indicated below:

FISH FRIENDLY STORIES	WATERSHEDS	STREAM QUALITY	RAVINE AND NEARSHORE AQUATIC LIFE
Our Ravines			
Orchestrating a Solution			
Working with Nature			
Hatching Trout			
A Love for Fish			
You Can Help!			

Standard alignments are available for each story in the Appendices, beginning on page 125.

Our Ravines

From the Mouths of the Highland Park Ravines

WHERE: Highland Park, IL

We are the ravines of Highland Park. Although our streams start in different places, we are connected because we all flow into Lake Michigan. We are special because unlike most of Illinois, which is very flat, we are made up of steep slopes that are unique to this area of the North Shore. We are home to plants and animals that you can't find elsewhere. It's important for us to stay clean so that these plants and animals can continue to use us for their habitat.

WHAT ARE RAVINES?

We are steep valleys worn down by running water. Over time we get deeper and larger as water continues to flows through us. This is called stream-cutting erosion. Our connection to Lake Michigan is what makes us such a unique ecosystem.

About 10,000 years ago, the last glaciers retreated away from this region, carving out the bottom of what we now call the Great Lakes. Across the North Shore, these glaciers left a moraine, or a giant pile of rock, clay, and sand. Over thousands of years rainwater flowed naturally over this moraine, slowly creating the ravines between Winnetka, IL and Kenosha, WI.

Sometimes we are flowing with water, like after a storm, and sometimes there is a just a trickle of water passing through. Every drop of water that lands on the ground east of Green Bay Road in Highland Park ends up in our streams. That drop of water, whether it fell as rain or came from a sprinkler in a lawn, travels down to our streams and sometimes carries other things with it as it flows. Water can bring chemicals from lawns, salt from roads or soil down to the ravines. We are connected with everyone who lives in this area because we are part of the same watershed, or water community.

Are You Fish Friendly?

Student Page

FISH IN THE WATER?

Some fish like us because we provide a place for them to spawn each spring. They swim upstream from the lake and some build their nests in our waters because we can provide calmer waters and shelter for their young. These fish also love us because we provide shelter from predators like birds, raccoons, and bigger fish. We are very important to these fish because the ones that were born here will remember that stream and come back to reproduce every year.

One of our streams, which is named 7L, has recently been restored by people in the Highland Park community. They made a lot of changes to the stream and surrounding area that make us a better habitat for the fish that make their nests there. There are now at least five fish species that use us for their habitat - White suckers, Lake chub, Longnose dace, Sticklebacks and Rainbow trout.

Not only are we a fun place to explore and play, but we are also one of the most fish friendly places in Highland Park! As long as our community continues to be protected and taken care of, the unique plants and animals of our ecosystem will continue to thrive here. Come visit us and see who lives here!

CRITICAL THINKING

1. What is special about the connections between the ravines and Lake Michigan?

____

2. Brainstorm five possible sources of pollution that could impact the ravine ecosystems.

____

____

3. What are some of the ways that you can help protect the ravines?

____

____

Orchestrating a Solution

WHAT: Ravinia Festival South Parking Lot, Permeable Parking Lot

WHERE: Highland Park, IL

Have you ever visited the Ravinia Festival to see your favorite band? Did you notice how Fish Friendly the parking lots were? Probably not. It's difficult to tell at first glance, but the new parking lots are helping to protect local ravine habitat.

Before it was replaced, the gravel parking lot at Ravinia Festival would flood after rain storms. The gravel was so compact that it was *impervious*, so the water could not move through the parking lot. The parking lot flooded about 25 days every year. During these times, no one could use the parking lot, and it created *flashy outflow*, when there is more runoff after a storm. Flashy outflow flooded stormwater drains, which lead to Lake Michigan through a local ravine in Highland Park. This *flash flood* made it difficult for fish to live in the ravine.

BEFORE

AFTER

Are You Fish Friendly?

Student Page

In 2009, the parking lot was replaced with over 27,000 square feet of permeable pavers and an underground water storage vault that holds nearly 250,000 gallons of stormwater. This storage vault acts like a giant rain barrel. Rain trickles through the parking lot and fills the water vault. The water is slowly pumped into the city's storm drain system, so flash floods are rare. In July of 2011, eight inches of rain fell on the parking lot in just 48 hours, and the parking lot never flooded. In fact, the project was so successful that Ravinia Festival has replaced another parking lot with the same system.

Photo credit: W.B. Olson

Next time you visit Ravinia Festival, take a closer look at the parking lot. There is a good chance that rain water is being stored beneath your feet. The slow release of this water into the stormwater system is friendly to the fish of Lake Michigan and the Highland Park Ravine systems.

