ONTARIO ecoschools écoécoles de l'ONTARIO

THE GREAT LAKES: A LEARNING AND ACTION RESOURCE

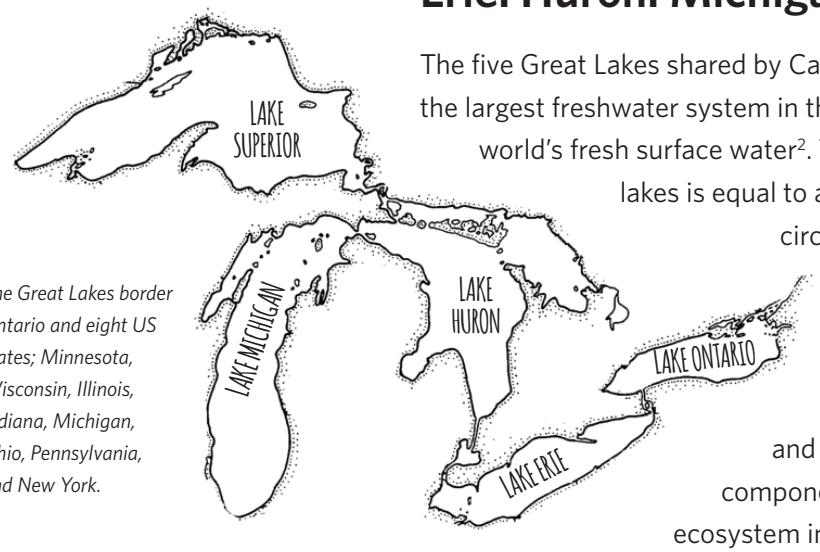
TABLE OF CONTENTS

ALL ABOUT THE GREAT LAKES

"The Great Lakes are vitally important to Ontario families. They provide us with drinking water, quality of life, and prosperity. We need to keep the Great Lakes healthy now, and for our children, grandchildren, and future generations. We need Great Lakes that are drinkable, swimmable and fishable."[1]

FROM ONTARIO'S GREAT LAKE STRATEGY

Erie. Huron. Michigan. Ontario. Superior.



The Great Lakes border Ontario and eight US states; Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York.

The five Great Lakes shared by Canada and the United States are the largest freshwater system in the world, containing 18% of the world's fresh surface water[2]. The combined shoreline of all five lakes is equal to approximately 45% of the Earth's circumference[3]. Connected to the Atlantic Ocean by the St. Lawrence Seaway, the impact of the Great Lakes extends beyond regional borders. The Great Lakes Basin and nearby watersheds are an integral component of a healthy and sustainable ecosystem in Ontario.

Formed after the last ice age by glacial erosion, the Great Lakes are dynamic bodies of water that have adapted and changed over thousands of years. As the thick ice melted, the lakes took shape, new bodies of water emerged, and the current drainage system developed. Lake Ontario formed approximately 7000 years ago when the last of the ice disappeared, flowing into the Atlantic Ocean via the St. Lawrence River[4]. The retreating sheet of ice also temporarily merged Lakes Superior, Michigan, and Huron into the expansive Lake Nipissing. As water levels shifted and the ice-free land rose, the three lakes resumed their distinct, separate forms, connected by rivers and tributaries. The Great Lakes evolved into their current shape approximately 3000 years ago, which includes a 3700 km long inland waterway that stretches through Canada from the Gulf of St. Lawrence to Lake Superior[5].

The Great Lakes contain enough freshwater to flood the continental United States and people have been drawn to their shores for centuries[6]. From the First Nations communities who lived in longhouses farming and hunting, to the 33 million people currently supported by the lakes across geographic borders. 8.5 million Canadians receive their drinking water from the Great Lakes[7], which continue to provide essential natural resources, contribute to economic activity, and act as a transportation hub. Over the years, the impact of human activity and the corresponding development has changed both the lakes and land around them.

The Great Lakes Basin covers more than 750 000 square kilometres[8]. Each lake and surrounding area has their own distinct characteristics and unique qualities that contribute to basin as a whole.

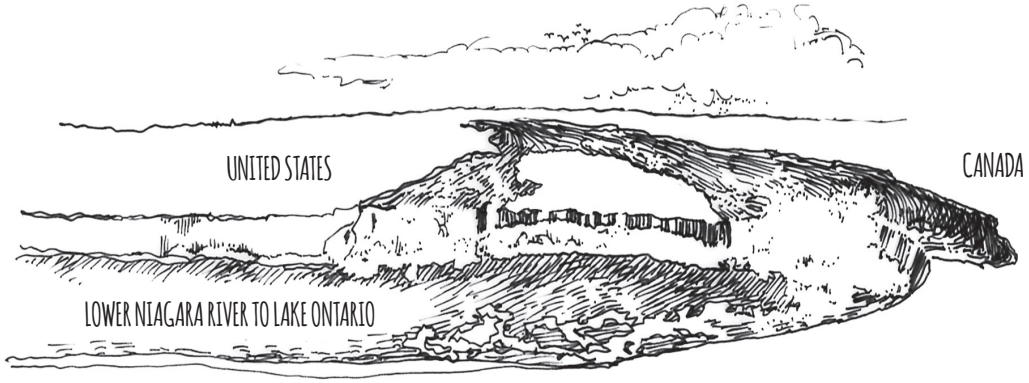
Lake Profiles

Lake Erie – The shallowest and warmest of all five lakes, Lake Erie's complex ecosystem supports a vibrant fishing industry and is also a breeding ground for invasive species and algal blooms[9]. The lake's rich natural resources contributed to the development of active manufacturing industries on both sides of the border. As a result of urbanization, deforestation, and pollution, the condition of the lake and its surrounding area declined considerably. In an attempt to restore the lake, international agreements were made and conservation efforts began in the 1970s. While the condition of Lake Erie has improved considerably, pollution and algal blooms remain a constant concern[10].

Lake Huron – The second largest of the five lakes with the longest shoreline, Lake Huron was the first to be visited by European explorers and was initially called "la mer douce" or the gentle sea[11]. Georgian Bay, the eastern part of Lake Huron, was once thought to be a sixth lake. The bay is separated from the rest of the lake by the Bruce Peninsula and Manitoulin Island – the largest freshwater island in the world[12]. As the only Great Lake without a major city on its shores, the land around Lake Huron remains heavily forested and rich in natural resources.

