

Water & Biodiversity: Cleaning Up Our Act

Case Study Based Lessons for Grade 6 and Grade 9



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International Day for Biological Diversity 2013

Water and Biodiversity

In December 2000 the United Nations designated May 22nd as the International Day for Biological Diversity (IBD) to celebrate biodiversity and to raise awareness of the threats that face life on our planet. The theme for IBD 2013 is *Water and Biodiversity*. This is an apt and important theme, for as the Convention on Biological Diversity so eloquently puts it, "Water is essential for life. No living being on planet Earth can survive without it. It is a prerequisite for human health and well-being as well as for the preservation of the environment." Water is a great equalizer; it is essential to human life, and is a particularly precious resource for all species that rely on freshwater for survival. Only about 3% of the Earth's water is freshwater, the majority of which is frozen in glaciers or the polar ice caps. In fact, less than 1% of the water on earth is freshwater available to species — like us — that rely upon it to survive.

Given the scarcity and importance of the resource, it could be assumed that we would treat water with the highest respect. Unfortunately, as with many things that support and nourish us, we take our freshwater resources for granted, which is an attitude that has had wide reaching effects on biodiversity in our communities. Because water is so necessary for life, challenges affecting our water also affect all the other species that call our communities home.

These lesson plans are intended to raise awareness of the impact humans have had on aquatic ecosystems. Moreover, they are intended to make students aware of the conservation efforts that are ongoing in their communities, and to inspire hope and encourage action towards the protection of our critically important freshwater resources.

The grade six (6) lesson plans focus on the case study of the Jefferson Salamander in Halton Region, Ontario. This tiny amphibian must cross a busy roadway to travel to the temporary (vernal) pool where it breeds and lays its eggs each spring. Due in part to high mortality experienced crossing roadways; the Jefferson Salamander is considered a Species at Risk. The case study explores the successful collaboration between a Conservation Authority (Conservation Halton), the City of Burlington and local citizens to close a busy commuter road during breeding season and protect the Jefferson Salamander. In preparation for their own town hall meeting about the issue, students will explore the diverse species that rely on fleeting vernal pools to breed, feed, and survive.

The grade nine (9) lessons use local case studies featuring degraded aquatic ecosystems that have been restored by partnerships between landowners and the Hamilton-Halton Watershed Stewardship Program. The students use the case studies as a starting point for some investigative reporting as well as the development and implementation of their own stewardship activity in the community.

It is our hope that the students complete these lesson plans knowing that although humans have — in large part — created the problems facing freshwater ecosystems; we are also working towards solutions for these problems. We hope that they will feel inspired to become part of the small but dedicated team that are working to preserve one of our greatest and most necessary resources, water.

We would like to extend thanks to the staff of Conservation Halton and the Hamilton Region Conservation Authority for their assistance with this project. In particular Sheila O'Neal (Watershed Stewardship Manager of the Hamilton-Halton Watershed Stewardship Program) and Brenda Van Ryswyk (Natural Heritage Ecologist—Conservation Halton).

Cleaning Up Our Act: Building a Vernal Pool

Lesson 1 Overview

In this set of two lessons, students build their understanding of the concept of biodiversity by examining the real-life case study of the Jefferson Salamander in Halton Region, Ontario. Water plays a significant role in the life cycle of this species, which is listed as endangered at both the provincial and national level.

This first lesson introduces students to vernal pool habitats and the community of organisms that rely upon them. Vernal pools are temporary wetlands that generally come into being in the spring, as pooling water results from melting snow and spring rain. These temporary pools usually dry up in the mid- to late- summer; however, during their brief existence they support a wide variety of life. Due to the fact that they dry up each summer and are not connected to other wetlands, vernal pools are not home to fish. Without these top predators vernal pools make perfect breeding habitat for wood frogs and various salamanders. Tadpoles and larvae can develop in relative safety until the pool dries up. Fairy shrimp also require vernal pools for breeding. The feast of amphibians, larvae and eggs also attracts organisms such as great blue herons, skunks, racoons and predatory insects to the pools.

Jefferson salamanders are listed as *obligate* vernal pool dwellers, meaning that their very existence depends upon these unique habitats. Jefferson salamanders migrate to vernal pools each spring to reproduce; therefore, loss of these habitats or the construction of barriers, such as roads, between their forest habitat and the breeding pool has contributed greatly to their decline.

In this lesson students conduct web research on the Jefferson Salamander and other species that rely upon vernal pools. They then create their own vernal pool for display. This exercise leads into lesson two where students examine a case study reflecting the impact on the biodiversity supported by vernal pools when a busy roadway is constructed nearby.

*Note to Teacher - This lesson will likely take more than two periods of class time.

Grade 6 Science and Technology/Understanding Life Systems: Biodiversity

CURRICULUM EXPECTATIONS

- 2.4** use appropriate science and technology vocabulary, Including classification, biodiversity, natural community, interrelationships, vertebrate, invertebrate, stability, characteristics, and organism, in oral and written communication
- 2.5** use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes
- 3.4** describe ways in which biodiversity within and among communities is important for maintaining the resilience of these communities
- 3.5** describe interrelationships within species, between species, and between species and their environment

LEARNING GOALS

At the end of this lesson, students will...

- Be able to identify the key features that make a vernal pool a unique habitat.
- Be able to describe the biodiversity supported by vernal pools.
- Be able to explain basic interactions between species that rely on vernal pools and between the species and their environment.
- Perform a web search for information about vernal pool species and organize the information they gather into an effective and informative display

INSTRUCTIONAL COMPONENTS AND CONTEXT

Readiness (Diagnostic Assessment)

A_{for}L Assessment for learning

These lessons are intended to support and deepen student understanding of the concept of biodiversity through the use of case studies. Students should have a preliminary understanding of the concept of biodiversity and species classification prior to commencing these lessons.

Glossary See page 54

Materials

- Class set of computers with Internet access for student research activity
- Class set of
 - Build a Vernal Pool Research Organizer (Appendix 2)
 - Build a Vernal Pool Assessment Rubric (Appendix 3)
- Websites for student research project:
 - *Ontario Vernal Pools Association*
www.ontariovernalpools.org
 - *The Vernal Pool Association*
http://www.vernalpool.org/vpinfo_1.htm
 - *Vernal Pools Spring to Life via Discovery News*
<http://news.discovery.com/animals/videos/animals-vernal-pools-spring-to-life.htm>
- Class set of materials to complete vernal pool pictures/dioramas
 - Scissors
 - Glue
 - Tape
 - Pencil Crayons
 - Paint/paint brushes
 - Construction paper
 - Found natural materials (students to collect from a safe location)
 - Poster board for pictures or boxes for dioramas

MINDS ON

Whole Class → Introduction to Vernal Pools – Here today, gone tomorrow!

This activity reinforces that aquatic habitats come in all shapes and sizes. Students are guided from the largest aquatic habitats to one of the smallest – the vernal pool.

1. Ask the students to name the four elements that are necessary for life – food, shelter, air, water. Explain to the class that water will be the focus of this lesson.
2. Write the word water in the centre of the blackboard. As a whole class or in small groups, ask the class to brainstorm as many aquatic habitats as they can and write them on the board to create a word web. Examples include, but are not limited to, oceans, seas, lakes, streams, rivers, marshes, swamps, bogs, fens, reservoirs, estuaries and bays.
3. Celebrate the number of aquatic habitats that the students were able to contribute. Explain that water is essential for life; therefore, aquatic habitats are important because they support an incredible diversity of organisms.
4. Ask the students if they can think of any aquatic habitats that are temporary (periodically dry up). Students may come up with tidal pools or vernal pools. Both are aquatic habitats that communities of organisms rely upon that dry up periodically.
5. Explain that water is such an important resource that organisms have evolved to rely on even temporary pools. In Southern Ontario, pools of water left in the forest from snow melt and spring rains are important habitats that support both aquatic and terrestrial communities. This type of wetland is called a **vernal pool** (vernal meaning related to or occurring in spring). Several defining characteristics of vernal pools are that they:
 - Contain water during the growing season, but in most years will dry up by late summer
 - Are located in a confined depression with no permanent stream going in or out
 - Contain no fish
6. Show the students the video to help them visualize what a vernal pool looks like - *Vernal Pools Spring to Life* via Discovery News <http://news.discovery.com/animals/videos/animals-vernal-pools-spring-to-life.htm>
7. In small groups, ask the students to complete a quick drawing of what they imagine a vernal pool would look like in the spring. On their drawing they can list or draw the type of organisms they think might rely on their vernal pool and what each would gain from living in or near the pool.
8. Explain that the students will be building their own vernal pool. Using the jigsaw strategy they will be engaging in web research to investigate vernal pools, the creatures and communities that rely on vernal pools, and then create a visual representation of a vernal pool based on their research.
9. After they complete their research the students will come back to these drawings and see how much they have learned about these important habitats.

Cross-Curricular Connections:

Visual Arts

- D1.1 create two-dimensional, three-dimensional, and multimedia art works that explore feelings, ideas, and issues from a variety of points of view
- D1.3 use elements of design in art works to communicate ideas, messages, and understandings

Assessment:

A_{for}L Assessment for learning

- Utilize the students' sketches as an informal assessment tool to determine the level of support they will need with regards to their research project. This is a good opportunity to assess if students have a preliminary understanding of the importance of interconnections between species in a community and between species and their environment.

Differentiated Instruction:

- Ensure that students are paired with supportive classmates for all group work.
- Keep in mind that the group discussion and brainstorming on the blackboard will benefit audio and visual learners but kinaesthetic learners might need additional reinforcement of the concepts being introduced.
- Some students might benefit from communicating their initial thoughts on vernal pools one on one or through a written assignment instead of through a visual piece.

ACTION!

Small Group → Building a Vernal Pool (Jigsaw Strategy)

1. Divide the class into small home groups of 5 students each. Each home group will create a vernal pool background that they will populate after participating in the jigsaw activity.
2. Allow the home groups to explore the websites listed on their “Building a Vernal Pool” worksheet to gain an understanding of what a vernal pool looks like. The students should look for the biotic and abiotic factors that a vernal pool includes (e.g., located in a forested habitat, often contain downed woody debris, isolated with no stream entering or exiting the pool, generally shallow and full of leaf litter).
3. Provide the students with a large piece of paper on which to draw their vernal pool or a box in which to create a diorama.

Outdoor extension: Allow the students to explore the schoolyard to find natural objects they can work into their picture/diorama to make it more realistic and three dimensional. Note: Be sure not to disturb any sensitive habitats and return any unaltered natural materials to the schoolyard once the projects have been completed and assessed.