CRITICAL THINKING

1. What do you think causes a flash flood?

____

2. What do you think is the difference between pervious and impervious surfaces? Which would be the most fish friendly?

____

____

3. How could we create more fish friendly surfaces in Highland Park?

____

____

Project information for this case study is available on the Landscape Architecture Foundation website: http://www.lafoundation.org/research/landscape-performance-series/case-studies/case-study/393/ as of April 7, 2013. Before and after photos are courtesy of SmithGroupJJR.

Working with Nature

WHO: Liz Ettelson
Natural Areas Program, Park District of Highland Park

WHERE: Highland Park, IL


Liz Ettelson measuring water quality in Ravine 7L

Imagine working in an office with over 250 acres of prairie, woodlands, ravines and wetlands, all in your own backyard. Welcome to the world of Liz Ettelson, who works in the Natural Areas Program for the Park District of Highland Park. Ettelson's job description includes controlled burns on the lake bluffs and removing acres of invasive species like buckthorn and garlic mustard.

As a child growing up in this area, Ettelson loved to be outside and at the beach. Today she is inspired by the plants and animals with which we all share a community. "I want kids in Highland Park to see how great it is that this is in their own back yard."

Lately, Ettelson has been assisting with the restoration of fish habitat and testing water quality in the Park District's ravines. It all began as a hunch, with the only proof being stories from long time residents, but it was thought that fish might be able to live in those old ravines. Since Ravine 7L at Millard Park was restored as a part of the Great Lakes Restoration Initiative, Ettelson has been measuring stream flow, turbidity, temperature, pH, and other factors that determine whether or not fish can survive in the stream. This ravine is one of 11 in the Highland Park Ravine system.

Are You Fish Friendly?

Student Page

This hard work is paying off. "Every time I see fish in the ravines it is so awesome," Ettelson says. Five species of fish have been identified in Ravine 7L since restoration was completed. These species are Lake chub, White sucker, Stickleback, Longnose dace and Rainbow trout. "I never thought I could do this kind of work at home because we don't have big natural areas like those out in Colorado and Montana, but there is so much that needs to be done here."

CRITICAL THINKING

1. Name all the plants and animals that you know live in your community.

____

____

____

2. Ettelson's job is to protect natural areas in Highland Park. Think of two actions that you can take as a Highland Park citizen to protect these areas.

____

____

Are You Fish Friendly?

Working with Nature
Extension: Get Involved!

INVASIVE SPECIES REMOVAL

Rid your home or school of invasive species! Garlic Mustard, Buckthorn, Japanese Knotweed, and Goutweed are among the invasive plants commonly found in or near Highland Park. To identify common woodland invasive species, visit: http://www.inhs.illinois.edu/research/CAPS/docs/WoodlandWeedsfinal.pdf

To learn more about invasive species remove efforts, visit the Northeastern Illinois Invasive Plants Partnership website: http://niipp.net/?page_id=1016

VOLUNTEERING

Are you interested in volunteering with the Natural Areas Program at the Park District of Highland Park? They need your help! If you are interested in helping to protect these unique areas, contact Liz Ettelson at eettelson@pdhp.org

Hatching Trout

WHO: Highland Park High School
A classroom hatchery for Rainbow trout

WHERE: Highland Park, IL


Mr. Hill's trout aquarium

Do you have any pets at home? What about pets in your classroom? Classes around Highland Park are adopting pets that may surprise you: *Oncorhynchus mykiss*, more commonly known as the Rainbow trout. The latest group to raise trout is the students in Mr. and Mrs. Hill's Environmental Science classes at Highland Park High School.

In October of 2012 Mr. and Mrs. Hill received 380 trout eggs and kept them in a 67 gallon aquarium in their classroom. Over the winter and spring, students in their environmental science classes watched as the eggs hatched into larval fish, which grew into fry.

HOW TO KEEP A PET TROUT

Keeping 380 pets is no easy task. "Nico Ugolini and Jeremy Solomon were the caretakers after the eggs hatched," Mr. Hill said. "They tested the water chemistry and other students helped feed the fish and changed their water regularly. Some volunteered to do this over weekends and holidays."

Having trout in the classroom brought science alive for students in Mr. Hill's and Mrs. Hill's classes. "They loved feeding the fish and learning about fish biology, conservation, water chemistry, and the sources and impacts of water pollution," Mr. Hill said. Students also learned a difficult lesson about density dependence, where limiting factors allow only a certain number of fish to survive in a habitat. "Students were all engaged in the fish themselves. They all certainly responded to the losses we had."