Lake Michigan – The only Great Lake to be entirely in the United States, Lake Michigan is the third largest of the five lakes. Connected to Lake Huron by the Straits of Mackinac, the cul-de-sac like structure of Lake Michigan keeps water slowly circulating in the basin for years before eventually flowing into Lake Huron[13]. The shores of Lake Michigan differ considerably on the north and south sides of the lake. The northern shore is heavily forested, sparsely populated, and home to the world's largest freshwater dune system, while the busier southern shore is dominated by active industrial and agricultural production[14].

Lake Ontario – Although Lake Ontario is the smallest of the Great Lakes, more Canadians live on its watershed than on any other watershed in the country. With an average depth second only to Lake Superior, Lake Ontario maintains cooler temperatures and never completely freezes over[15]. The lake connects the Great Lakes with the Atlantic Ocean through the St. Lawrence River and all the water from the other four lakes flow through it. With this water flow comes a flow of pollution, which combined with the run-off and waste from its own shoreline, makes Lake Ontario the most threatened of the Great Lakes[16].

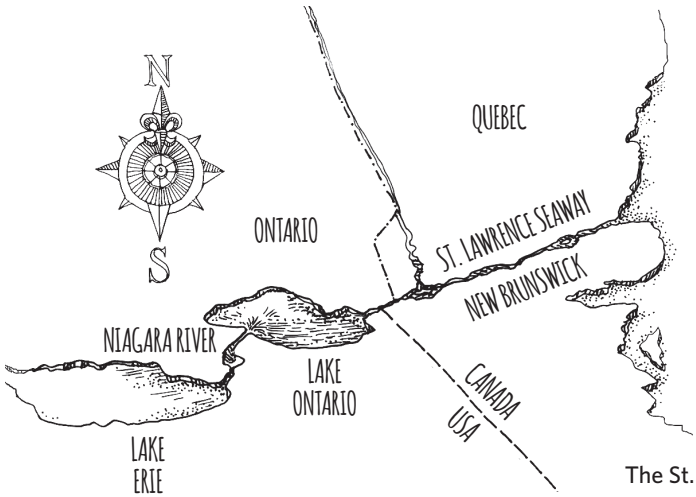


Niagara Falls connects Lake Erie to Lake Ontario

One of the region's most popular tourist destinations, Niagara Falls lies on the border of Ontario and New York. The falls were formed approximately 10,000 years ago when glaciers retreated and water began to flow from Lake Erie to Lake Ontario[17].

Lake Superior – The world's largest freshwater lake, Lake Superior contains more water than all the other four lakes combined[18]. The northernmost Great Lake is rich in natural resources and known for its cool, clear water. The area around the lake is sparsely populated, remote, and beautiful with rocky shores that attract a large number of tourists each year. Over 350 shipwrecks line the bottom of the lake[19], one of the most famous being the *Edmund Fitzgerald*.

Lake St. Clair and the St. Lawrence River – In addition to the five Great Lakes, Lake St. Clair and the St. Lawrence River are integral components of the freshwater system. The small Lake St. Clair has the largest delta system in the region and connects Lake Huron to Lake Erie[20]. The St. Lawrence River lies at the end of the inland waterway, flowing from Lake Ontario into the Gulf of St. Lawrence, which leads into the Atlantic Ocean. Constructed in the 1950s, the St. Lawrence Seaway allows for a steady stream of ships to pass from the Great Lakes into the ocean and beyond[21]. The extensive transportation system is among the busiest in the world, which shipping cargo alone providing approximately 60,000 jobs in the region[22].



The St. Lawrence Seaway
The St. Lawrence Seaway brought North American and European markets closer together with faster shipping times.

The Great Lakes: A Systems Perspective

The Great Lakes and related waterways are only one aspect of the Great Lakes Basin. The basin also includes the areas surrounding the lakes that are home to diverse populations, industrial developments, agricultural pursuits, and complex transportation systems. The basin's rich natural resources contribute to the development of local industries and economic activity. It is crucial to recognize that while the lakes have a direct effect on their shorelines, the activities occurring around the lakes impact both the water quality and ecosystem as a whole as well. In fact, to fully understand and appreciate the Great Lakes Basin, it is crucial to understand land use around the lakes. As populations increase and industries expand, so do the environmental threats to the basin as a whole.

While environmental decline is not new and has been occurring in and around the Great Lakes for over a century, the fast pace of industrialism and continued use of natural resources have increased the pace of degradation. Cross-border efforts were made to establish environmental agreements and local conservation authorities adopted initiatives that focus on learning from and protecting our natural resources. This is even more crucial in the 21st century as consumption and development increase. The chart on the next page outlines ways all residents of Ontario can contribute to the safety and security of the Great Lakes Basin and ensure a sustainable future.

Threats to the Great Lakes

THREAT/ISSUE	BACKGROUND INFORMATION	WHAT YOU CAN DO AT HOME AND AT SCHOOL
Algal Blooms	Algal blooms develop when excess phosphorus compounds and other nutrients enter water systems. Not all algal blooms are harmful to the environment, however, both Cladophora and blue-green algae threaten the lakes and impact quality of life in local communities. Cladophora contributes to the mounting decay on beaches and may nourish bacteria growth. Blue-green algae contains toxins and harmful pathogens.	• Reduce fertilizer use and make informed decisions when buying household products • Reduce stormwater overflow by using rain barrels or effective draining systems • Prevent contamination by regularly maintaining your septic system
Climate Change	Temperatures and weather patterns are changing around the world, caused in part by greenhouse gas emissions. These changes can affect water levels and disturb existing ecosystems. Climate change contributes to other environmental issues, such as algal bloom growth, extreme weather conditions, and the spread of diseases.	• Conserve water and energy by reducing water use and turning off lights/electronics • Use active and sustainable transportation
Energy Generation	The Great Lakes help to generate 80% of Ontario's electricity through nuclear, thermoelectric, hydroelectric, and wind power plants. These facilities rely on lake water, affecting the quantity and quality, as well as disrupting fish and wildlife routines.	• Conserve water and energy by reducing water use and turning off lights/electronics
Invasive Species	Non-native species enter the Great Lakes through land, air, and water – often on the bottom of boats. Within the Great Lakes there are 186 established non-native species, some of which are harmful to local ecosystems. These invasive species affect habits and fisheries, spread disease, and compete with native species for food. Asian carp, sea lampreys, round goby, and zebra and quagga mussels are currently the most well-known species threatening the Great Lakes.	• Plant native species and use local fish for bait • Keep your boats clean
Urban Sprawl	The bigger our cities become, the more space they take up and this impacts the natural environment. The Great Lakes Basin is one of the fastest developing regions in Canada, which affects the quality of the air and water. Urban sprawl also leads to increased energy use, habitat loss, and threatens wildlife.	• Use active and sustainable transportation • Research and choose permeable surfaces for paved areas to absorb rainwater

All information above comes from Pollution Probe factsheets, retrieved August 2015 from www.pollutionprobe.org.