4. Once the vernal pools have been created, it is time to populate them! Select five organisms from the list of vernal pool dwellers in Appendix 1. Ensure your selections represent a variety of classes of organisms to help students understand the breadth of the biodiversity vernal pools support. You might select more than five, depending on the number of expert groups you choose to create or how many organisms you would like the students to study. Five recommended organisms are Jefferson Salamander (amphibian), Wood Frog (amphibian), Fairy Shrimp (branchiopod), Skunk (mammal) and Snapping Turtle (reptile). Ensure that Jefferson Salamander is one of the organisms represented so students are well prepared for lesson 2.
5. Break the students out of their home group and into their expert groups. Each expert group will use the “Building a Vernal Pool” worksheet to guide them through their web research on the organism they have chosen to study. If sufficient computers are available, each student can work on the worksheet independently and then report back to the expert group to ensure a breadth of information is gathered. Otherwise, students can pair up and assign rotating researcher and recorder roles. Students will use the websites provided on their worksheet as a starting point for their research. Ensure the students are aware that you will be collecting the research organizers to help with the assessment of the final product.
6. Once students have completed their research, have the expert groups meet to discuss their results and ensure that all group members have recorded the material their group mates have gathered on their worksheet. They must be prepared to be an expert on their organism when they present to their home group.
7. Have the students rejoin their home groups and present their organism to their classmates.
8. Once the presentations are complete, the home groups will work together to create depictions and textual descriptions of their organisms based on their research and place them in their vernal pool habitat. Descriptions should include the name, class and interesting characteristics of each organism as well as a visual cue indicating how they relate to other organisms in the community. The final product should be visually appealing and provide the viewer with accurate and interesting information about vernal pools and the biodiversity they support. Students should include their research organizers when submitting their projects to assist with assessment.

Cross-Curricular Connections:**Visual Arts**

D1.3 use elements of design in art works to communicate ideas, messages, and understandings

D1.4 use a variety of materials, tools, techniques, and technologies to determine solutions to design challenges (e.g., mixed media) understandings

Assessment:**A_{as}L Assessment as learning**

- Circulate among the students as they work in their groups, ask the students to assess their progress on their research project and support them in finding solutions if they identify gaps in knowledge or teamwork.

A_{of}L Assessment of learning

- See Appendix 3 for the formal assessment rubric for the Building a Vernal Pool Activity.

Differentiated Instruction:

- Break down and explicitly state what is expected in each section of the research organizer.
- Consider allowing some students to complete the project working in pairs and others to work independently based on their strengths and learning styles.
- Brainstorm alternatives to the diorama with the class and allow groups to choose one of these alternatives where appropriate. (e.g., PowerPoint or Prezi presentation)
- Check in with students at each stage of the process (brainstorming, research, vernal pool construction) to monitor work completion and check for understanding. Provide supportive feedback and modify instructional strategies at each stage.

CONSOLIDATION

Individual ➔ *Reflection*

1. Display the vernal pools in the classroom. Ask the students to refer back to their original sketch of a vernal pool; in their home groups, students should compare their current understanding of the concept with their knowledge displayed in the sketch (prior to their research). Then allow time for home groups to rotate and look at all of the completed pictures/dioramas. Home group members should take turns staying with their completed piece of work in order to answer any questions from their classmates.
2. Ask the students to write a journal entry answering the following questions.
 - a. After comparing your initial drawing of a vernal pool to the completed projects what did you learn about vernal pools that surprised you?
 - b. How do the community of organisms in a vernal pool rely on each other?
 - c. Do organisms that rely on vernal pools rely on other habitats? What would happen to the community of organisms that live nearby if a vernal pool was removed? For example, if a vernal pool was removed from a forest what would happen to the community of organisms that live in the forest?
 - d. Do you think vernal pools are valuable? Why or why not?
3. Display the vernal pools in a prominent location in the school for all students to enjoy!

Outdoor Extension: If possible, take the students to investigate a vernal pool near the school. These delicate habitats are in existence briefly, generally from April until June. Students should not enter the pool, but can look for evidence of animal life (e.g., frog and salamander eggs, animal scat or evidence of feeding activity, tracks in the mud etc.). Students should be discouraged from picking up any salamanders they find or altering the habitat in any way. Jefferson Salamanders are protected by law due to their status as an endangered species.

OR

Visit a local Conservation Area or outdoor education field centre, many offer pond or stream study programs that get students up close and personal with the wetland species listed in Appendix 1 and can help illustrate how these species relate to each other and are impacted by human activities.

Cross-Curricular Connections:

A_{OL} Assessment as learning

- Utilize the journal writing exercise as an opportunity for students to assess how far their understanding of vernal pools has progressed since they completed their first sketch at the beginning of the lesson.

A_{of} Assessment of learning

- Utilize student engagement with their classmates during the walkabout and the journal entry as assessment pieces reflecting the students' growing understanding of vernal pool biodiversity.

Differentiated Instruction:

- Some students might benefit from the option of speaking with you one-on-one about their ideas, instead of submitting a journal reflection.
- Outdoor opportunities such as those in the "Outdoor Extension" are valuable for all students and particularly for those students who are kinaesthetic learners.

Safety Considerations:

- Visit any outdoor location you plan to take the students to prior to your field trip. Ensure you are familiar with the terrain, identify hazards and carry out a risk assessment.
- Remind the students of likely weather conditions and encourage them to come dressed appropriately on the day of your field trip.
- Ensure all students are aware of the physical boundaries of the area of study.
- Be sure to follow all applicable board policies related to field trips and working with outside agencies.
- For more tips on planning safe outdoor excursions with students, please refer to the Back to Nature Network's wonderful teacher resource "Into Nature", available online at: <http://www.back2nature.ca/resources-research/education>

Cleaning Up Our Act: Save the Jefferson!

Lesson 2 Overview

In lesson 2 students explore how human activity can impact species that rely upon vernal pools for their survival. Students examine the real life case study of the Jefferson Salamander in Halton Region, Ontario. Staff at a local environmental agency (Conservation Halton) became aware that many of these endangered amphibians were being killed while migrating from their forest homes to the vernal pools where they breed each spring. A road had been constructed on the migration route and the salamanders were being run over by passing cars. A partnership between Conservation Halton and the local municipality (City of Burlington) developed, resulting in the closure of the road during the salamander's spring migration.

In this lesson, students will assume roles of various concerned community members and write a brief statement summarizing their perspective on a proposed road closure to protect the salamanders. The class will then engage in a Town Hall Meeting and debate the road closure while in character. Ultimately, the students decide if the road closure is in the best interest of all concerned. Finally, students will examine media pieces from the real life case study in Halton Region and discover how the community reacted to the road closure.

*Note to Teacher - This lesson will take at least two periods of class time

Grade 6 Science and Technology/Understanding Life Systems: Biodiversity

CURRICULUM EXPECTATIONS

- 1** assess human impacts on biodiversity, and identify ways of preserving biodiversity
- 1.1** analyse a local issue related to biodiversity taking different points of view into consideration to propose action that can be taken to preserve biodiversity, and act on the proposal

LEARNING GOALS

At the end of this lesson, students will...

- Be able to describe how human activities can negatively impact biodiversity in their community.
- Be able to demonstrate that environmental issues are complex due to the wide variety of interests/opinions represented in a given community.
- Think critically about different viewpoints related to an environmental issue.
- Summarize and defend a viewpoint in a class discussion.
- Be able to explain ways that humans can take steps to rectify environmental issues affecting biodiversity in their community.

INSTRUCTIONAL COMPONENTS AND CONTEXT

Readiness (Diagnostic Assessment)

Utilize student's final journal entries from Lesson 1 – "Building A Vernal Pool" to assess their readiness to progress from discussing the biodiversity supported by vernal pools to the impact human activity can have on the community of organisms that call them home.

You may choose to have the students read the MNR fact sheet on the Jefferson Salamander in preparation for Lesson 2.
<http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@species/documents/document/270949.pdf>

Glossary See page 54

Materials

- Podium for Town Hall presentations – if desired
- Class set of
 - The Story of the King Road Closure and Student Worksheet (Appendix 4)
 - Save the Jefferson! Town Hall Organizer (Appendix 5)
 - Save the Jefferson! Town Hall Assessment Rubric (Appendix 6)
- Website and Media Pieces for student support:
 - Background information on the Jefferson Salamander via the Ministry of Natural Resources
<http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@species/documents/document/270949.pdf>
 - *Endangered salamanders left to cross King Road at own risk*
Inside Halton, March 18, 2011 (Appendix 7)
 - *Section of King Road may close for endangered salamander migration*
Inside Halton, February 10, 2012 (Appendix 7)
 - *Salamander detour set up on Burlington road*
CBC, March 9, 2012 (Appendix 7)
 - *Burlington closes section of King Rd. for endangered salamander crossing*
Toronto Star, March 12, 2013 (Appendix 7)
 - *Why small salamanders are forcing road closure (2:15) via CHCH News*
<http://www.chch.com/home/item/12061-why-small-salamanders-are-forcing-road-closure>

MINDS ON

Small Group → Preparing for the “Save the Jefferson” Town Hall Meeting

1. Give each student “The Story of the King Road Closure: Conservation Halton’s View” to read independently. The statement introduces students to the real life case study of a road closure in Southern Ontario to protect an endangered vernal pool species that they should all be familiar with – the Jefferson Salamander!
2. Ask the students to reflect on the dilemma faced by the community by answering the following questions independently using “The Story of the King Road Closure Student Worksheet”.
 - What is the issue being faced by the Jefferson Salamander?
 - Thinking about your own vernal pool – what effect would a busy road nearby have on the other species that live there?
 - Why would saving the Jefferson Salamander be important for other species that rely on the vernal pools?
 - What did the community decide to do about the issue?
 - Who were the community members involved?
 - Who do you think would be in favour of the road closure and who would be against the road closure? Why?
 - Are there alternative solutions that could save the Jefferson? What are they?
3. Discuss the answers to the questions as a class. Record the list of community members that the students have compiled for future reference.
4. Gather the students in the same groups as in lesson 1. Inform the students that they will be examining different perspectives people have on the issue of protecting endangered species. They are going to participate in a Town Hall Meeting where the main issue on the agenda is a proposed road closure to protect Jefferson Salamanders. Each group of students will represent a group in the community and will need to adopt that group’s perspective for the Town Hall Meeting.

Cross-Curricular Connections:**Language: Oral Communication**

- 1.2 demonstrate an understanding of appropriate listening behaviour by adapting active listening strategies to suit a variety of situations, including work in groups
- 1.8 identify the point of view presented in oral texts, determine whether they agree with the point of view, and suggest other possible perspectives
- 2.2 demonstrate an increasingly sophisticated understanding of appropriate speaking behaviour in a variety of situations, including paired sharing, dialogue, and small- and large-group discussions
- 2.3 communicate orally in a clear, coherent manner, using appropriate organizing strategies and formats to link and sequence ideas and information

Assessment:**A^{as}L Assessment as learning**

- Circulate among the students as they work in their groups. Ask the students to assess their progress on their preparation for the Town Hall Meeting. Support them in finding solutions if they identify gaps in knowledge or teamwork.

A^{of}L Assessment of learning

- Utilize the responses from the small group discussions as an informal assessment piece reflecting the student’s developing understanding of expectations 1 and 1.1.
- Review the Town Hall Organizers to ensure all groups are sufficiently prepared for the Town Hall Meeting.