Are You Fish Friendly?

Student Page

RELEASE

In April 2013, after raising the fish for about five months, students released the trout into a ravine stream in Highland Park. After a release, the fry will hopefully live in the ravine until they are big enough and strong enough to survive in Lake Michigan. When you visit the ravines, look for Rainbow trout and other fish, like White suckers and Lake chubs. You might get lucky!

CRITICAL THINKING

1. Density dependence is caused by limiting factors in a habitat. What might have been some of the limitations for the trout in Highland Park High School's aquarium? *(Hint: think about what animals need to have a healthy habitat)*

____

____

____

2. If the Hills had three aquariums, would they be able to support more fish or less fish? Why?

____

____

____

RAVINE Education Program

Stories of Stewardship

Are You Fish Friendly?

Hatching Trout

Extension: In Your Classroom

EXPLORE HATCHERIES

In the United States, each state has a fish hatchery program. Illinois has three fish hatcheries, where fish are raised in large numbers and released into local lakes, rivers, and streams. Since 1984, the Illinois Hatchery System has released 500 million fish, including trout, salmon, bass, walleye, bluegill, and catfish. To read more about these hatcheries, visit: www.ifishillinois.org/programs/hatchery.html

To see a searchable database with specific stocking activities in the Great Lakes, visit: http://www.glfc.org/fishstocking/exactsearch.htm.

Also, the Michigan Department of Natural Resources offers a readable database for their release activities throughout the state of Michigan: http://www.michigandnr.com/fishstock/.

BRING TROUT TO YOUR CLASSROOM

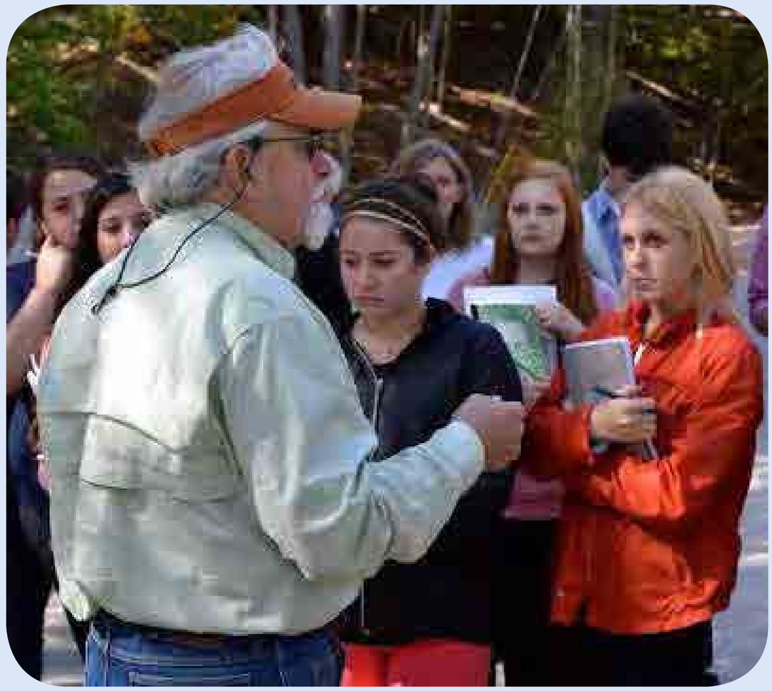
To become involved in Trout in the Classroom, connect with your local Trout Unlimited Chapter. In Northern Illinois, the Gary Borger Chapter works with several classrooms, including the Hills'. Visit the Gary Borger Chapter website for contact information: http://garyborger.tu.org/.

Juvenile Rainbow trout

A Love for Fish

WHO: Mr. Jim Tingey
Fisher, retired teacher, artist

WHERE: Highland Park, IL



Jim Tingey teaching a class at Ravine 7L

Jim Tingey received his first fishing pole when he was five years old – actually, he made the pole out bamboo growing in his backyard. The goldfish in his neighbor's pond captured his attention, and soon he had used his homemade pole to catch his first fish. When Tingey returned home to show off his catch, he received his first lesson in catch and release fishing. "My mom told me to take it back to the fish pond and put it back," Tingey remembers. "Being a large goldfish, it made the trip back and still lived for many years, though it never swam in a vertical position – sort of at an angle."

An avid fish lover, in 2011 he fished in 13 states and caught fish from 36 different species. Nearly all of these fish were released back into their habitat. "I think catch-and-release promotes the opportunity to catch something, but not kill it, let it go back, and live," he says. "Maybe it will be caught a second time, for fun, by another angler."