SCHOOL COMMUNICATIONS

Use this information in school newsletters, campaign posters, and morning announcements

Why the Great Lakes? Most people who call Ontario home live within the watersheds of the Great Lakes and St. Lawrence Seaway. These beautiful lakes support a unique ecosystem and provide Ontarians with drinking water, energy, food, recreational opportunities, and numerous economic advantages. The Great Lakes are facing threats including increased harmful pollutants, urban growth, rising levels of phosphorus, and invasive species. This year [insert school name] will be participating in a Great Lakes Awareness and Action Campaign. On [day, week, month, etc.] we encourage students and families to take action to protect our Great Lakes. Prior to this date and ongoing throughout the campaign, students will have the opportunity to participate in a variety of activities such as [insert activities/workshops/lessons/events]. Thank you for your support in helping to protect the health and sustainability of the Great Lakes and the St. Lawrence Seaway.

Calendar Highlights

Include a Great Lakes focus to your environmental campaigns and events throughout the year.

- **World Rivers Day** (last Saturday of September): Celebrate local waterways and encourage the improved stewardship of the rivers and tributaries of the Great Lakes.
- **Waste Reduction Week** (end of October): Engage the school in action and education around the impact of waste on the Great Lakes. Emphasize the importance of properly disposing of hazardous waste and reducing plastic waste.
- **World Water Day** (March 22): Organize activities and education around water conservation, stormwater run-off, and water stewardship.
- **Earth Hour** (end of March): Turn-off the lights and get people talking about the effect of Ontario's electricity generation on the Great Lakes.
- **Earth Day/Week/Month** (April 22): Use this annual event to host activities dedicated to Great Lakes health and sustainability. Focus on issues such as local food or invasive species.
- **Biological Diversity Day** (May 22): Increase understanding of biodiversity within the Great Lakes Basin. Take action to plant native species and care for local forests and wetland habitats.
- **Clean Air Day** (June 4): Use the Great Lakes as a lens to focus on climate change, active transportation, and reducing greenhouse gas emissions.

Great Lakes Facts & Trivia:
Why Protect the Great Lakes?

Incorporate facts and trivia about the Great Lakes into your daily announcements and encourage students to share their own knowledge and reflect on why it is important to protect the Great Lakes.

- The Great Lakes contain nearly 20% of the Earth's fresh surface water.
- 80% of Ontario's power generation depend on the Great Lakes-St. Lawrence River basin[23].
- 95% of Ontario's agricultural lands depend on the Great Lakes-St. Lawrence River basin[24].
- There are over 3,500 plant and animal species found in the Great Lakes region[25].
- The Great Lakes provide drinking water to 8.5 million Canadians[26].
- The Great Lakes Basin is home to 90% of Ontario's population and 40% of Canada's economic activity[27].

LINKS TO ONTARIO ECOSCHOOLS PROGRAM

Teamwork and Leadership	There are many organizations, conservation authorities, and local experts across Ontario active in researching and conserving the Great Lakes Basin.	
	ACTION: Increase awareness about the environmental issues facing the Great Lakes Basin while fostering a strong EcoTeam.	**TIP:** Invite a presenter to speak with your whole school or facilitate a whole school educational program focused on the Great Lakes (1.8).
Energy Conservation	The Great Lakes help to generate 80% of Ontario's electricity (nuclear, coal, and natural gas facilities), which draws water from the lakes, affects water quality, and impacts fish and wildlife.	
	ACTION: Turn off lights and electronic equipment to reduce unnecessary energy use.	**TIP:** Develop a whole school campaign to target school energy practices. Highlight connections between individual actions and impacts on the Great Lakes Basin (2.11).
Waste Minimization	Along the shores of the Great Lakes 80% of human-generated litter is comprised of plastics.	
	ACTION: Reduce the use of disposable plastic items.	**TIP:** Implement weekly waste-free lunches to reduce waste, specifically plastic packaging (3.3).
	The improper disposal of hazardous waste including paints, chemical cleaning products, batteries, and medicine can have detrimental and long-lasting effects. If not disposed of properly, these toxins can negatively impact human health and wildlife populations within the Great Lakes Basin.	
	ACTION: Divert waste that may contain hazardous materials from regular garbage disposal.	**TIP:** Develop a whole school campaign focused on the importance of reducing waste and properly disposing of hazardous materials. Highlight connections between individual action and the impacts on the Great Lakes Basin (3.11).
School Ground Greening	Invasive species reach the Great Lakes through water, land, and air. Invasive species can cause significant harm by disrupting local ecosystems and introducing parasites and disease.	
	ACTION: Plant native species.	**TIP:** When planning your School Ground Greening project always research, source, and plant native species to reduce the risk of invasive species accidentally being released into the local ecosystem (4.3).
	When fertilizers that contain phosphorus enter the Great Lakes they can lead to an over growth of algae, called algal blooms. Algal blooms can alter the aquatic food chain, affect habitat, produce toxins, and harm commercial fisheries.	
	ACTION: Eliminate the use of fertilizers containing phosphorus.	**TIP:** When planning, planting, and caring for your School Ground Greening project eliminate the use of fertilizers containing phosphorus and consider using compost.
Curriculum	Integrate the Great Lakes Basin into your classroom lessons. Focus on various aspects of the Great Lakes including natural, human, and environmental systems. • See Classroom Lessons and Learning Activities (pages 10-22).	
Environmental Stewardship	Create a whole school action and education campaign that is directly connected to conserving the Great Lakes. • See Whole School Activities (page 8).	