MINDS ON *(continued)*

5. Assign or have the students choose roles from the list the compiled in the initial discussion. If they need assistance they can also choose from the list of community members below. Ensure you have a wide variety of perspectives represented.
 - Emergency Services Staff (EMS, Fire Fighter, Police Officer)
 - Local Environmental Agency Staff – e.g., Ecologists
 - City Staff - Roads and Maintenance
 - City Councillors (Politicians)
 - Local Naturalist/Environmentalist Group Members
 - Local residents/Commuters
 - Jefferson Salamanders (it may be interesting to hear the perspective of other vernal pool dwellers as well, particularly predators of the Jefferson Salamander and its eggs)
6. Provide each group with a copy of the 'Inside Halton' article dated March 18, 2011 (Appendix 7) and the 'Save the Jefferson! Town Hall Meeting Organizer' (Appendix 5). Using the article to help provide context, students will work in their groups to summarize their position on the issue of the road closure. The summary will outline their perspective on the plight of the Jefferson Salamander, their perspective of the proposed road closure and suggestions for how to solve the issue (which may or may not include closing the road).
7. After completing the Town Hall Meeting Organizer you may wish to review the organizers and provide feedback before proceeding with the remainder of the lesson. Students may also use this time to gather props and costumes.

Cross-Curricular Connections:

Differentiated Instruction:

- Students might benefit from reading the article and working on the student worksheet with a partner, rather than independently.
- Break down and explicitly state what is expected in each section of the graphic organizer.
- Check in with students at each stage of the process. Monitor work completion and check for understanding. Provide supportive feedback and modify instructional strategies at each stage.
- Consider creating additional roles in the Town Hall Meeting that would benefit students for whom public speaking is a barrier (e.g., a student may play the role of a local reporter and produce an article about the proceedings at the Town Hall Meeting)

ACTION!

1. Once each group is sufficiently prepared, work with the students to develop a set of rules that they can all agree to that will set the tone of the meeting. (e.g., one person speaks at a time; demonstrate respect for the speaker by listening attentively etc.). Make sure that the students are aware that they will be assessed on their ability to abide by these rules.
2. Each group will present their position on the road closure to the class. They should introduce themselves, outline their perspective, and explain why their view is important. They must be organized and persuasive if they want to convince the rest of the community of their position. No alternative solutions will be presented at this point – all perspectives must be heard first.
3. After each presentation the rest of the community will have the opportunity to ask questions for clarification. Encourage the students to stay in character and ask questions that would be important to their community group.
4. Once the initial presentations are complete, the groups will meet to discuss their position. Has anything that has been said changed their perspective? Do they have further questions or concerns they would like to address?
5. Each group will now have another opportunity to present – this time they will be able to speak in favour of or in opposition to the road closure once more and explain their reasoning. They might also decide to present alternative solutions for the community to consider.
6. After each presentation the rest of the community will have the opportunity to ask questions about the new solutions presented. New solutions should be recorded in a prominent location as a visual reminder. Encourage the students to think of the vernal pool ecosystem (abiotic and biotic factors, including humans!) as a whole when examining the alternatives. Do the solutions proposed protect the vernal pool and all who benefit from it? Would proposed solutions benefit one species or community at the expense of another?
7. After the final presentations are complete, the groups will meet to discuss their position on the road closure prior to voting. Each student will be able to vote on the outcome of the debate. As in real life, it may be the case that students representing the same interest group have developed different opinions on the road closure during the course of the meeting. It is important for students to recognize that this is one of the reasons this type of decision can be so difficult for communities to make.
8. The students may vote for their preferred option for saving the Jefferson Salamander by private ballot or by show of hands. Share the result with the class. Celebrate the successes of the debate; especially if the students were able to demonstrate respect for one another while clearly communicating differing viewpoints.

Cross-Curricular Connections:

Assessment:

A_{of}L Assessment of learning

- Collect the Town Hall Organizers to assist with formal assessment of the Town Hall Meeting. See Appendix 6 for the formal assessment rubric for the Town Hall Meeting.

Differentiated Instruction:

- Students might benefit from playing a larger role in one stage of the assignment in exchange for a smaller role in another (for example, more participation in the planning stage in exchange for a smaller speaking role, or vice versa). Allow students to play to their strengths.
- Prior to presenting for the second time, meet with each group to discuss their new position. Improvising and presenting new ideas will be more stressful and challenging for some students than it will be for others.

CONSOLIDATION

Whole Class or Groups

1. After the Town Hall Meeting is adjourned and students have shed their assumed roles, divide the students up into new groups to discuss the following questions. Each group should have at least one representative of each community group present so they may compare perspectives.
 - Why would it be difficult for a community to implement a strategy to save an endangered species? (e.g., opposing viewpoints, other issues competing for time and financial resources, public unaware of the issue)
 - What do you think would help make it easier for a community to make decisions that help support biodiversity?
 - What are some ways students can help support biodiversity in the community? (e.g., lifestyle changes that help protect habitat, stewardship opportunities with local environmental agencies, educating the public etc.). Have the students record their ideas for future reference should you choose to engage in the lesson extension below.
2. Share the answers to the discussion questions as a class.
3. Provide the students with copies of media reports (Appendix 7) on the King Rd. closure.
 - *Section of King Road may close for endangered salamander migration*
Inside Halton, February 10, 2012
 - *Burlington closes section of King Rd. for endangered salamander crossing*
Toronto Star, March 12, 2013

These documents provide some perspective on how the closure has been perceived by the community after implementation. They may be surprised to discover that, despite initial debate, response to the closure after it took place was positive.

4. Ask the students to write a journal entry about how this result makes them feel. Are they surprised? Why or why not? How does this affect their desire to undertake environmental action in their community? What type of action could they take to help protect salamanders and other vernal pool species in their life? (some examples include: observing salamanders without touching them, not altering vernal pool habitats, educating others in the community, making sure litter ends up in the trash)

Outdoor Extension: Take advantage of the student's enthusiasm for saving the Jefferson Salamander and explore projects that they could become involved in to help species at risk in their own community (e.g.: invasive plant species removal, school ground clean ups, school ground greening projects, developing public awareness campaigns, building and installing bird or bat boxes)

Cross-Curricular Connections:

A_{of}L Assessment of learning

- Utilize involvement in discussion and the journal entries as informal assessment pieces reflecting the students' developing understanding of human impact on biodiversity - expectations 1 and 1.1.

Differentiated Instruction:

- Students might benefit from working individually or in pairs on the discussion questions rather than in large groups.
- Students might benefit from the option of speaking with you one-on-one about their ideas, instead of submitting a journal reflection.

Appendix 1

Vernal Pool Species Teacher Reference

Class	Species
Amphibians	Blue-spotted salamander O Jefferson salamander O Spotted Salamander O Red-spotted newt F Wood frog O Spring peeper F Northern leopard frog F Gray tree frog Bull frog Green frog American toad O
Arachnid	Water Mite
Birds	Mallards F Red Winged Blackbird Canada Goose Great Blue Heron Marsh Wren Kingfisher
Bivalve	Freshwater Fingernail Clam
Branchiopods	Fairy shrimp O Daphnia
Insects	Backswimmer F Caddis fly larvae F Damselfly larvae Dragonfly larvae Green Darner F Mosquitoes F Predaceous Diving Beetle larvae Water Boatmen F Water Scorpion Whirligig Beetle larvae
Mammals	Beaver Muskrat Mink Skunk Red Squirrel
Reptiles	Snapping turtle F Blanding's turtle Eastern garter snake F Northern Water Snake F Milk Snake

Note:

"O" designates an Obligate Vernal Pool Species (a species that are unable to successfully complete their lifecycle without vernal pools)

"F" designates a Facultative Vernal Pool Species (a species that may use vernal pools, but are also able to successfully complete their lifecycles using other wetlands)

Other listed species benefit from the presence of vernal pools as a source of food or water but are not dependent upon vernal pools to complete their lifecycle.

Appendix 2

NAME _____

Research Organizer

Use this worksheet to help you and your expert group to complete web research on your vernal pool organism. Make sure to share all the information on your sheet with your expert group mates before returning to your home group. Remember, when you return to your home group, you will be the expert on this organism!

Use the following websites to start your research.

- www.ontariovernalpools.org
- http://www.vernalpool.org/vpinfo_1.htm
- <http://news.discovery.com/animals/videos/animals-vernal-pools-spring-to-life.htm>

Species	
Class (e.g., Mammal, Amphibian)	
What does this organism eat?	
What predators might eat this organism?	
Does this organism rely on any other habitats to survive? (e.g., forest, meadow) How?	
How is a vernal pool an important part of this organism's life cycle?	
Is this organism facing any challenges related to human activity? What are they?	



Provide a colour sketch of your organism on the back of this page. (How big is your organism? What colour is it? Does it have any interesting physical adaptations that should be included in your drawing?)

Appendix 3

Building a Vernal Pool Assessment Rubric

Expectation	Level 4	Level 3	Level 2	Level 1
Knowledge of Content (Knowledge & Understanding)	The completed vernal pool demonstrates excellent knowledge of vernal pool habitats and the biodiversity they support. Demonstrates significant understanding of the interrelationships between species and between species and their environment.	The completed vernal pool demonstrates considerable knowledge of vernal pool habitats and the biodiversity they support. Demonstrates considerable understanding of interrelationships between species and between species and their environment.	The completed vernal pool demonstrates satisfactory knowledge of vernal pool habitats and the biodiversity they support. Demonstrates limited understanding of the interrelationships between species and between species and their environment.	The completed vernal pool demonstrates limited or incomplete knowledge of vernal pool habitats and the biodiversity they support. Does not demonstrate an understanding of the interrelationships between species and between species and their environment.
Initiating & Planning (Thinking & Investigation)	The home group used initiating and planning skills and strategies with a high degree of effectiveness. Group discussions were effective and all group members contributed to the final product.	The home group used initiating and planning skills and strategies with considerable effectiveness. Most group discussions were effective and all group members contributed to the final product.	The home group used initiating and planning skills and strategies with some effectiveness. Group discussions were somewhat effective and most group members contributed to the final product.	The home group used initiating and planning skills and strategies with limited effectiveness. Group discussions were frequently ineffective or some group members did not contribute to the final product.
Quality of Research (Thinking & Investigation)	Every element of the completed project is accurate and reflects thorough research. Exceeded the requirements with no errors.	Most elements of the completed project are accurate and properly researched. Met the requirements with minimal errors.	Research was completed inconsistently. Some of the organisms do not have complete information or the vernal pool is lacking key elements.	Research was not complete. Many of the organisms did not have complete information and the vernal pool is lacking key elements.
Vocabulary (Communication)	Written elements of the final product demonstrate excellent use of appropriate terminology. Spelling and grammar are excellent, with almost no errors.	Written elements of the final product demonstrate good use of appropriate terminology. Spelling and grammar are good, with few errors.	Written elements of the final product demonstrate fair use of appropriate terminology. Spelling and grammar are satisfactory, with some errors.	Written elements of the final product do not demonstrate use of appropriate terminology. Spelling and grammar are poor with many errors.
Expression & Organization (Communication)	Visual and textual elements work together to create an attractive, detailed and informative finished product.	Visual and textual elements work together to create a detailed and informative final product.	Visual and textual elements somewhat work together to create an informative final product.	Visual and textual elements do not work together or are missing. A viewer would have difficulty deriving meaning from the final product.

Appendix 4

NAME _____

The Story of the King Road Closure

Conservation Halton's View

We have been aware of the salamander population in the area for some time and have taken DNA samples to confirm that there are 'Jeffersons' breeding in ponds (vernal pools) on land protected by Conservation Halton. Road kill surveys recorded Jefferson Salamander deaths due to vehicle traffic during migration. The City of Burlington looked at several options to solve the situation and the road closure was chosen as the most appropriate option.