Tingey has combined catch-and-release fishing with another lifelong hobby, painting. He encourages other fishers to practice catch-and-release when fishing. When they catch a trophy fish, he is there to help. If someone sends him a picture of a special catch, he paints the fish so that it can be remembered forever.

Are You Fish Friendly?

When asked about how this helps fish populations, Tingey says that it has a small impact, but he adds that there are even more ways fishers can help fish. “The biggest issue with sport fishing is the type of lures used with massive barbed treble hooks that wreck a fish. Even though people put the fish back in the water, sometimes it is just a matter of time before it will die.”

Here are Tingey’s suggestions for protecting the fish you catch:

1. Use single hooks instead of treble hooks
2. Trim the barbs off your hooks so that the hook is easier to remove
3. When you let the fish go, don’t “throw it back”. Belly smackers are no fun when you are swimming, and they’re no fun for the fish when they are released.

Also, don’t forget that there is no fishing allowed in the Highland Park ravines!

CRITICAL THINKING

1. What are the benefits and draw backs of catch and release fishing?

____

____

2. How might releasing a giant trophy fish back into its natural habitat impact fish populations? *(Hint: think about the lifecycle of fish – do fish spawn when they are old or young?)*

____

____

3. Mr. Tingey combines his love for fish with his painting talent to help fishermen become better conservationists. Within your group, think of a way that you might use your special talents and hobbies to help others in your community become better conservationists.

____

____

You Can Help!

WHO: You

WHERE: Highland Park Ravines

WHAT TO BRING: Garbage bag, rubber globes, empty water bottle

Visit a ravine that is close to your home with your parents. This might be in your backyard, down the street, or across town. The Park District of Highland Park invites you to visit Ravine 7L at Millard Park or Ravine 3L at Rosewood Beach. Bring a garbage bag and gloves to pick up trash and help keep the ravines clean for fish. If possible, fill a bottle with water from the ravine and bring it to class to discuss water quality.

QUESTIONS

1. Which ravine are you visiting? ____

2. When you visit the ravine, take notes on what you see.

____

____

____

3. What types of plants are growing?

____

____

Are You Fish Friendly?

Student Page

4. Did you observe any animals in the ravine, and where were they? Also, what evidence of animals did you observe? (Examples: tracks, scat, feathers, animal sounds, etc.)

____

____

5. Do you see water flowing through? Do you think fish might be living in the ravine today? Why or why not?

____

____

6. How would the ravines look different if you were here during another season? Would there be different plants and animals?

____

____

7. If you lived in this ravine, how would you fulfill your habitat needs? (food, water, shelter, space?)

____

____

8. List any garbage items you found in the ravine.

____

____

9. Did you collect a water sample to share with the class? ☐ Yes ☐ No

Are You Fish Friendly?

Student Page

10. In the space below, create a sketch of something unique that you observed at the ravine today.

GLOSSARY

RAVINE Education Program

Abiotic	The non-living components of an ecosystem.
Absorbent	Able to soak up liquid easily.
Acidic	A substance with more hydrogen ions (H+) than hydroxide ions (OH-). pH of an acidic substance is 6 or less.
Acre	A measurement of area equal to 43,560 square feet, or one football field without endzones.
Adaptation	Physical characteristics and/or behaviors that organisms have developed over time to survive in their ecosystem.
Adipose fin	A fleshy fin located near the tail of Rainbow trout.
Alkaline (basic)	A substance with more hydroxide ions (OH-) than hydrogen ions (H+). pH of an alkaline substance is 8 or more.
Anal Fin	A fin usually located near the vent, which assists with balance.
Aquatic	Growing or living in water.
Ballast water	The water that a ship takes on in order to stay stable while floating.
Basin	The total land area drained by a river or its branches.
Benthic	The bottom region of a water body.
Biodiversity	The variety of species living in a place.
Biotic	The living components of an ecosystem.
Bluff	An outcropping of rock, usually high above a river or lake system.
Carnivore	An organism that eats other animals.
Carrying capacity	The maximum population that a habitat can support.
Cartography	The study of maps and map making.
Caudal fin	Also called the tail fin, this fin propels the fish through the water.