WHOLE SCHOOL ACTIVITIES

Get your whole school community involved in learning about and acting on behalf of Ontario's Great Lakes. School EcoTeams can develop and present the following initiatives:

- Whole school assembly
- Student themed eco-skits
- Student featured videos
- Talent show/coffee house
- Speaker series
- Student organized info booths
- Eco-themed spirt days

Great Lakes Pledge: Create a Great Lakes cut-out or water droplet to distribute to every student. Ask them to write down their pledge to Great Lakes conservation, collect them, and display the pledges in a common area of the school.

Great Lakes Heroes Awards: Present students or classes who are actively engaged in positive environmental action around the Great Lakes, such as promoting conservation initiatives or taking on a class-wide campaign, with a Great Lakes Hero award.

World Water Day: As a school, participate in World Water Day by dedicating time to focus on water conservation on both a local and global level. Students can lead/participate in a variety of activities including plastic water bottle test tasting, class water bottle challenges, and Great Lakes quizzes.

Great Lakes Themed Art Show: Display student created art work in the school foyer or library. Art can be made out of plastic water bottles or have a Great Lakes theme and students can act as docents to educate their peers and families.

The Great Gulp Campaign: As a whole school, take a synchronized "gulp" of tap water to emphasize a collective commitment to tap water. Hold school-wide or classroom presentations on or leading up to the gulp to explain why tap water is important.

Get to Know your Great Lakes/Watershed: Invite your local conservation authority to deliver school-wide or class presentations on the Great Lake(s) and watersheds in your area. Focus on how students interact with their Great Lake and plan a visit to learn more.

Great Canadian Shoreline Cleanup: The Great Canadian Shoreline Cleanup holds clean up campaigns twice a year, from September to October and April to July. Schools can also host private cleanup events and participate in their year-round cleanup activities on the shores of the Great Lakes.

Yellow Fish Road Campaign: Collaborate with Yellow Fish Road to mark local storm drains in your community with a fish stencil to remind people that it is important to keep the drains clean and not to contaminate the water quality.

Buy Local Campaign: As a whole school, commit to supporting local goods and business owners. Students can educate their families and explain that local products rely less on harmful emissions that damage the natural environment.

CLASSROOM LESSONS

SCIENCE NORTH SCIENCE NORD

FRESHWATER OF THE GREAT LAKES

This lesson has been adapted from the lesson Freshwater Neighbourhoods , Mysteries of the Great Lakes, A Science North Production

DESCRIPTION

This lesson is intended to give students a concrete understanding of how little freshwater there is available on our planet and that it must be cared for, used responsibly, and shared by all living things. The easily accessible freshwater stocks on Earth that are not frozen or stored underground is about 0.01% of the total water on Earth. The Great Lakes hold 20% of the world's surface freshwater. Students will have time to reflect on the importance of water in their everyday lives and on people living within the Great Lakes region. Learning that water is a limited resource will help students appreciate the need to use water resources wisely and take actions to care for the Great Lakes.

ESTIMATE OF WHERE THE EARTH'S WATER CAN BE FOUND	
Oceans, saline lakes and other saltwater	97.4800 %
Icecaps/glaciers, frozen and underground freshwater	2.5100 %
Freshwater lakes	0.0070 %
Soil moisture	0.0009 %
Atmospheric water vapour	0.0009 %
Marshes and wetlands	0.0009 %
Rivers	0.0002 %
Incorporated in biota	0.0001 %
Total	100.0000 %

http://atlas.nrcan.gc.ca/site/english/maps/freshwater/1

CURRICULUM CONNECTIONS, K-3

KINDERGARTEN - Science and Technology
Overall Expectation 3: demonstrate an understanding of the natural world and the need to care for and respect the environment

GRADE 1 - Science and Technology
Understanding Life Systems – Needs and Characteristics of Living Things
Overall Expectation 2: investigate needs and characteristics of plants and animals, including humans

GRADE 2 - Science and Technology
Understanding Earth and Space Systems - Air and Water in the Environment
Overall Expectation 1: assess ways in which the actions of humans have an impact on the quality of air and water, and ways in which the quality of air and water has an impact on living things

GRADE 3 – Social Studies
People and Environments: Living and Working in Ontario
Overall Expectation B1. Application: demonstrate an understanding of some key aspects of the interrelationship between the natural environment, land use, employment opportunities, and the development of municipal regions in Ontario

PLANNING NOTES

Materials
- Map of the world
- 20L/5.3 gallon aquarium or bucket filled with water
- Clear container that can hold about 1 L of water
- Measuring cup
- Clear test tube
- Teaspoon

Recommended class time
- 40 minutes

Things to think about
- This lesson is meant to be impressionistic. The volumes of water are not exactly accurate to scale, but are close enough to deliver the message. This lesson is most effective when delivered with drama and reverence.

TEACHING/LEARNING STRATEGIES

Ignite

- As a class, ask students to raise their hand if they have had a drink of water today.
- Ask students why drinking water is important and share their answers.
- Invite students to share where water can be found: oceans, rivers, lakes, taps, wells, etc.
- Discuss the difference between saltwater and freshwater.
- Ask: Which type of water is required by humans, animals and plants? (Freshwater).
- Show students a map of the world and have them point out the different parts of the map that indicate water.

Explore

- Explain that the aquarium, or bucket, represents all the water on Earth. Point to the different bodies of water on the map.
- Using a clear measuring cup, or cylinder, remove 3 cups, 700ml, or 24 oz. of water from the bucket. Place it in the container beside the aquarium/bucket for visual impact.
- The water left in the aquarium is saltwater (found in oceans and seas). Explain that the water in the container represents all the freshwater on Earth, including water that is frozen in glaciers and icecaps, groundwater, moisture in the soil and atmosphere, and in rivers, lakes, streams, ponds, and swamps.
- Discuss the problem of accessing water that is frozen, held underground, or in the atmosphere. Help students come to the conclusion that these sources of freshwater are not readily available for plants, animals, and humans.
- Using a teaspoon remove 1 teaspoon of water from the container and put it into the test tube. Explain that this represents all the available fresh surface water on Earth and must be shared by all living things. It comes from rivers, lakes, ponds, swamps, etc.
- Put the test tube next to the container again, for visual impact. Allow students to take this in for a moment.