Some discussion occurred about whether it would be a permanent closure of King Road on the migration route or just a temporary closure. City council voted in winter 2010 to temporarily close a portion of King Road each spring to allow the endangered species to cross safely for mating purposes.

When the closure did not occur in 2011 some of the public were disappointed. City staff had planned to wait until permanent road block mechanisms could be installed due to safety issues (inability of larger vehicles to turn around, emergency vehicle access, and snow plowing needs). Partly in response to public feedback, the closure occurred in 2012 using temporary blockades.

The city collaborated with conservation staff on the timing of the closure so it would coincide with the prime migration period. Conservation staff performed road surveys on mornings after migration conditions to confirm the barriers were effective and no road kills occurred. No road kills were observed in the closure area in 2012.

There are no houses in the closure area; the road is mainly used as a shortcut between two towns to bypass areas with heavy commuter traffic. It was found that some commuters drove into the ditch to get around the blockade and bypass the closure. In response to this, the city added more concrete barriers.

From a conservation perspective, the only potentially negative outcome of this closure is now this location is widely known as Jefferson Salamander habitat. People are visiting the area specifically for "sightseeing" and searching for salamanders. This could have a negative effect if people interfere with migration, disturb habitat, or harm the breeding areas. Increased traffic to the forest habitat is harmful but increased traffic to the breeding ponds could be even more harmful. Many people are unaware that it is illegal to touch a Jefferson Salamander without an ESA (Endangered Species Act) permit. They are a protected species and therefore cannot be interfered with, nor can their habitat be altered or harmed.

Appendix 4

The Story of the King Road Closure

Student Worksheet

1. What is the issue being faced by the Jefferson Salamander? _____

2. Thinking about your own vernal pool – what effect would a busy road nearby have on the other species that live there?

3. Why would saving the Jefferson Salamander be important for other species that rely on the vernal pools?

4. What did the community decide to do about the issue? _____

5. Who were the community members involved? _____

6. Who do you think would be in favour of the road closure and who would be against the road closure? Why?

7. Are there other ways to save the Jefferson? Describe an alternate solution. _____

Appendix 5

Research Organizer

You will be working as a group to present your opinion about a proposed road closure in your community to save Jefferson Salamanders migrating to a vernal pool to breed. The road is used by 1500 cars per day. Closing the road would require setting up concrete barriers along two sections of road for a week or two. Use this worksheet to help your community group think about your perspective on the road closure and to prepare for the *Save the Jefferson!* Town Hall Meeting. Remember, you will need to stay in character while presenting and defending your perspective in order to win the favour of your fellow community members in the final vote to determine if the road will be closed.

Our Community Group is...	
Why is our perspective important to this debate?	
How do we use the area around the road and vernal pool?	
What are our concerns about the proposed road closure?	
What do we like about the proposed road closure?	
What other information would we like to know about the road closure to make an informed decision?	
Are we for or against the road closure? Why?	
Are there alternative ways to save the Jefferson that we would like to propose?	

Appendix 6

Save the Jefferson!

Town Hall Meeting Assessment Rubric

Expectation	Level 4	Level 3	Level 2	Level 1
Knowledge of Content (Understanding)	Demonstrated thorough understanding of the complexity of viewpoints reflected in the Town Hall Meeting and how those viewpoints could affect biodiversity in the community.	Demonstrated good understanding of the complexity of viewpoints reflected in the Town Hall Meeting and how those viewpoints could affect biodiversity in the community.	Demonstrated some understanding of the complexity of viewpoints reflected in the Town Hall Meeting or how those viewpoints could affect biodiversity in the community.	Demonstrated limited understanding of the complexity of viewpoints reflected in the Town Hall Meeting or how those viewpoints could affect biodiversity in the community.
Critical Thinking (Thinking & Investigation)	Used critical thinking processes, skills, and strategies while presenting and questioning other groups with a high degree of effectiveness.	Used critical thinking processes, skills, and strategies while presenting and questioning other groups with considerable effectiveness.	Used critical thinking processes, skills, and strategies while presenting or questioning other groups with some effectiveness.	Used critical thinking processes, skills, and strategies while presenting or questioning other groups with limited effectiveness.
Expression & Organization (Communication)	All presenters were in character and demonstrated a clear understanding of the perspective of their community group. Arguments were organized in a tight, logical fashion.	Most presenters were in character and demonstrated a clear understanding of the perspective of their community group. Most arguments organized in a tight, logical fashion	Most presenters were in character and demonstrated an understanding of the perspective of their community group. Arguments were sometimes not clear or logical.	Presenters were frequently not in character or the group did not demonstrate an understanding of the perspective of their community group. Arguments were rarely clear or logical.
Communication with Audience (Communication)	All statements, language, and responses were respectful and in adherence with the Town Hall rules that had been agreed upon by the class.	Most statements, language and responses were respectful and in adherence with the Town Hall rules that had been agreed upon by the class.	Some statements, language and responses were respectful and in adherence with the Town Hall rules that had been agreed upon by the class.	Statements, language and responses consistently violated the Town Hall rules that had been agreed upon by the class.
Making Connections (Application)	The group made connections between society and the environment with a high degree of effectiveness	The group made connections between society and the environment with considerable effectiveness	The group made connections between society and the environment with some effectiveness	The group made connections between society and the environment with limited effectiveness

Appendix 7

Articles

InsideHalton

<http://www.insidehalton.com/print/969028>

insideHALTON
com



Endangered salamanders left to cross King Road at own risk

Tina Depko, BURLINGTON POST STAFF

March 18, 2011

Green-minded drivers may want to plan a detour around the section where King Road meets the escarpment for the next few weeks.

Endangered Jefferson salamanders will start making their way across the road to breeding ponds starting as early as next week.

While city council voted in winter 2010 to temporarily close a portion of King Road every spring to allow the endangered species to cross safely for mating purposes, the road will remain open for the second consecutive year.



Endangered salamanders left to cross King Road at own risk.
Endangered Jefferson salamander

Vito Tolone, a senior transportation planner with the city, said there wasn't enough time to inform residents of a closure, but that the city is committed to the undertaking next spring.

"To do this properly and safely, we need to undertake a full advertising and notification campaign, and install proper interpretive signage and road closures," said Tolone. "Next spring, we'll have all the necessary items in place to do the job." Conservation Halton had been working with city staff about the timing of the temporary closure and are strong proponents of it, according to spokesperson Hassaan Basit.

"They (the salamanders) move on the first warm (anything above four degrees Celsius) rainy nights of spring and ideally the road should be closed for a two- or three-week time period to give them adequate time," he said.

Now that the closure has been nixed, Basit asks drivers to avoid driving on the north portion of King Road where it meets the escarpment, especially during rainy evenings.

"Avoiding driving on these really wet spring nights when amphibians are moving in general or especially trying to avoid driving near wetlands or other amphibian habitats on these nights... would help prevent road kills in general," Basit said.

He confirmed that the breeding trek for the little guys is going to start soon, possibly next week.

"I have not seen any out yet myself, but with the snow melting as fast as it is they should be moving shortly, it could be as early as early next week," Basit said. "The adults will cross back into the forest as soon as they have finished breeding — within a few weeks, usually maybe longer, sometimes a little weather dependent again, they just don't like moving much when it's dry. The hatchlings will emerge from the pond mid to late

InsideHalton

<http://www.insidehalton.com/print/1296093>

insideHALTON
 .com



Section of King Road may close for endangered salamander migration

Tim Kelly, Burlington Post

February 10, 2012

As quietly as the amphibians move in the night, Burlington's community services committee passed a report to close a northern portion of King Road for up to three weeks this March/April to protect the endangered Jefferson salamander.

Part of a very busy Wednesday evening committee meeting, the item regarding the salamanders didn't even merit a word of discussion as it was moved to the consent agenda, meaning it received unanimous consent and will come before council for final approval on Tuesday, Feb. 21.

Staff recommended in its report to committee that the voluntary road closure instituted from April 1-22, 2011, had been "insufficient to protect this species."

The report also said that, "based on the results of the Road Mortality Survey conducted by Conservation Halton it has been confirmed that the surrounding Jefferson salamander population is being impacted by vehicular traffic during spring migration."

The road closure will take place from approximately 1865 King Rd. to Mountain Brow Road.

After the meeting, Ward 1 Councillor Rick Craven admitted the voluntary road closure instituted last year did not work.

"We have a report from the Conservation Authority which clearly indicates the voluntary closure doesn't work so let's go to the next logical and reasonable step to do this well.

"Everybody realizes and understands that the Jefferson salamander is a threatened species and we need to do our part to try and make sure to protect and preserve that species," said Craven.

A specific date for when the road will be closed and reopened has yet to be revealed.



Section of King Road may close for endangered salamander migration. Jefferson salamander

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Appendix 7 (continued)

Articles

Toronto Star

[News / GTA](#)

Burlington closes section of King Rd. for endangered salamander crossing

A section of King Rd. will be closed for three weeks to help the endangered Jefferson Salamander species cross over to their breeding ponds safely

Conservation Halton

Burlington will close King Rd. for three weeks to allow the endangered Jefferson salamander access to its breeding grounds.

By: Erica Rae Chong Staff Reporter, Published on Tue Mar 12 2013

The city of Burlington has closed a section of King Rd. for a special group of protected residents, as they move from one side of the road to the other.

King Rd. will be shut between North Service Rd. and Mountain Brow Rd. to help endangered Jefferson Salamanders avoid traffic and cross over to their breeding ponds safely.

The closures will be in effect from March 18 to April 8.

“The Jefferson Salamander is a protected species. It is at risk and has a very limited population,” said Bruce Zvaniga, Burlington’s director of transportation.

Staff at Conservation Halton estimate there are 100 or fewer of the species in the area. They have discovered the salamander’s breeding pattern is to cross King Rd. during this time and use the ponds that develop in spring for breeding. They usually do this at night when it is wet and dark and often traffic fails to spot the tiny grey animals.

The three-week closure is an annual commitment by city council in protecting the species.

“We hope to give the salamanders the best chance of surviving and protect the environment,” said Zvaniga.

The estimated cost of the road closure is around \$1,500.

Salamander detour set up on Burlington road

Only 100 endangered 'Jeffy' salamanders estimated to populate the area

[CBC News](#)

Posted: Mar 9, 2012 8:35 PM ET

Last Updated: Mar 9, 2012 8:40 PM ET

A salamander detour has been set up in Burlington to create safe passage for the endangered amphibians, which otherwise risk being squashed by cars and foot traffic.

Only about 100 Jefferson salamanders — or "Jeffys", as they're commonly known — are still living in the forest near a stretch of road up the Niagara Escarpment.

With a lifespan of only 30 years, the slithery creatures are a precious part of the local ecosystem, but experts say they inhabit one of the only areas in Ontario where they must cross the road to breed. In

'We considered crossing guards, but that wasn't going to work'

—Rick Goldring, mayor of Burlington

this case, it's a portion of King Road that ferries some 1,500 cars on a typical day.

Conservation Halton wants to make sure the salamanders can freely scamper from their winter homes to lay eggs in the ponds across the street.

"There were egg masses within the pools that would confirm that last night, there were some movement activities," Leslie Matich, with Conservation Halton, told CBC News on Friday.