GLOSSARY (continued)

Coastal	Area along water, near a stream, river, lake, or ocean.
Conservation	A coherent, consistent practice of wise and thoughtful decision-making and consumption of natural resources for present and future generations.
Consumer	An organism that eats other living things.
Cubic feet per second	A measurement of a liquid's flow rate. For example, if a bucket is filled with one cubic foot of water (7.5 gallons), and the bucket is emptied in 1 second, it is emptied at a rate of one cubic foot per second.
Cubic foot	A measurement of volume equal to 7.5 gallons.
Current	The continuous movement of water in a certain direction.
Dissolved Oxygen (DO)	The dissolved form of oxygen, which occurs in a liquid.
Dorsal fin	A fin located on the back of fish, which assists with balance and maneuverability.
Ecology	The study of ecosystems.
Ecosystem	A place where living and non-living things interact.
Ecotone	The transitional zone between ecosystems.
Erosion	To wear away by the action of water, wind, or glacial ice.
Food chain	A simplified section of a food web.
Food web	The natural flow of energy and matter through the living and non-living components of an ecosystem.
Gallon	A measurement of volume equal to four quarts, eight pints, or 128 fluid ounces.
Geographic Information System (GIS)	A computer mapping program that can be used to create maps at local, state, national, and global scales, using specific sets of data.
Groundwater	Water that travels through the ground, where it is cooled and purified naturally.
Habitat	A natural environment where an organism lives. Habitats contain the food, water, shelter and space an organism needs in order to survive.
Herbivore (primary consumer)	An organism that eats only plants or other producers.

GLOSSARY (continued)

Impervious	A surface that cannot be penetrated.
Indicator	In ecology, a plant or animal whose existence in an area is linked to specific environmental conditions.
Invasive species	A species that can be native OR non-native to an ecosystem, and whose introduction can cause harm to the environment, native species, the economy, or human health. Invasive species generally have no natural predators in their environment and reproduce rapidly.
Lateral line	A line of special scales with pore-like openings that detects disturbances in water.
Limiting factors	Situations that prevent a population from exceeding carrying capacity (i.e., disease, predator-prey relationships, pollution, and habitat destruction.
Macroinvertebrates	Invertebrates (animals without a backbone) large enough to be seen without a microscope.
Mile	A measurement of distance equal to 5,280 feet or 1,609 meters.
Native species	A species that lives in a region or place without an intervention from people.
Naturalized species	A non-native species that brings minimal negative impacts to a new ecosystem.
Nearshore ecosystem	A system of shallow areas along the shoreline of a large lake that provides an abundance of food, shelter, and space for many freshwater species.
Neutral	A substance with about the same amount of hydroxide ions (OH^-) and hydrogen ions (H^+). pH of a neutral substance is between 6-8.
Non-native species	A species (not in captivity) introduced by humans to a place outside of its historical range.
Omnivore	An organism that eats both plants and animals.
Opaque	Not clear; not transmitting or reflecting light or radiant energy.
Open water ecosystem	A system of deep, dark, and cold water lacking food and shelter for most freshwater species.
Operculum	Gill cover, which protects fish gills.
Parr	Juvenile trout or salmon.
Pelagic	Any water in a lake or ocean that is not near the bottom or the shore.
Pelvic fins	Paired fins on a fish that provide stability and help to steer the fish when swimming in an upward or downward direction.

GLOSSARY (continued)

Permeable	Allowing a substance like water flow through.
Pervious	A surface that can be penetrated.
pH	A measurement of the ratio of Hydrogen ions (H+) to Hydroxide ions (OH-). pH is measured on a scale from 0-14.
Pool	A stretch in a stream where stream velocity is lower than average, and water depth is above average.
Population	Number of organisms of the same species in a place.
Preference	When one option is favored over another option.
Primary consumer (herbivore)	An organism that eats only plants or other producers.
Producer	An organism that creates its own food
Ravine	A landform narrower than a canyon that is often the product of erosion from streams.
Riffle	A stretch in a stream where stream velocity is higher than average, usually because of a drop in elevation.
Runoff	Water that is not absorbed by the ground.
Salinity	The amount of salt in a solution.
Sand	Loose material produced by the natural breaking up of rocks.
Secondary Consumer	An organism that eats other consumers. Secondary consumers can be either omnivores or carnivores.
Sediment	Soil material carried away by moving water. Sediment is a form of pollution that can alter an ecosystem.
Sedimentation	The process of depositing sediment in layers.
Silt	Very small soil or clay particles in water.
Solute	A substance that is dissolved in another substance.
Solution	A homogenous mixture of two or more substances.
Solvent	A substance that dissolves another substance.
Species	A group of organisms with common attributes and the ability to reproduce fertile offspring together.