Reflect

- As a class discuss the following questions:
  1. Why is it important to keep our freshwater sources clean?
  2. What are some actions you can take at home and at school to conserve water?

Debrief

- The Great Lakes hold 20% of the world's surface freshwater. The Great Lakes Basin is home to 90% of Ontario's population and provides drinking water to approximately 8.5 million Canadians. The Great Lakes have a rich and diverse ecosystem and support a wide array of plant and animal life. It is important that we work to ensure the health of the Great Lakes.

EXTENSION

1. Have students list different sources of freshwater and saltwater and explain the difference between the two. Ask students to explain why freshwater is so important to animals, plants, and humans.
2. Using blocks, or a diagram, ask students to illustrate that the Great Lakes hold 20% or 1/5 of the Earth's freshwater. Ask students if they think the name "Great Lakes" is an appropriate one and to compare them to other "Great Lakes" regions (East Africa).
3. Have students brainstorm actions they can take to conserve water and care for the Great Lakes. Then, students can create informational posters to put up around the school.

SCIENCE NORTH SCIENCE NORD

OVERFED LAKES

This lesson has been adapted from the lesson Overfed Lakes by Beth Savan (1991)

DESCRIPTION

In this experiment, students will see firsthand the effects of excess fertilizer and detergent (nutrient) input into a body of water. The introduction of profuse amounts of nutrients will allow algae to grow in the water, and show how eutrophication (a process whereby the water becomes oxygen starved by the decay of bacteria) occurs, or can occur, in a lake. This experiment will be a catalyst for discussions about the effects of algal blooms in Lake Erie and provide opportunity for students to reflect on actions they can take to reduce the impacts of phosphorus containing fertilizers and detergents on the Great Lakes.

CURRICULUM CONNECTIONS, 4-8, SCIENCE AND TECHNOLOGY

GRADE 4

Understanding Life Systems – Habitats and Communities
Overall Expectation 1: Analyse the effects of human activities on habitats and communities

GRADE 5

Understanding Matter and Energy – Properties of and Changes in Matter
Overall Expectation 1: evaluate the social and environmental impacts of processes used to make everyday products

GRADE 6

Understanding Life Systems – Biodiversity
Overall Expectation 1: assess human impacts on biodiversity, and identify ways of preserving biodiversity

GRADE 7

Understanding Matter and Energy – Pure Substances and Mixtures
Overall Expectation 1: evaluate the social and environmental impacts of the use and disposal of pure substances and mixtures

GRADE 8

Understanding Earth and Space Sciences – Water Systems
Overall Expectation 1: assess the impact of human activities and technologies on the sustainability of water resources

PLANNING NOTES

Materials

- Plant fertilizer and/or fish food
- Glass jar or fish bowl full of water
- Water plants (if possible)

Recommended class time

- Initial experiment will take 40 minutes with follow-up over one or two weeks

Things to think about

- Follow established safety procedures and protocol when implementing the experiment

This lesson has been adapted from: Savan, B. I. (1991). Earthcycles and Ecosystems. Toronto: KidsCan Press, 96 pp.

TEACHING/LEARNING STRATEGIES

Ignite

- As a class, explain that you will be conducting an experiment examining the effects of excess nutrients on water.
- Define the word nutrients: a substance that provides nourishment essential for growth and the maintenance of life.
- Have students share different types of nutrients that they are familiar with.
- Explain that in aquatic ecosystems certain elements are defined as nutrients because they are essential for life processes in aquatic organisms. These nutrients include carbon, nitrogen, phosphorus, and silicon.
- Split the class into smaller groups and ask each group to hypothesize what they think will happen to the water when nutrients are added.

Explore

- Provide each group with a fishbowl or a glass jar, preferably with water plants and without fish.
- Have student add excessive nutrients (fish food or fertilizer) to the water. You may have the entire class add the same type of nutrient, or you may have each group use different types of nutrients, to compare and contrast results.
- Place the bowl in a sunny spot where it can remain undisturbed for a week or two.
- After one week, have each group add more food or fertilizer to their bowl.
- Throughout the following weeks have students monitor their bowls and observe any changes. Is it greenish? Is there a scummy skin on the water? If so, students have grown algae and the bowl is not a good home for fish.
- Have students revisit their hypothesis. Discuss the varying results as a class.
- Explain that algae are organisms that are like plants and vegetables, which are found in both fresh and salt water environments (such as the sea, rivers, lakes or ponds) and grow with the addition of nutrients and sunlight.

Reflect

- As a class discuss the following questions:
  1. Was the algae growth the expected result?
  2. Are too many nutrients a good thing or a bad thing in a lake? Why?
  3. What would happen if there were too few / no nutrients in a lake?

Debrief

- As a class clarify that algae are critical to life on Earth because they provide the primary energy source for many marine organisms and are also responsible for producing oxygen.
- Explain that too much algae can actually threaten the health of a lake. An overgrowth of algae, similar to what happened during their experiment, is what occurred to Lake Erie in the 1970s. At the time, Lake Erie was said to be dying due to large amounts of algae growth, known as algal blooms.
- Explain that recently there has been a resurgence of algal blooms, which is again a threat to the health of Lake Erie.
- Variables such as agricultural fertilizers and detergents rich in nutrients are washed into the lakes through stormwater runoff and ground water.

EXTENSION

1. Students can research different causes of algal blooms on the Great Lakes and what local organizations and various levels of government are doing to manage them.
2. Students can investigate one of the harmful effects of algal blooms on the Great Lakes and create informative posters about preventing and reducing these effects.
3. Students can brainstorm actions they can take to reduce the growth of algal blooms and create a school-wide information campaign on the topic.

This lesson has been adapted from: Savan, B. I. (1991). Earthcycles and Ecosystems. Toronto: KidsCan Press, 96 pp.

SCIENCE NORTH SCIENCE NORD

TESTING THE WATERS

This lesson has been adapted from the lesson Testing the Waters , Mysteries of the Great Lakes, A Science North Production

DESCRIPTION

The Great Lakes hold 1/5 of the world's entire supply of accessible freshwater. With an astounding number of people, animals and plants dependent on this source of freshwater, it is imperative the Great Lakes and ecosystem are healthy. However, human activity has already drastically altered and in many instances damaged this precious resource. Scientists who are concerned with measuring the quality of the Great Lakes water must take into consideration such factors as temperature, acidity, dissolved solids, particulate matter, dissolved oxygen, hardness and suspended sediment. Each of these factors reveals something about the health and quality of the water. In this lesson, students will have the opportunity to learn about the importance of water quality and observe and test the quality of different water samples. They will investigate water density and acidity and their relationship to the Great Lakes.