Caution against stepping on salamanders

"It's just ingrained within them to keep going back over to the same pool every single year to breed."

So Burlington's city council recently agreed to close a stretch of road nearby, reasoning that losing one Jeffy could be devastating to their survival.

There were no objections from local politicians, said Burlington mayor Rick Goldring.

"We considered crossing guards, but that wasn't going to work," he said.

Finding the Jeffies is hard work, as they prefer to travel at night, so keeping the road clear is critical.

As for those planning to do some salamander sleuthing to find a Jeffy on their own, Conservation Halton stressed caution, saying that many of the salamanders are killed every year because they're accidentally stepped on.

Cleaning Up Our Act: Human Impacts on Aquatic Ecosystems

Lesson 1 Overview

This lesson encourages students to engage deeply with the impact of human activity on aquatic ecosystems. The lesson begins with an introduction to two case studies featuring real success stories of people working together to be stewards of biodiversity in Southern Ontario. Next, the students are given the task of writing an investigative newspaper report that will be split into two parts.

Part one of the report is the focus of this lesson, and includes the following components: a detailed description of how three (3) types of human activity affect water quality and how each activity affects biodiversity; at least two (2) graphs that communicate interesting data about how humans impact aquatic ecosystems; and a conclusion about our relationship with water.

The lesson ends with a consolidation about what they have learned throughout the research process, and a lead up to the following lesson, which will re-focus on the introductory case studies, this time with a focus on stewardship efforts.

*Note to Teacher - Depending on the nature of your class and your level of expectations for the assessment, this lesson will require more than two periods of 75-minutes for completion.

Grade Nine Science, Academic (SNC 1D) Biology: Sustainable Ecosystems

CURRICULUM EXPECTATIONS

- B1.1** assess, on the basis of research, the impact of a factor related to human activity (e.g., urban sprawl, introduction of invasive species, overhunting/overfishing) that threatens the sustainability of a terrestrial or aquatic eco-system
- B2.** investigate factors related to human activity that affect terrestrial and aquatic ecosystems, and explain how they affect the sustainability of these ecosystems.
- B2.4** plan and conduct an investigation, involving both inquiry and research, into how a human activity affects water quality (e.g., leaching of organic or inorganic fertilizers or pesticides into water systems, changes to watersheds resulting from deforestation or land development, diversion of ground water for industrial uses), and, extrapolating from the data and information gathered, explain the impact of this activity on the sustainability of aquatic ecosystems
- B2.5** analyse the effect of human activity on the populations of terrestrial and aquatic ecosystems by interpreting data and generating graphs (e.g., data from Statistics Canada, Parks Canada, and other websites on: the concentration in water of chemicals from fertilizer run-off and their effect on the growth of algae; stressors associated with human use of natural areas, such as trampled vegetation, wildlife mortality from motor vehicles, and the removal of plants, animals, and/or natural objects; suburban developments and their impact on the food supply for animals such as foxes and raccoons)
- B3.5** identify various factors related to human activity that have an impact on ecosystems (e.g., the introduction of invasive species; shoreline development; industrial emissions that result in acid rain), and explain how these factors affect the equilibrium and survival of ecosystems (e.g., invasive species push out native species and upset the equilibrium in an ecosystem; shoreline development affects the types of terrestrial and aquatic life that can live near lake shores or river banks; acid rain changes the pH of water, which affects the type of aquatic life that can survive in a lake)

LEARNING GOALS

At the end of this lesson, students will...

- Understand why water and aquatic ecosystems are important to human life.
- Understand how human activity impacts aquatic ecosystems.
- Think critically about the role that they play in impacting the sustainability of aquatic ecosystems.
- Assess and interpret the information they gather, and communicate these results graphically and through words in a research-based newspaper report.
- Begin to consider how they can change their actions to positively affect change on water ecosystems in the local community (to be further developed in Lesson 2).

INSTRUCTIONAL COMPONENTS AND CONTEXT

Readiness (Diagnostic Assessment)

A_{for}L Assessment for learning

Prior to the introduction of this lesson...

- Review the concept of 'biodiversity' with students.
 - Write 'Biodiversity' in the centre of a word web on the board, and ask students to volunteer to write words, ideas, concepts that relate to the term.
 - After looking at the word web, ask students how their actions might affect biodiversity in their community, particularly with respect to aquatic ecosystems.
- To deepen student understanding of biodiversity, show them Our World, Ontario. (via the Ontario Ministry of Natural Resources <http://www.mnr.gov.on.ca/en/Business/Biodiversity/2ColumnSubPage/286676.html>)

Glossary See page 54

Materials

- Computer with Internet access and projector for teacher-led activity
- Class set of computers with Internet access for student activity
- Class set of handouts
 - Research & brainstorming graphic organizer
 - Investigative Report Organizer
 - Investigative Report Rubric (Part One)
- Websites for lesson components and student support:
 - Biodiversity: Our World Ontario via Ontario's Ministry of Natural Resources*
<http://www.mnr.gov.on.ca/en/Business/Biodiversity/2ColumnSubPage/286676.html>
 - Going to the Source, on Source Water Protection via Ecojustice*
<http://www.ecojustice.ca/blog/going-to-the-source-on-source-water-protection>
 - Gail Krantzberg's Passion For Water via Ontario's Greenbelt*
<http://greenbelt.ca/multimedia/videos/gail-krantzbergs-passion-water>
 - Statistics Canada- *Human Activity & the Environment* Annual Report (see 'wastewater discharges' section)
<http://www5.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=16-201-XIE&lang=eng#formatdisp>
 - Parks Canada- *Aquatic Management*
<http://www.pc.gc.ca/pn-np/bc/yoho/plan/ecosystemes-ecosystems/aqua-connect.aspx>
 - Environment Canada- *Water*
<http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=65EAA3F5-1>
 - Conservation Ontario- *Watershed Monitoring*
http://www.conservation-ontario.on.ca/watershed_monitoring/index.html
 - Environment Canada- *The Importance of Wetlands*
<http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=27147C37-1#Section2>
 - Ontario's Greenbelt*
<http://www.greenbelt.ca>

MINDS ON

Whole Class → *Water: Who Cares?*

1. After assessing students' prior knowledge of 'biodiversity',
 - a. Introduce how we impact water by showing *Canada's Source Water* (2:36) via *YouTube* <http://www.youtube.com/watch?v=Yt7eG62fYgU>
 - b. Now, introduce the importance of stewardship of Ontario's aquatic ecosystems by showing *Gail Krantzberg's Passion For Water* (2:17) via Ontario's Greenbelt <http://greenbelt.ca/multimedia/videos/gail-krantzbergs-passion-water>
2. Provide the class with copies of the Water & Biodiversity Case Studies found in Appendix 2 and review them together. Inform the class that the photos are of actual case studies featuring degraded aquatic environments in Southern Ontario and the stewardship efforts that have taken place to restore them to a healthy state.
3. Ask students to **reflect** on the following questions and use the **think, pair, share** method to focus their thoughts. Pose the questions to your class, and ask them to **think** about their answers individually and write a short journal entry to submit to you. Then, ask students to **pair** up with a partner to talk about their answers, and finally, **share** ideas as a class.
 - a. Why are wetlands in Ontario so important to us?
 - b. How do my own actions impact the quality of our water?
 - c. In what ways are we affected by the quality of our water?

Cross-Curricular Connections:

Grade Nine English - Writing

1. Developing and Organizing Content: generate, gather, and organize ideas and information to write for an intended purpose and audience (1.1, 1.2, 1.3, 1.4, 1.5)
2. Using Knowledge of Form and Style: draft and revise their writing, using a variety of literary, informational, and graphic forms and stylistic elements appropriate for the purpose and audience (2.1, 2.2)

Assessment:

A_{for}L Assessment as learning

- Utilize the journal entry & involvement in the class discussion as informal assessment pieces reflecting students' developing understanding of human impact on aquatic ecosystems.

Differentiated Instruction:

- Summarize and reinforce the content of each video. Contemplate the use of supporting print or media materials where needed.
- Where appropriate consider speaking one-on-one with students rather than requiring the submission of a written journal reflection.
- The presentation of videos will benefit audio and visual learners but kinaesthetic learners might need additional reinforcement of the concepts being introduced.

ACTION!

Working in Pairs (computer lab with Internet access) → *What Part Do I Play?*

1. Distribute the 'Cleaning Up Our Act: Research & Brainstorming Organizer' (Appendix 3) to the class. The students will be investigating local human impacts on water by researching information from Conservation Ontario, Statistics Canada, Parks Canada, and other websites. This organizer will be a place for students to brainstorm as they begin their research. They will choose three types of human impact to investigate further in their report.
2. Distribute the 'Cleaning Up Our Act: Investigative Report Organizer – Part One' (Appendix 4) and pose the following situation to the class:

You and your partner have been hired by the local newspaper to write a two-part investigative report about how humans impact aquatic ecosystems. Your first article is meant to **inform** about the challenges that we have created related to aquatic ecosystems. You will eventually write a second article about local initiatives to protect water that is meant to **empower** citizens to take action (focus of lesson 2).

Part One of your report must include:

- A detailed description of how three (3) types of human activity affect water quality (i.e. leaching of pollution into water systems).
 - Explain how each human activity affects biodiversity. What is the impact of this activity on the sustainability of aquatic ecosystems?
- At least two (2) graphs that communicate any interesting data you have collected about how humans impact aquatic ecosystems (i.e. sources of pollution, the percentage of pollution contributed by each province, etc.)
 - Use the style of graph that best displays the information you choose to represent (pie graph, bar graph or line graph). Remember that your target audience (the population reading the newspaper) must be able to easily interpret each graph. You may also include other diagrams to enhance your article.
- A conclusion about our relationship with water and how our actions have affected biodiversity. What impact does water quality have on our lives? Why is biodiversity important and what might be the best course of action to take to solve the problems that you have outlined (this will be developed further in part two of your report)?

The editor of the newspaper expects that all reports will be based on research and data gathered from various credible sources. Here is a list of resources that might be helpful for students in the completion of their two-part newspaper article:

- *Conservation Ontario- Watershed Monitoring* found online at http://www.conservation-ontario.on.ca/watershed_monitoring/index.html
- *Statistics Canada- Human Activity & the Environment Annual Report* (see 'wastewater discharges' section)- found online at <http://www5.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=16-201-XIE&lang=eng#formatdisp>

Cross-Curricular Connections:

Grade Nine Math - Linear Relations

1. Apply data-management techniques to investigate relationships between two variables
2. Demonstrate an understanding of the characteristics of a linear relation

Assessment:

A_{for}L Assessment as learning

- See Appendix 5 for the formal assessment rubric for the Cleaning Up Our Act Investigative Report (Part One)

Differentiated Instruction:

- Brainstorm with the class alternatives to article writing as a method to communicate the information they learn. Consider allowing students freedom to choose one of these alternatives.
- Students may benefit from defined roles in the article writing process (i.e. researcher, editor etc.)
- Check in with students at each stage of the report writing process to monitor work completion and check for understanding. Provide supportive feedback and adjust instructional strategies at each stage as needed.