GLOSSARY (continued)

Square mile	A measurement of area equal to a 640 acres.
Stormwater	Water that falls on the land during a storm.
Stream ecosystem	A system of flowing water supported by groundwater and runoff, and provides food, shelter, and space for many freshwater species. The availability of these resources can change seasonally, depending on the stream's flow rate.
Substrate	The material make-up of the benthic (bottom) region of an aquatic ecosystem.
Suspended solids	Solid matter that is contained within a volume of water. May include silt and clay particles, plankton, algae, and fine organic debris.
Terminal mouth	A horizontal pointing mouth common on fish species that consume other fish, such as the Rainbow trout.
Terrestrial	Related to earth. In the context of ecology, terrestrial describes a land-based ecosystem, as opposed to an aquatic ecosystem such as a ravine stream or a lake.
Tolerance	The ability to deal with something that is difficult or painful.
Ton	A measurement of mass equal to 2,000 pounds or 907 kilograms. An average car weighs about one ton.
Topographic map	Maps with contour lines that express changes in elevation.
Translucent	Almost transparent; allowing light to pass through diffusely.
Transparent	Able to be seen through with clarity.
Trophic level	Feeding levels of a food chain (i.e., producer, primary consumer, secondary consumer, and decomposer).
Turbidity	A measurement of light passing through water (i.e., relative clarity).
Velocity	Speed, like the speed of a current in a stream.
Vent	The location on a fish where solid and liquid waste are released.
Ventral mouth	A downward pointing mouth common on bottom feeding fish species, such as the White sucker.
Watershed	An area of land where all the water drains into the same place.

RAVINE Education Program

Alignments with Next Generation Science Standards Performance Expectations

Code	Grade	Performance Expectation	Build a Watershed	Know Your Watershed	Map Your Watershed	Soaking in the Ravines	Let's Be Clear	Take a Deep Breath	A Matter of Balance	Living with Limits	A Ravine's Web of Life	Go Fish!	Head to Tail	How Healthy is the Habitat?	To Invade or Not to Invade	Invasive Species Reports	Our Ravines	Orchestrating a Solution	Working with Nature	Hatching Trout	A Love for Fish	You Can Help!
			Ravine Education Program Activities																			
4-LS1-1.	4	Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.									X	X	X									
4-LS1-2.	4	Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.								X		X	X									
4-ESS1-1.	4	Identify evidence from patterns in rock formations and fossils in rock layers for changes in a landscape over time to support an explanation for changes in a landscape over time.			X												X					
4-ESS2-1.	4	Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.	X		X	X	X										X	X				
4-ESS2-2.	4	Analyze and interpret data from maps to describe patterns of Earth's features.	X	X	X												X					
4-ESS3-2.	4	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.				X	X	X	X						X	X	X	X	X	X	X	X
5-PS1-3.	5	Make observations and measurements to identify materials based on their properties.				X	X	X	X													
5-PS1-4.	5	Conduct an investigation to determine whether the mixing of two or more substances results in new substances.						X														
5-PS2-1.	5	Support an argument that the gravitational force exerted by Earth on objects is directed down.		X	X																	

Alignments with Next Generation Science Standards Performance Expectations

RAVINE Education Program

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			Ravine Education Program Activities																			
5-PS3-1.	5	Use models to describe that the energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.									X											
5-LS1-1.	5	Support an argument that plants get the materials they need for growth chiefly from air and water.									X											
5-LS2-1.	5	Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.								X	X	X		X	X							
5-ESS2-1.	5	Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.	X		X	X				X	X			X			X	X				X
5-ESS2-2.	5	Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.		X																		
5-ESS3-1.	5	Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.	X	X		X	X	X	X	X							X	X	X	X	X	X
3-5-ETS1-2.	3-5	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.				X																
3-5-ETS1-3.	3-5	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.				X	X	X	X													

Alignments with Next Generation Science Standards Performance Expectations

			Ravine Education Program Activities																			
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MS-PS1-2.	6-8	Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.						X														
MS-PS1-4.	6-8	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.						X														
MS-LS1-2.	6-8	Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.											X									
MS-LS1-3.	6-8	Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.											X									
MS-LS1-4.	6-8	Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.								X	X	X	X		X	X						
MS-LS1-5.	6-8	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.					X	X	X		X	X		X						X		
MS-LS1-6.	6-8	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.								X	X			X	X				X			
MS-LS1-8.	6-8	Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.								X			X									

RAVINE Education Program

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MS-LS2-1.	6-8	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.								X	X	X		X	X	X						
MS-LS2-2.	6-8	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.								X	X	X		X	X	X						X
MS-LS2-3.	6-8	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	X							X	X	X		X								
MS-LS2-4.	6-8	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.					X	X	X	X	X	X		X	X	X	X	X		X	X	X
MS-LS2-5.	6-8	Evaluate competing design solutions for maintaining biodiversity and ecosystem services.				X	X	X	X					X	X	X		X				
MS-LS4-1.	6-8	Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.											X									
MS-LS4-2.	6-8	Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.											X									
MS-ESS2-1.	6-8	Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.		X							X	X										