CURRICULUM CONNECTIONS, 9 & 11

GRADE 9 - Science, Academic

Biology: Sustainable Ecosystems

Overall Expectation B1: assess the impact of human activities on the sustainability of terrestrial and/or aquatic ecosystems, and evaluate the effectiveness of courses of action intended to remedy or mitigate negative impacts

GRADE 11 - Science, Workplace Preparation

Environmental Science: Natural Resource Science and Management

Overall Expectation E2: investigate methods scientists use to classify and monitor natural resources, and conduct investigations using those methods

PLANNING NOTES

Materials

Water Density Experiment:

- Clear cups
- Types of water: cold, hot freshwater, saltwater (optional: other liquids, such as oil, shampoo, vinegar)
- Scissors
- Straws
- Modeling clay
- Permanent maker
- Kettle (optional)
- Ice cubes (Optional)
- *Measuring Water Density Recording Sheet* (Appendix 1)

Water Acidity Experiment:

- Red cabbage
- Purified water
- Cooking pot
- Sieve
- Knife
- Small sampling jars
- Water/liquid samples (purified water, rainwater, pond, stream, river and lake water, saltwater and other liquids like, vinegar, tea, lemonade etc.)
- *Testing Water Acidity Recording Sheet* (Appendix 2)

Recommended class time

- 3-5 class periods

Things to think about

- This lesson can be split up into two separate lessons, or each of the experiments can be done as stand-alone activities. To further investigate the properties of water, additional experiments can be performed using water samples from more than one of the Great Lakes.

TEACHING/LEARNING STRATEGIES

Ignite

- Ask students what they know about water – what are the different properties? Why is the freshwater in the Great Lakes so important?
- Show students a number of water samples, including tap water, rainwater, water from a puddle, water with food colouring and water with something smelly like vinegar. After they have had an opportunity to observe these samples ask them to determine which samples they would use for drinking, bathing, swimming, fishing. Record their ideas.
- As a class discuss the importance of the following properties that scientists must consider when determining the quality of water:
  - **Temperature** affects the level of oxygen, as well as the ability of organisms to resist pollutants. This makes water temperature particularly important to fish and aquatic plans. Many species of fish eggs will not survive if water temperatures are too warm or too cold.
  - **Density** is the quality or condition of being dense; a measure of how much mass is contained in a given unit volume (density = mass/volume). Temperature and the amount of dissolved minerals are two factors that can change the density of water.
  - **Acidity/pH** refers to the amount of hydrogen ions present in substances, such as soil or water. Water that is too acidic lessens the change of fish eggs coming to maturity or various plants growing.
  - **Dissolved Oxygen** is required by fish and water dwelling organisms to live. A level of 10 dissolved molecules of oxygen per million molecules of water is considered normal.
  - **Turbidity** is the amount of particulate matter and suspended sediment, such as clay, silt, plankton, or microscopic organisms, suspended in water. The more cloudy or opaque the water is the greater its turbidity.

Explore – Water Density

- As a class, discuss density of different types of water. Temperature can affect water density, ask students what type of liquid they think will be the most dense – hot, cold, fresh, salt?
- Ask students to record their hypotheses on *Measuring Water Density Recording Sheet* (Appendix 1).
- Cut a drinking straw in half and use a felt marker and ruler to draw a scale on it. At one end of the straw, place a ball of modelling clay about the size of a pea. This instrument is called a hydrometer and is used to measure the density of liquids.
- Now fill 2/3 of a cup with cold water and place your hydrometer in the liquid. The hydrometer will sink or rise depending how dense the water is.
- Once it has settled, record the number on the hydrometer at the water's surface.
- Record observations on *Measuring Water Density Recording Sheet.*
- Now fill 2/3 of a cup with hot water and place your hydrometer in the liquid.
- Once it has settled, record the number on the hydrometer at the water's surface.
- Record observations on *Measuring Water Density Recording Sheet.*
- Now do the same for the other types of water/liquids and record how high the hydrometer floats.
- In small groups, complete the observation questions on *Measuring Water Density Recording Sheet* and compare the conclusions with their hypotheses.

Explore – Water Acidity

- As a class discuss the importance of maintaining a stable pH balance – most freshwater fish species must have an aquatic environment with pH levels between 6.7 and 8.6. If the pH level is too low, the reproduction of certain species and the survival of eggs are threatened. Explain that pollutants are released when snow and ice melt. Areas with calcium carbonate from limestone or sandstone can neutralize the acid, areas without cannot. Ask students if and why they think acidity levels are rising. How does this impact the Great Lakes?
- Explain that red cabbage juice works well to indicate acidity – the redder it gets, the more acidic the water is. The bluer it gets, the more alkaline it is. Introduce the different water samples that students will be testing (purified water, rainwater, pond, stream, river, and lake water, saltwater, etc.) and ask students to complete the hypothesis on *Testing Water Acidity Recording Sheet* (Appendix 2).
- To purify the water, boil for 20 minutes. If you use distilled water you do not have to boil it first.
- Chop up a head of red cabbage. Boil the cabbage in a cooking pot with the distilled water until it has lost its dark colour.
- Using the sieve, strain the cabbage and let the coloured water cool in a jar. You can keep your jar of cabbage juice in the refrigerator until you need it.
- Put a couple of tablespoons of one water type in a clear sampling cup/jar. Add a couple of tablespoons of red cabbage juice too.
- Observe the colour the cabbage juice becomes. The redder it gets, the more acidic the water is. The bluer it gets, the more alkaline it is.
- Do the same for each of the other liquid samples.
- Take all your water/liquid samples and place them in order of acidity – dark red to light blue. Record observations on *Testing Water Acidity Recording Sheet.*
- If litmus paper or a pH metre is available, compare the results to your red cabbage test.
- In small groups, complete the observation questions on *Testing Water Acidity Recording Sheet* and compare the conclusions with their hypotheses.