- *Parks Canada- Aquatic Management*- found online at <http://www.pc.gc.ca/pn-np/bc/yoho/plan/ecosystemes-ecosystems/aqua-connect.aspx>
 - *Environment Canada- Water*- found online at <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=65EAA3F5-1>
3. Speak with your school newspaper (or local newspaper) and inquire about publishing a selection of the best articles of the class. This will provide further incentive for students to write an effective piece.

CONSOLIDATION

Whole Class → *Discuss and Reflect*

1. Following completion of part one of their investigative reports, bring the students back together for a follow up discussion. This is a good opportunity to review the questions from the start of the lesson, so that students can share their research and new ideas with their classmates.
 - a. Why are wetlands in Ontario so important to us?
 - b. How do my own actions impact the quality of our water?
 - c. In what ways are we affected by the quality of our water?
2. As a 'ticket out the door', ask students to write another short journal entry that answers the following questions to see how much knowledge they have gained...
 - a. How has your research expanded your understanding of human impact on aquatic ecosystems in our community?
 - b. What actions might we take to improve the situation?

Outdoor Extension:

Take the class to explore a local wetland and photo document any threats to biodiversity they witness. Have the students share their photos with each other in class or on a class blog.

or

Visit a local Conservation Area or Outdoor Education Field Centre, many offer pond or stream study programs that get students up close and personal with wetland species. This will help illustrate how these species are affected by human activities.

Assessment:

A_{for}L Assessment as learning

- Utilize involvement in discussion (& possible journal entry) as informal assessment pieces reflecting the students' developing understanding of human impact on biodiversity and the importance of water.

Differentiated Instruction:

- Where appropriate consider speaking one –on-one with students rather than requiring the submission of a written journal reflection.

Cleaning Up Our Act: Human Stewardship of Aquatic Ecosystems

Lesson 2 Overview

This lesson reviews how humans have negatively affected water and aquatic ecosystems (by drawing from lesson 1), and begins to shift students' thinking towards how we can create positive change. Students explore the concept of stewardship through further examination of the case studies introduced in lesson 1. Students will be given the opportunity to research different ways that they can impact biodiversity at the watershed/community level. Teachers have the option of working with their students to plan water stewardship projects or to support their students in volunteering for pre-planned local initiatives.

This project will be the basis of the second part of their investigative newspaper reports (continued from lesson 1). Students will be expected to think critically about their stewardship projects in order to demonstrate an understanding of how they have affected the sustainability of an aquatic ecosystem. The lesson ends with a discussion that consolidates what they have learned by being stewards of the environment.

The lesson contains the option to extend the learning by allowing students to use their research, articles, and stewardship projects as a starting point for launching a campaign to inform the student body about environmental issues in their community.

*Note to Teacher - Due to the scope of the hands-on project, this lesson will take more than one period of 75-minutes for completion and will most likely require that students complete some of the assignment components on their own time.

Grade Nine Science, Academic (SNC 1D) Biology: Sustainable Ecosystems

CURRICULUM EXPECTATIONS

- 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
- B1.1** assess, on the basis of research, the impact of a factor related to human activity (e.g., urban sprawl, introduction of invasive species, overhunting/overfishing) that threatens the sustainability of a terrestrial or aquatic ecosystem
- B2.** investigate factors related to human activity that affect terrestrial and aquatic ecosystems, and explain how they affect the sustainability of these ecosystems
- B2.4** plan and conduct an investigation, involving both inquiry and research, into how a human activity affects water quality (e.g., leaching of organic or inorganic fertilizers or pesticides into water systems, changes to watersheds resulting from deforestation or land development, diversion of ground water for industrial uses), and, extrapolating from the data and information gathered, explain the impact of this activity on the sustainability of aquatic ecosystems
- B2.5** analyse the effect of human activity on the populations of terrestrial and aquatic ecosystems by interpreting data and generating graphs (e.g., data from Statistics Canada, Parks Canada, and other websites on: the concentration in water of chemicals from fertilizer run-off and their effect on the growth of algae; stressors associated with human use of natural areas, such as trampled vegetation, wildlife mortality from motor vehicles, and the removal of plants, animals, and/or natural objects; suburban developments and their impact on the food supply for animals such as foxes and raccoons)
- B3.** demonstrate an understanding of the dynamic nature of ecosystems, particularly in terms of ecological balance and the impact of human activity on the sustainability of terrestrial and aquatic ecosystems
- B3.5** identify various factors related to human activity that have an impact on ecosystems (e.g., the introduction of invasive species; shoreline development; industrial emissions that result in acid rain), and explain how these factors affect the equilibrium and survival of ecosystems (e.g., invasive species push out native species and upset the equilibrium in an ecosystem; shoreline development affects the types of terrestrial and aquatic life that can live near lake shores or river banks; acid rain changes the pH of water, which affects the type of aquatic life that can survive in a lake)

LEARNING GOALS

At the end of this lesson, students will...

- Understand why water and aquatic ecosystems are important to human life.
- Understand how human activity impacts the quality of water.
- Think critically about the role that they play in impacting the sustainability of aquatic ecosystems.
- Assess and interpret the information they gather, and communicate these results in a research-based newspaper report.
- Be able to plan and initiate an effective water stewardship project that affects the biodiversity of a sustainable ecosystem.
- Think critically about how they can change their actions to positively impact their community.

INSTRUCTIONAL COMPONENTS AND CONTEXT

Readiness (Diagnostic Assessment)

A_{for}L Assessment for learning

Prior to the introduction of this lesson...

Ensure that students have completed part one of their investigative report. They should have a firm grasp of the different ways in which humans negatively impact water quality and biodiversity in aquatic ecosystems. Use the Investigative report (Part One) assessments to ensure that the students are prepared for the next step of the project.

Note to Teacher

Contact your local Conservation Authority or any of the initiatives/organizations listed here to inquire about opportunities for stewardship. You will need to know this information well in advance to provide support to students for their stewardship projects.

Glossary See page 54

Materials

- Computer with Internet access and projector for teacher-led activity
- Class set of computers with Internet access for student activity
- Class set of handouts
 - Investigative Report Organizer (Part Two)
 - Investigative Report Rubric (Part Two)
- Websites for lesson components and student support:
 - *Project 33: Great Lakes United'* via YouTube at <http://www.youtube.com/watch?v=8CxSQf714fc&list=UUgpQuJLTMsj18ouY6jPqyNw> (there are numerous case studies linked to this YouTube channel)
 - *'2010 CRD EcoStar Water Stewardship Winner - Mary Cooper'* (3:19) via YouTube at <https://www.youtube.com/watch?v=Ay6dmrrnKvo>
 - *'Troubled Waters part 4: Ecological Resilience'* (6:50) via YouTube at <https://www.youtube.com/watch?v=JvwkZq3v15k>
 - *Conservation Ontario- Watershed Monitoring* http://www.conservation-ontario.on.ca/watershed_monitoring/index.html)
 - *The Great Canadian Shoreline Cleanup* www.shorelinecleanup.ca
 - *The Children's Water Education Council* for information about student volunteerism at local Children's Water Festivals. www.cwec.ca

MINDS ON

Whole Class → Stewardship: How Can We Help?

- Write "Human Impact on Water" in the centre of a word web on the board and ask students to volunteer to write words, thoughts, ideas that come to mind. Refer to part one of their investigative reports and ask students what they have learned about human impact on aquatic ecosystems.
- Based on part one of the investigative report, students might focus exclusively on negative impacts but the point of this lesson is to begin to shift their thinking towards how we can positively affect change in the community. Ask students the following question:
 - What types of action can we take to solve some of the problems that we have created?
 - Use the **think, pair, share** method; pose the question to your class, ask them to **think** about their answers individually then **pair** up with a partner to talk about their answers, and finally, **share** ideas as a class.
- Reinforce the concept of stewardship by showing any or all of the following projects to the class:
 - 'Project 33: Great Lakes United' via YouTube at <http://www.youtube.com/watch?v=8CxSQf714fc&list=UUgpQuJLTMsj18ouY6jPqyNw> (there are numerous case studies linked to this YouTube channel)
 - '2010 CRD EcoStar Water Stewardship Winner - Mary Cooper' (3:19) via YouTube at <https://www.youtube.com/watch?v=Ay6dmrrnKvo>
 - 'Troubled Waters part 4: Ecological Resilience' (6:50) via YouTube at <https://www.youtube.com/watch?v=JvwkZq3v15k>
- Review the local case studies of water stewardship with the class (Appendix 2). Explain that the class will be planning water stewardship projects and students will be expected to answer the same questions that are outlined in these cases.
- If desired, follow up with some background information about water stewardship from the Alliance for Water Stewardship (found online at <http://www.allianceforwaterstewardship.org/about-aws.html#what-is-water-stewardship>)

"Stewardship is about taking care of something that we do not own. Stewardship approaches that focus on the management of public goods like forests, fisheries or, in our case, freshwater resources, are based on the premise that we are all accountable for the sustainable management of those resources and are, therefore, based on collective responses.

Water Stewardship is the use of freshwater that is socially and economically beneficial as well as environmentally sustainable.

Environmentally sustainable water use maintains or improves biodiversity and ecological processes at the watershed level. Socially beneficial water use recognizes basic human needs and ensures long-term benefits (including economic benefits) for local people and society at large."

Cross-Curricular Connections:**Grade Nine English - Writing**

- Developing and Organizing Content: generate, gather, and organize ideas and information to write for an intended purpose and audience (1.1, 1.2, 1.3, 1.4, 1.5)
- Using Knowledge of Form and Style: draft and revise their writing, using a variety of literary, informational, and graphic forms and stylistic elements appropriate for the purpose and audience (2.1, 2.2)

Grade Nine English - Oral Communication

(With Project Extension)

- Speaking to Communicate: use speaking skills and strategies appropriately to communicate with different audiences for a variety of purposes (2.1, 2.2, 2.3, 2.4, 2.5)

Grade Nine Drama

(With Project Extension)

- The Creative Process: use the creative process and a variety of sources and forms, both individually and collaboratively, to design and develop drama works (A1.2, A1.3)

Assessment:**A_{for}L Assessment as learning**

- Utilize involvement in the class discussion as an informal assessment piece reflecting the students' developing understanding of human impact on biodiversity and the importance of water.

Differentiated Instruction:

- Ensure that students with exceptionalities are paired with supportive classmates for 'think, pair, share' activity.
- Summarize and reinforce the content of each YouTube video as it ends.
- The presentation of videos and case studies will strongly benefit audio and visual learners but kinaesthetic learners might need additional reinforcement of the concepts being introduced.

ACTION!

Working in Small Groups (computer lab with Internet access) → *Take Action in Your Community*

1. Distribute the 'Investigative Report Organizer - Part Two' (Appendix 6). You may choose whether you want to complete a class-wide stewardship project OR small group projects, depending on the nature of your students. In any case, students will be required to write a report of their participation. Present the assignment to the class:

The local newspaper editor is expecting part two of your investigative report on her desk, so it is time to get back to work! This component of the report requires that you and your partner join forces with another pair to form an ESI Ontario Team (Environmental Stewardship Investigators of Ontario).

Now that you have explored how Canadians have negatively impacted water and biodiversity, it is time to take action and investigate how you can get involved in a water stewardship project in your own community. The task might sound daunting - but it might be as easy as going in your backyard or exploring the wetlands in your local community to find an ecosystem that could use some support. Your stewardship plan does not need to be as elaborate as those in the case studies. Simple, inexpensive solutions to problems in your community include litter picks, invasive plant species removal and volunteering with existing environmental organizations.