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			Ravine Education Program Activities																			
MS-ESS2-2.	6-8	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.	X	X	X	X											X					
MS-ESS2-4.	6-8	Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.	X	X		X											X					
MS-ESS3-1.	6-8	Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.	X	X	X	X											X					
MS-ESS3-3.	6-8	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	X			X	X	X	X					X	X	X						X
MS-ETS1-1.	6-8	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.				X																
MS-ETS1-2.	6-8	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.				X																

Alignments with Common Core English Language Arts Standards

Code	Grade	Standard	Build a Watershed	Know Your Watershed	Map Your Watershed	Soaking in the Ravines	Let's Be Clear	Take a Deep Breath	A Matter of Balance	Living with Limits	A Ravine's Web of Life	Go Fish!	Head to Tail	How Healthy is the Habitat?	To Invade or Not to Invade	Invasive Species Reports	Our Ravines	Orchestrating a Solution	Working with Nature	Hatching Trout	A Love for Fish	You Can Help!
			Ravine Education Program Activities																			
CCRA.R.1	K-12	Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.															X	X	X	X	X	X
CCRA.R.6	K-12	Assess how point of view or purpose shapes the content and style of a text.													X		X	X	X	X	X	X
CCRA.R.7	K-12	Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.			X		X	X								X						
CCRA.R.9	K-12	Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.													X							
CCRA.R.10	K-12	Read and comprehend complex literary and informational texts independently and proficiently.															X	X	X	X	X	X
CCRA.W.2	K-12	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.			X		X	X	X					X								
CCRA.W.3	K-12	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details and well-structured event sequences.								X	X											
CCRA.W.4	K-12	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.			X			X	X					X								

RAVINE Education Program

Alignments with Common Core English Language Arts Standards

			Ravine Education Program Activities																			
Code	Grade	Standard	Build a Watershed	Know Your Watershed	Map Your Watershed	Soaking in the Ravines	Let's Be Clear	Take a Deep Breath	A Matter of Balance	Living with Limits	A Ravine's Web of Life	Go Fish!	Head to Tail	How Healthy is the Habitat?	To Invade or Not to Invade	Invasive Species Reports	Our Ravines	Orchestrating a Solution	Working with Nature	Hatching Trout	A Love for Fish	You Can Help!
CCRA.W.4	K-12	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.			X			X	X					X								
CCRA.W.6	K-12	Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.														X						
CCRA.W.7	K-12	Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.														X						
CCRA.W.8	K-12	Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.														X						
CCRA.W.9	K-12	Draw evidence from literary or informational texts to support analysis, reflection, and research.														X						
CCRA.SL.1	K-12	Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.														X						
CCRA.SL.2	K-12	Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.														X						
CCRA.SL.3	K-12	Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.													X		X	X	X	X	X	X

Park District of Highland Park

Great Lakes RESTORATION

RAVINE Education Program

Alignments with Common Core English Language Arts Standards

			Ravine Education Program Activities																			
Code	**Grade**	**Standard**	**Build a Watershed**	**Know Your Watershed**	**Map Your Watershed**	**Soaking in the Ravines**	**Let's Be Clear**	**Take a Deep Breath**	**A Matter of Balance**	**Living with Limits**	**A Ravine's Web of Life**	**Go Fish!**	**Head to Tail**	**How Healthy is the Habitat?**	**To Invade or Not to Invade**	**Invasive Species Reports**	**Our Ravines**	**Orchestrating a Solution**	**Working with Nature**	**Hatching Trout**	**A Love for Fish**	**You Can Help!**
CCRA.SL.4	K-12	Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.														X						
CCRA.SL.5	K-12	Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.														X						
RH.6-8.1	6-8	Cite specific textual evidence to support analysis of primary and secondary sources.														X						
RH.6-8.5	6-8	Describe how a text presents information (e.g., sequentially, comparatively, causally).													X		X	X	X	X	X	X
RH.6-8.7	6-8	Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.			X			X	X					X								
RH.6-8.8	6-8	Distinguish among fact, opinion, and reasoned judgment in a text.													X		X	X	X	X	X	X
RST.6-8.1	6-8	Cite specific textual evidence to support analysis of science and technical texts.														X						
RST.6-8.2	6-8	Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.													X							
RST.6-8.3	6-8	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.				X	X	X	X					X								