Reflect

- As a class discuss the following questions:
  1. What did you learn about the properties of water? Did anything surprise you?
  2. Were any of your hypotheses dramatically different from your conclusions? What did this teach you?
  3. What experiment did you find more interesting? Why?
  4. What are some actions you can take at home and at school to help maintain healthy water systems?

Debrief

- About 70% of the Earth's surface is covered in water and of that water, 97% is saltwater and 3% is freshwater. Unpolluted freshwater is essential for the survival of humans as well as many other species. Freshwater plants and animals cannot survive in saltwater. It is incredibly important that we maintain a healthy ecosystem in the Great Lakes Basin, as it provides drinking water to approximately 8.5 million Canadians.

EXTENSION

Filter water – Collect a variety of water samples and use coffee filters to help purify them. Place a coffee filter inside a funnel within a glass jar and pour in one of the water samples. Remove the filter and observe any changes – did the filter colour change? Is there sediment? Does the water sample look different? Repeat the process with different types of water and make sure to record and sort all observations.

TESTING THE WATERS
MEASURING WATER DENSITY RECORDING SHEET

NAME(S)	DATE

Hypothesis:
Which liquid do you think will be the most dense? Why?

Observations:

TYPE OF LIQUID	cold freshwater	hot freshwater	saltwater	other:	other:
Hydrometer reading					

Think about it:
Did the hydrometer float higher or lower in the saltwater compared to the freshwater?

Did the hydrometer float higher or lower in the cold water compared to the warm/hot water?

The more dense the liquid/water, the higher the hydrometer floats. In which liquid did the hydrometer float the highest?

Conclusion
Which liquid was the most dense? Was your initial predication right?

SCIENCE NORTH SCIENCE NORD

TESTING THE WATERS
TESTING WATER ACIDITY RECORDING SHEET

NAME(S)	DATE

Hypothesis:
Which liquid do you think will be the most acidic? Why?

Observations:

	Most blue				Most red
Sample Name					

Think about it:
Of your samples, which one was the most acidic?

Think about the source of the water samples. Can you make any conclusions as to why one is more acidic or alkaline than the other?

How did your cabbage juice results compare to the litmus paper or pH metre?

Conclusion
Which liquid was the most acidic? Was your initial predication right?

SCIENCE NORTH SCIENCE NORD

LEARNING ACTIVITIES

FISH OF THE GREAT LAKES: CRAFTING PROJECT

This activity has been adapted from FishNet: The Great Lakes Craft & Release Project
For more information on this project including lesson plans, resources, and 52 fish patterns visit: www.projectfishnet.org

Get Started: Display a map of the Great Lakes and highlight the lake closest to your school. Explain the importance of biodiversity found within the Great Lakes and nearby watersheds.

Explore: Fish throughout the Great Lakes are central to the health, economy, and sustainability of the region. Issues such as overfishing, pollution, climate change, and invasive species are responsible for a decline in fish populations and have become a threat to biodiversity. Throughout history fish have been a main indicator of the Great Lakes' health. Have students research the significance of fish within the Great Lakes region and the impact of human activity on biodiversity and their habitat.

Create:

- **Craft:** Select one, or various, fish species that are native to the Great Lakes and regionally appropriate to your school. Distribute templates of the selected fish to each student. You may choose to have students craft 2 or 3-dimensional fish from paper or textiles. Students may use markers, paint, or found materials to decorate their fish. Based on their research, have students detail the fish to match its colouration in the wild. You may choose to have older students label the fish anatomy. Have students research their species and share with one another.
- **Release:** Exhibit fish in a classroom, library, front foyer, or hallway bulletin board. You may hang fish with string or tape them to a wall. For an interactive installation, hang fish from the ceiling suspended at different levels with clear fishing line so people may interact with the fish and take a swim through a Great Lake.
- **Educate:** Invite the school community to a Great Lakes release event. Mount pictures, facts, history, and background information on the Great Lakes. Consider turning your event into a fundraiser. Sell your fish so that visitors may contribute to a campaign, organization, activity, or initiative that will benefit biodiversity and the health of fish within the Great Lakes.

Reflect & Discuss: As a class, reflect on the importance of biodiversity within the Great Lakes region. How does biodiversity loss threaten the sustainability of the Great Lakes? What are actions you can take to protect fish within the Great Lakes?

The Great Lakes and their adjoining streams, rivers, and lakes support diverse ecosystems. In fact, there are over 3,500 plants and animals that live within the bioregion, some of these species cannot be found anywhere else on Earth[28]. There are more than 160 fish species that inhabit the Great Lakes[29]. Each lake has its own unique combination of fish, which maintain both cultural and commercial importance.

GET TO KNOW A GREAT LAKE AND CONSERVATION INITIATIVE

Get Started: Display a map of the Great Lakes and highlight the lake closest to your school. Explain the importance of the Great Lakes and nearby watersheds.

Explore: Conservation authorities across Ontario are working hard to protect our Great Lakes and their resources. A variety of initiatives are in place to educate communities who can participate in regional conservation campaigns. Ask students to select one of the Great Lakes (or as a class, focus on the one closest to you) to explore in depth or concentrate on a specific issue, such as natural environment, wildlife population, size, and surrounding industries. What environmental issues is their lake currently facing? What conservation initiatives are currently in place at provincial and local levels?

Create: Distribute cut-out templates of lake(s) and ask your students to fill one side of the template with their key facts and information. On the other side of their lake template, students can record any local conservation initiatives and Great Lakes related projects happening around them. Students can contact their conservation authorities directly for information or work together to find out more about local projects.

Reflect & Discuss: Ask students to share their Great Lake with their classmates, make sure that everyone has the opportunity to learn about all five lakes. Display the student-created lakes in a place where everyone can read them. As a class, reflect on the importance of local conservation initiatives. How can you (as a student, class, or school) get involved? How can you take what you learned about the Great Lakes and turn it into meaningful action?

The five Great Lakes; Huron, Erie, Michigan, Ontario, and Superior, are connected by an inland waterway that traverses 3700 km through Ontario reaching the Atlantic Ocean via the St. Lawrence Seaway. Created after the last ice age, each lake is unique and has its own distinct characteristics from diverse aquatic life to the presence of hundreds of shipwrecks. One thing they have in common is increased pollution and the resulting threats to healthy and sustainable ecosystems.