RESEARCH & PLAN: Before taking action, it is important to plan your project. Start by researching existing projects to get ideas and discover opportunities for volunteer work. Ask your ESI Team Supervisor (your teacher) about local projects and use the Internet to find more ideas. Check out the websites given to you in the outline for part one of the report. Here are some additional resources:

- **Conservation Ontario**
www.conservation-ontario.on.ca
- **Children's Water Education Council**
www.cwec.ca
- **The Great Canadian Shoreline Cleanup**
www.shorelinecleanup.ca
- **Great Lakes United**
www.glu.org

*Review all assignment components as outlined in Investigative Report Organizer (Part Two) and Investigative Report Rubric (Part Two). Ensure that students have considered all safety requirements and have consulted with your local Conservation Authority before embarking on a self-planned stewardship action.

2. Set a deadline for students to have completed their stewardship project and written report. Provide ample time for them to research, plan, take action, and write. If you choose not to do a class-wide stewardship project, students will most likely be expected to take action on their own time.

Assessment:

A_{for}L Assessment as learning

- See Appendix 7 for the formal assessment rubric for the Cleaning Up Our Act Investigative Report (Part Two)

Differentiated Instruction:

- Consider allowing students feedback to determine if the class will complete individual, small group or whole class stewardship projects.
- Breakdown and explicitly state what is expected in each section of the assignment.
- Students may benefit from defined roles in the article writing process (i.e. researcher, editor etc.)
- Check in with students at each stage of the report writing process to monitor work completion and check for understanding. Provide supportive feedback and adjust instructional strategies at each stage as needed.

Safety Considerations:

- Prior to approving each stewardship project, you will want to pre-plan a safe list of appropriate locations/organizations for students to contact.
- Send a letter home to parents to inform them of the project expectations and to ensure adequate adult supervision.
- If students are volunteering with a pre-planned project, contact the project supervisor. Ensure that at least one responsible adult is in attendance when they are taking action.
- Be sure to follow all applicable board policies related to field trips and working with outside agencies.
- For more tips on planning safe outdoor excursions with students, please refer to the Back to Nature Network's wonderful teacher resource "Into Nature", available online at: <http://www.back2nature.ca/resources-research/education>

CONSOLIDATION

Whole Class → *Discuss and Reflect*

1. Following completion of part two of their investigative reports, bring the students together for a follow up discussion. This is a good opportunity to review the questions that the students were expected to answer when concluding their reports.
 - a. What effects did the stewardship project have on the local environment?
 - b. How has it affected the survival of the aquatic ecosystem? How will you ensure that the project has lasting effects on biodiversity?
 - c. Has the project had any impacts on the local economy?
2. As a 'ticket out the door', ask students to write a short journal entry that answers the following questions to encourage reflection on how the experience has changed their own perspective on the environment and their ability to foster change.
 - a. Describe your relationship with water. How do your actions affect the water around you? How are you affected by the quality of water?
 - b. Has your perspective on water changed since we began this investigation?
3. Project Extension:
Encourage the students to use their research, articles, and stewardship projects as a springboard for launching a campaign to inform the student body about environmental issues pertaining to water. Students can create a variety of promotional pieces to communicate the importance of water stewardship (including videotaped news reports, songs, posters, dramatic performances, dance routines, and social media campaigns). These create fantastic opportunities for cross-curricular connections and enriched assessment.

Assessment:

A_{AS}L Assessment as learning

- Utilize involvement in discussion and the journal entry as informal assessment pieces reflecting the students' developing understanding of human impact on biodiversity and the importance of water. Students should demonstrate an awareness overall expectations B1, B2, and B3.

Differentiated Instruction:

- Where appropriate, consider speaking one-on-one with students rather than requiring the submission of a written journal reflection.
- See Project Extension for an additional opportunity to differentiate.

Appendix 1

Water & Biodiversity Case Study #1: *Livestock Access Restriction*

BEFORE - March 2002



AFTER - October 2007



Special thanks to Sheila O'Neal, Watershed Stewardship Manager of the Hamilton-Halton Watershed Stewardship Program, for sharing these inspiring cases for the purpose of this lesson.

1. Introduction: Why did you choose to focus on this site? Was there a set of criteria that you used to determine that there was high need for intervention? Describe the conditions of the wetland when you first arrived (physical habitat, energy sources, water quality biotic interactions, hydrology, etc.)

Sheila: This site is at a highly visible location on a main road in the former Town of Flamborough. Therefore it was a well-known location displaying a visibly degraded watercourse. During the time Conservation Halton was developing the Grindstone Creek Watershed Plan in the mid 1990's, an exercise was undertaken involving agencies, community residents and watershed landowners, inviting them to come together to identify sources of stress on the watershed. This location was identified as a stress on the watershed.

If you were to look at the final (Grindstone Creek Watershed) Plan you would see a map showing this location identified as a priority for stewardship action to address impaired water quality and lack of riparian (streamside) buffer (natural vegetation).

The land through which this stream flows is a floodplain. A small number of cattle (up to 15) were grazing vegetation in the floodplain and on the stream banks and trampling the floodplain, stream banks and stream bottom. Cattle were dropping their solid and liquid manure into and very near to the stream. The stream had become over widened and was fully exposed to sunlight.

2. Body: In what ways did human activity impact this wetland and create some of the problems that you encountered? How did human activity impact the sustainability of the aquatic ecosystems? Describe the water stewardship project that you initiated. What action took place to improve the condition of the wetland?

Sheila: By allowing cattle access to the stream:

- The vegetation on the creek banks was grazed right down and the banks became trampled making the banks unstable.
- This instability would lead to erosion of the stream banks which would then lead to increased levels of sediment in the stream.
- Increased levels of sediment in the stream would disrupt the natural balance of sediment that exists in flowing water. When flowing water would slow further downstream the excess sediment could fall out and smother eggs that fish had laid or it could fill spaces between pebbles and stones that would have been habitat for aquatic insects.

- With the stream bottom trampled the natural structure of the stream bottom, which is habitat for aquatic insects, would have been very limited.
- Manure or manure runoff reaching the stream would increase the nutrient levels in the flowing water. This could lead to increased algae production. Increased algae could use up oxygen needed by fish and other aquatic animals.
- The creek was fully exposed to the sun, which would cause the water to be warmer than it would have been if it had shade.
- There was no streamside vegetation to provide habitat for smaller streamside dwelling creatures or protection for wildlife using the streamside as a travel corridor. The ecological connection between downstream natural areas and upstream natural areas was significantly diminished along the stretch of creek where the cattle were allowed access.

We contacted the landowner to ask if they would consider fencing their cattle from the stream. We negotiated with the landowner and came up with a fencing project that worked for both the landowner and for the creek. We also negotiated a creek-crossing project at this site so the cattle could continue to graze on the property but not near the creek.

3. Conclusion: What effects did the stewardship project have on the local environment? How has it affected the equilibrium and survival of the ecosystem? Has the project created lasting change?

Sheila: Our program undertakes photo monitoring at many of our projects. The photos you have seen show change over time at this project site. We can see from the photos that the stream-side vegetation has grown back naturally. The landowner's family planted some shrubs and trees within the fenced streamside area. We can see that the stream has narrowed as the stream-side vegetation has become reestablished. That means that the water in the stream moves faster. Faster water should mean more oxygen in the water available to fish and other aquatic life. The stream is more shaded than it was, so the temperature should be cooler. The Great Blue Heron in the October photo tells me there is fish — the fishing is good in this stretch of stream.

I believe it has (created lasting change). The project location is very high profile so it serves as a good demonstration to the community of how to protect a stream if you have livestock. I would expect the fish and other aquatic life that use that section of stream, as well as the terrestrial life in the area, find the increase in diversity at this site to be of value to them.

Appendix 1 (continued)

Water & Biodiversity Case Study #2: *In-stream Barrier Mitigation*

BEFORE - June 2003



AFTER - September 2004



Special thanks to Sheila O'Neal, Watershed Stewardship Manager of the Hamilton-Halton Watershed Stewardship Program, for sharing these inspiring cases for the purpose of this lesson.

1. Introduction: *Why did you choose to focus on this site? Was there a set of criteria that you used to determine that there was high need for intervention? Describe the conditions of the wetland when you first arrived (physical habitat, energy sources, water quality biotic interactions, hydrology, etc.)*

Sheila: This site was identified as a barrier to fish passage by Hamilton Conservation Authority summer staff undertaking stream and fish monitoring. The landowner was contacted by the summer staff requesting permission to gain access to the property for purposes of monitoring and the landowner agreed.

This particular stream system is considered cold or cool water. As watersheds have become urbanized and developed the number of cold water stream systems have been impacted and as a result the aquatic species that inhabit them have been impacted. This landowner was willing to discuss with us the possibility of restoring the fish passage as long as a stream crossing could be maintained. We negotiated the project and moved forward with it.

The stream was naturally vegetated on both sides and flowing through a forested valley system near the Niagara Escarpment in the Hamilton Conservation Authority's watershed. The stream was cold, clear and flowing. An old farm laneway crossed the stream and had been built up in height over a period of decades when at some point the three culverts were put in the stream and the crossing built up over top of the three culverts as you can see in the photo. Fish were not able to swim upstream through the culverts.

2. Body: *In what ways did human activity impact this wetland and create some of the problems that you encountered? How did human activity impact the sustainability of the aquatic ecosystems? Describe the water stewardship project that you initiated. What action took place to improve the condition of the wetland?*

Sheila: The installation of the culverts perched so high over the water caused this to be a barrier to fish in this stream system. Very simply it had been decades since fish had been able to swim upstream through this property due to the size of the jump they would have to make. This is a narrow and shallow stream system and the fish are small that live here. Fish would have been able to swim downstream through the culvert or be washed downstream through the culvert

but they would never have been able to return upstream. In spite of all this, the stream appeared to be in good condition – cold, clear and flowing.

It is difficult to know the level of impact of this one culvert on the stream system. Barriers to fish passage are many throughout the watershed. Wherever a culvert is perched, it forms a barrier to the fish or aquatic organism too small to make the jump. Think about how many culverts cross streams and their tributaries. There are many. Fish barriers are difficult or impossible to swim past to travel upstream. This has an impact on populations of fish as they become fragmented and are unable to reach grounds they came from.

With the landowner's permission the project was designed so that it would expose the bottom of the stream thereby reconnecting upstream to downstream on this property. As well it was designed to create a crossing the landowner could use. Projects like this take a lot of planning and they must meet regulations and guidelines put in place to protect fish in the stream while the construction is going on and for the long term. It is important to know that the planning and preparation for these types can be complex but they are very worthwhile projects to do.

3. Conclusion: *What effects did the stewardship project have on the local environment? How has it affected the equilibrium and survival of the ecosystem? Has the project created lasting change?*

Sheila: We do photo monitoring at our projects and I can tell you that one major benefit I observed on site was that over time the pebbly stream bottom situated upstream of where the crossing was removed, became exposed again. The pebbly stream bottom had been buried under years of sediment that had fallen out in the stream due to the water having to slow down as it hit the culverts and the rock wall containing the culverts. I am not sure how far upstream this stream bottom improvement can be seen but considering how many decades this barrier had been in place I suspect the improvements went further upstream than what I had observed at the time.