RAVINE Education Program

Alignments with Common Core English Language Arts Standards

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			Ravine Education Program Activities																			
RST.6-8.4	6-8	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
WHST.6-8.1	6-8	Write arguments focused on discipline-specific content.				X		X	X					X								
WHST.6-8.2	6-8	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.												X								
WHST.6-8.2a	6-8	Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.												X								
WHST.6-8.2b	6-8	Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.												X								
WHST.6-8.2d	6-8	Use precise language and domain-specific vocabulary to inform about or explain the topic.	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
WHST.6-8.4	6-8	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.				X		X	X					X			X	X	X	X	X	X

RAVINE Education Program

Alignments with Common Core English Language Arts Standards

			Ravine Education Program Activities																			
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WHST.6-8.7	6-8	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.												X		X						
WHST.6-8.9	6-8	Draw evidence from informational texts to support analysis reflection, and research.	X													X						

RAVINE Education Program

Alignments with Common Core Mathematics Standards

			Ravine Education Program Activities																			
Code	Grade	Standard	Build a Watershed	Know Your Watershed	Map Your Watershed	Soaking in the Ravines	Let's Be Clear	Take a Deep Breath	A Matter of Balance	Living with Limits	A Ravine's Web of Life	Go Fish!	Head to Tail	How Healthy is the Habitat?	To Invade or Not to Invade	Invasive Species Reports	Our Ravines	Orchestrating a Solution	Working with Nature	Hatching Trout	A Love for Fish	You Can Help!
4.MD.A.1	4	Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table.		X	X	X	X	X	X					X								
4.MD.A.2	4	Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.	X	X	X	X								X								
4.MD.A.3	4	Apply the area and perimeter formulas for rectangles in real world and mathematical problems. For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.		X		X																
5.MD.A.1	5	Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.		X			X	X						X								

Alignments with Common Core Mathematics Standards

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			Ravine Education Program Activities																			
6.EE.C.9	6	Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation.					X	X	X					X								
7.EE.B.3	7	Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies.		X			X							X								
6.SP.B.5	6	Summarize numerical data sets in relation to their context.		X		X	X	X	X					X								
6.NS.A.1	6	Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fraction models and equations to represent the problem.		X		X																

RAVINE Education Program

Alignments with Common Core Mathematics Standards

			Ravine Education Program Activities																			
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6.NS.B.2	6	Fluently divide multi-digit numbers using the standard algorithm.		X																		
6.NS.B.3	6	Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.		X		X								X								
6.NS.C.5	6	Understand that positive and negative numbers are used together to describe quantities having opposite directions or values; use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.		X										X								

ADDITIONAL RESOURCES

RAVINE Education Program

COLLABORATORS

City of Highland Park, www.cityhpil.com

Park District of Highland Park, www.pdhp.org

Gary Borger Chapter of Trout Unlimited, http://garyborger.tu.org/

Great Lakes Restoration Initiative, http://greatlakesrestoration.us

CITY OF HIGHLAND PARK RESOURCES

Living in a Lakefront & Ravine Community, www.cityhpil.com/documents/21/HPBrochureFinal.PDF

Select Recommendations for Protecting your Ravine-Bluff Property, https://www.cityhpil.com/documents/21/SlopeMaintenanceDosandDonts.PDF

Select Native Plants for Restoration, https://www.cityhpil.com/documents/16/Select%20Native%20Ravine%20Plants%20for%20Restoration-%20April%202011.PDF

IN THE NEWS

Trib Local: "Lake Michigan Fish Making Use of Ravines," www.triblocal.com/highland-park-highwood/community/stories/2011/07/lake-michiagn-fish-making-use-of-lakefront-ravines/index.html

Trib Local: "Braeside Students Release their Small Fry this Week," www.triblocal.com/highland-park-highwood/2012/04/10/braeside-students-release-their-small-fry-this-week/index.html

Chicago Tribune: "Rare Plants Thrive in North Shore Ravines," http://articles.chicagotribune.com/2009-06-25/travel/chi-brotman-090910-rareplants-story_1_lake-michigan-preserves-plants

Chicago Wilderness: "Shedding Light on North Shore Ravines," http://173.254.34.128/CW_Archives/issues/fall2008/ravines.html

Alliance for the Great Lakes: "Cultivating Nature's Corridors to Cleanse the Great Lakes," www.greatlakes.org/RavineRescues

OTHER INFORMATION

Alliance for the Great Lakes: Lake Michigan Ravines, http://greatlakes.org/document.doc?id=750

Video of fish swimming up Ravine Drive in Highland Park, www.youtube.com/watch?v=C9pAeAEmUYk

Highland Park Ravines Project Blog, http://hpravines.blogspot.com