Local conservation authorities work to ensure that municipalities and regions across Ontario have sustainable natural environments, maintain parks and outdoor spaces, and facilitate education programs. They work to keep the Great Lakes Basin and St. Lawrence Seaway stable and protected from invasive species, climate change, and human expansion.

GREAT LAKES RESEARCH PROJECT

This activity has been adapted from The Great Lakes as a Learning Tool: A Resource for SHSM-Environment Teachers, TRCA

Get Started: Display a map of the Great Lakes and highlight the lake closest to your school. Explain the importance of the Great Lakes and nearby watersheds.

Explore: The Great Lakes directly impact our community and the habitat that we live in. First Nations communities settled in the Great Lakes region because of the freshwater and fertile soil. As the population grew and European settlers arrived, more of the land was used for farming and the lakes were used for transportation. Local communities continue to depend on the Great Lakes and pollution has become an increasing concern. Using the following research questions as guidelines, encourage students to explore the Great Lakes and the impact of human activity on the natural environment.

Suggested research questions:

- Lake Erie currently suffers from many invasive species, including the zebra and quagga mussels and round goby. What threat do these invasive species pose to the Great Lakes and the human population? What can be done to prevent invasive species from overtaking our freshwater?
- First Nations communities were the first to live beside the Great Lakes. Research and compare how people from various cultures understood and used the Great Lakes region. How did they benefit from and impact the water, climate, and wildlife? How has the human impact on the Great Lakes changed over the years?
- There is a proposal to build a deep geological repository for nuclear waste under Lake Huron. Ontario Power Generation says that this will safely store the waste for up to 100,000 years. The Great Lakes as we know them are less than 10,000 years old. Is the OPG assurance reasonable? Support your position with relevant data and information.

Reflect & Discuss: As a class, bring your information together and discuss what you learned about the Great Lakes. Did anything surprise you? Is there anything you want to learn more about or explore in greater detail? What do you think we can do to ensure that the Great Lakes are a safe source of freshwater and are protected?

The freshwater and fertile soils of the Great Lakes Basin have supported Canadians and our American neighbours for centuries. From heavily forested shorelines to the world's largest freshwater dune system, to industrial hubs, the areas surrounding the lakes and their tributaries are as diverse as the bodies of water are themselves. Over 33 million people currently live around the Great Lakes and depend on their resources. As human activity and industry in the region increases, so does the threat to a healthy, sustainable ecosystem.

REFERENCES

1. Ontario's Great Lake Strategy. Retrieved August 2015 from https://dr6j45jk9xcmk.cloudfront.net/documents/896/5-1-5-great-lakes-strategy-en.pdf
2. Great Lakes Quickfacts. Retrieved August 2015 from http://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=B4E65F6F-1
3. Great Lakes Quickfacts. Retrieved August 2015 from http://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=B4E65F6F-1
4. How They Were Made. Retrieved August 2015 from http://seagrant.wisc.edu/home/Default.aspx?tabid=590
5. How They Were Made. Retrieved August 2015 from http://seagrant.wisc.edu/home/Default.aspx?tabid=590
6. How They Were Made. Retrieved August 2015 from http://seagrant.wisc.edu/home/Default.aspx?tabid=590
7. Great Lakes Quickfacts. Retrieved August 2015 from http://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=B4E65F6F-1
8. Great Lakes Quickfacts. Retrieved August 2015 from http://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=B4E65F6F-1
9. Lake Erie Facts and Figures. Retrieved August 2015 from http://great-lakes.net/lakes/ref/eriefact.html
10. Great Lakes. Retrieved August 2015 from http://www.encyclopedia.com/topic/Great_Lakes.aspx
11. Top 10 Facts About Lake Huron. Retrieved August 2015 from http://www.northernontario.travel/algoma-country/top-10-facts-about-lake-huron
12. Top 10 Facts About Lake Huron. Retrieved August 2015 from http://www.northernontario.travel/algoma-country/top-10-facts-about-lake-huron
13. Lake Michigan Facts and Figures. Retrieved August 2015 from http://great-lakes.net/lakes/ref/michfact.html
14. Lake Michigan Facts and Figures. Retrieved August 2015 from http://great-lakes.net/lakes/ref/michfact.html
15. Lake Ontario. Retrieved August 2015 from http://www.waterkeeper.ca/lake-ontario/
16. Lake Ontario. Retrieved August 2015 from http://www.waterkeeper.ca/lake-ontario/
17. Great Lakes. Retrieved August 2015 from http://www.encyclopedia.com/topic/Great_Lakes.aspx
18. Lake Superior Facts and Figures. Retrieved August 2015 from http://www.great-lakes.net/lakes/ref/supfact.html
19. Learn More. Retrieved August 2015 from http://sciencenorth.ca/mysteriesofthegreatlakes/index.aspx?id=1269
20. Lake St. Clair. Retrieved August 2015 from http://www.great-lakes.net/lakes/stclair.html#overview
21. St. Lawrence River and Seaway. Retrieved August 2015 from http://www.great-lakes.net/lakes/stlaw.html#overview
22. Great Lakes. Retrieved August 2015 from http://www.encyclopedia.com/topic/Great_Lakes.aspx
23. The Importance of the Great Lakes. Retrieved August 2015 from: http://www.ontario.ca/environment-and-energy/protecting-great-lakes
24. The Importance of the Great Lakes. Retrieved August 2015 from: http://www.ontario.ca/environment-and-energy/protecting-great-lakes
25. Biodiversity: Ecosystem Services, Habitat Loss and Species at Risk. Pollution Probe. Great Lakes Fact Sheet. Retrieved August 2015 from: http://www.pollutionprobe.org/publications/great-lakes-fact-sheet-8-biodiversity/
26. Great Lakes Quickfacts. Retrieved August 2015 from: https://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=B4E65F6F-1
27. Great Lakes Quickfacts. Retrieved August 2015 from: https://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=B4E65F6F-1
28. Biodiversity: Ecosystem Services, Habitat Loss and Species at Risk. Pollution Probe. Great Lakes Fact Sheet. Retrieved August 2015 from: http://www.pollutionprobe.org/publications/great-lakes-fact-sheet-8-biodiversity/
29. Michigan Sea Grant. Retrieved August 2015 from: http://www.miseagrant.umich.edu/explore/native-and-invasive-species/species/fish-species-in-michigan-and-the-great-lakes/