At this site fish can now pass freely upstream and downstream on this property. Having the before and after photos in hand will allow this story to be told over and over and hopefully make a difference where landowners are willing to do these kinds of projects.

Appendix 2

Cleaning Up Our Act: Research & Brainstorming Organizer

In what ways does human activity impact water and the biodiversity it supports in Canada? Use this table to begin to organize your thinking before writing your newspaper article. The first row has been completed for you.

Human Impact	The Problem (& its effect on biodiversity)	Possible Solutions
Improper disposal of waste	Decaying waste can use up dissolved oxygen and threaten the survival of aquatic life.	Reduce pollution by properly disposing of waste and using less disposable products. Work with your local Conservation Authority to help clean up wetlands in your area.

Note: When writing your article, you will focus on three types of human impact in further detail.

Appendix 3

Investigative Report Organizer Part One *Cleaning Up Our Act*

YOUR ASSIGNMENT

- I. You and your partner have been hired by the local newspaper to write a two-part investigative report about how Canadians impact source water. Your first article is meant to **inform** Canadians about the problems that we have created related to aquatic ecosystems. You will eventually write a second article about local initiatives to protect water that is meant to **empower** citizens to take action.
- II. Part One of your report must include:
- A detailed description of how three (3) types of human activity affect water quality (i.e. leaching of fertilizers into water systems).
 - Explain how each human activity affects biodiversity in Canada. What is the impact of this activity on the sustainability of aquatic ecosystems?
 - At least two (2) graphs that communicate any interesting data you have collected about how Canadians impact aquatic ecosystems (i.e. sources of pollution, the percentage of pollution contributed by each province, etc.)
 - Use Microsoft Excel to create your graphs. You might use pie graphs, bar graphs or line graphs. Use whatever graph best displays the information that you are presenting. Remember that your target audience (the town population reading the newspaper) must be able to easily interpret each graph.
 - A conclusion about our relationship with water in Canada and how our actions have impacted biodiversity. How are we affected by the quality of our water in Canada? Why is biodiversity important and what might be the best course of action to take to solve the problems that you have outlined (this will be developed further in part two of your report)?
- III. The editor of the newspaper expects that your report will be written in a strong, persuasive voice- with the goal of influencing readers to make more sustainable choices. The editor also expects that your piece will be based on research and data that you gather from various sources. Here is a list of resources that might be helpful to start with:
- **Canada's Water Infostream** - found online at <http://www.councilofthefederation.ca/infostream.html>
 - **Statistics Canada - Human Activity & the Environment Annual Report** (see 'wastewater discharges' section) - found online at <http://www5.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=16-201-XIE&lang=eng#formatdisp>
 - **Parks Canada - Aquatic Management**- found online at <http://www.pc.gc.ca/pn-np/bc/yoho/plan/ecosystemes-ecosystems/aqua-connect.aspx>
 - **Environment Canada - Water**- found online at <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=65EAA3F5-1>
 - **Conservation Ontario - Watershed Monitoring** found online at http://www.conservation-ontario.on.ca/watershed_monitoring/index.html

Appendix 3 (continued)

REPORT LAYOUT

I. Human Activity: _____

a. Effects on water quality, biodiversity, sustainability _____

II. Human Activity: _____

a. Effects on water quality, biodiversity, sustainability _____

III. Human Activity: _____

a. Effects on water quality, biodiversity, sustainability _____

IV. Graph Plans

a. Graph One Description _____

b. Graph Two Description _____

V. Conclusion _____

Appendix 4

Investigative Report Rubric (Part One) *Cleaning Up Our Act*

Expectation	4	3	2	1
Understands Concepts (Knowledge & Understanding)	Demonstrates exceptional understanding of why water and water ecosystems are important to human life, and why human activity has a significant impact on the quality of our water.	Demonstrates clear understanding of why water and water ecosystems are important to human life, and why human activity has a significant impact on the quality of our water.	Demonstrates some understanding of why water and water ecosystems are important to human life, and why human activity has a significant impact on the quality of our water.	Demonstrates little or no understanding of why water and water ecosystems are important to human life, and why human activity has a significant impact on the quality of our water.
Evidence of Critical Thinking (Thinking & Investigation, Application)	Strong evidence of thinking critically about the role that student plays in impacting the sustainability of aquatic ecosystems.	Good evidence of thinking critically about the role that student plays in impacting the sustainability of aquatic ecosystems.	Some evidence of thinking critically about the role that student plays in impacting the sustainability of aquatic ecosystems.	Little or no evidence of thinking critically about the role that student plays in impacting the sustainability of aquatic ecosystems.
Quality of Research (Thinking & Investigation)	Information clearly relates to the main topic. It includes several supporting details and/or examples.	Information clearly relates to the main topic. It provides 1-2 supporting details and/or examples.	Information clearly relates to the main topic. No details and/or examples are given.	Information has little or nothing to do with the main topic.
Organization (Communication)	Information is very organized with well-constructed paragraphs and subheadings.	Information is organized with well-constructed paragraphs.	Information is organized, but paragraphs are not well-constructed.	The information appears to be disorganized.
Graphs (Communication)	Graphs are neat, accurate and add to the reader's understanding of the topic (effects of human activity on aquatic ecosystem).	Graphs are accurate and add to the reader's understanding of the topic (effects of human activity on aquatic ecosystem).	Graphs are neat and accurate and sometimes add to the reader's understanding of the topic (effects of human activity on aquatic ecosystem).	Graphs are not accurate OR do not add to the reader's understanding of the topic (effects of human activity on aquatic ecosystem).

Appendix 5

Investigative Report Organizer Part Two *ESI Ontario: Environmental Stewardship Investigators*

YOUR ASSIGNMENT

- I. The local newspaper editor is expecting part two of your investigative report on her desk soon, so it is time to get back to work! This component of the report requires that you and your partner join forces with another pair to form an ESI Ontario Team (Environmental Stewardship Investigators of Ontario).

Now that you have explored how Canadians have negatively impacted water and biodiversity, it is time to take action and investigate how you can get involved in a water stewardship project in your own community. The task might sound daunting- but it might be as easy as going in your backyard or exploring the wetlands in your local community to find out how you can improve biodiversity and positively impact ecological processes at the watershed level. You obviously do not have the money or resources that some of the case studies required but there are simple, cost-free solutions to problems in your community.

- II. **RESEARCH & PLAN:** Before taking action, it is important to plan your project. Start by researching existing projects to get ideas and discover opportunities for volunteer work. Ask your ESI Team Supervisor (your teacher) about local projects and use the Internet to find more ideas. Check out the websites given to you in the outline for part one of the report. Here are some additional resources:

- **Conservation Ontario**
www.conservation-ontario.on.ca
- **Children's Water Education Council**
www.cwec.ca
- **The Great Canadian Shoreline Cleanup**
www.shorelinecleanup.ca
- **Great Lakes United**
www.glu.org

- III. **TAKE ACTION:** Collect information along the way so that you can write a good investigative report. Part two of your report must include BEFORE and AFTER photographs that provide evidence of your completed project. In your report, answer the following questions:

1. Introduction

- i. Why did you choose to focus on this site? Was there a set of criteria that you used to determine that there was high need for intervention?
- ii. Describe the conditions of the wetland when you first arrived (physical habitat, energy sources, water quality, biotic interactions, etc.).

2. Body

- i. In what ways did human activity impact this wetland and create some of the problems that you encountered? How did human activity impact the sustainability of the aquatic ecosystems?
- ii. Describe the water stewardship project that you initiated. What action took place to improve the condition of the wetland?

3. Conclusion:

- i. What effects did the stewardship project have on the local environment? How has it affected the survival of the water ecosystem? How will you ensure that the project has lasting effects on biodiversity?
- ii. Has the project had any impacts on the local economy?

REPORT LAYOUT

WATER STEWARDSHIP PROJECT SITE: _____

1. INTRODUCTION

a. Why did you choose to focus on this site? Was there a set of criteria that you used to determine that there was need for intervention? _____

b. Describe the conditions of the wetland when you first arrived (i.e. physical habitat, energy sources, water quality, biotic interactions, etc.) _____

2. BODY

a. In what ways did human activity impact this wetland and create some of the problems that you encountered? How did human activity impact the sustainability of the aquatic ecosystem? _____

b. Describe the water stewardship project that you initiated. What action took place to improve the condition of the ecosystem? _____

3. CONCLUSION

a. What effects did the stewardship project have on the local environment? How has it affected the survival of the ecosystem? How will you ensure that the project has lasting effects on biodiversity? _____

b. Has the project had any impacts on the local economy? _____

DON'T FORGET TO INCLUDE BEFORE & AFTER PHOTOGRAPHS THAT PROVIDE EVIDENCE OF YOUR PROJECT

Appendix 6

Investigative Report Rubric (Part Two)

ESI Ontario

Expectation	4	3	2	1
Understands Concepts (Knowledge & Understanding)	Demonstrates exceptional understanding of how human activity impacts the quality of our water- and how this affects biodiversity in an aquatic ecosystem.	Demonstrates clear understanding of how human activity impacts the quality of our water- and how this affects biodiversity in an aquatic ecosystem.	Demonstrates some understanding of how human activity impacts the quality of our water- and how this affects biodiversity in an aquatic ecosystem.	Demonstrates little or no understanding of how human activity impacts the quality of our water- and how this affects biodiversity in an aquatic ecosystem.
Evidence of Critical Thinking (Thinking & Investigation, Application)	Strong evidence of thinking critically about the role that student plays in impacting the sustainability of aquatic ecosystems.	Good evidence of thinking critically about the role that student plays in impacting the sustainability of aquatic ecosystems.	Some evidence of thinking critically about the role that student plays in impacting the sustainability of aquatic ecosystems.	Limited evidence of thinking critically about the role that student plays in impacting the sustainability of aquatic ecosystems.
Quality of Stewardship Project (Application)	Makes connections between science, society, and the environment with a high degree of effectiveness	Makes connections between science, society, and the environment with considerable effectiveness	Makes connections between science, society, and the environment with some effectiveness	Makes connections between science, society, and the environment with limited effectiveness
Considers Intended Audience (Communication)	Writing and photographs communicate for intended audience and purpose with a high degree of effectiveness	Writing and photographs communicate for intended audience and purpose with considerable effectiveness	Writing and photographs communicate for intended audience and purpose with some effectiveness	Writing and photographs communicate for intended audience and purpose with limited effectiveness

Glossary

Definitions adapted from: Ontario Ministry of Education. (2007). *The Ontario Curriculum Grades 1–8: Science and Technology and Ontario Ministry of Education. (2008). The Ontario Curriculum Grades 9 & 10: Science.*

Abiotic element A physical but non-living feature of an ecosystem, such as climate, rocks, soils, ice, topography, and non-living organic matter.

Amphibian A class of vertebrate animals that spends part of its life cycle in water and part on land. Amphibians include cold-blooded, smooth-skinned vertebrates, such as frogs, toads, salamanders, and newts. They are found in many different kinds of ecosystems, even deserts.

Aquatic Ecosystem An ecosystem based in water (e.g., a pond, a lake, a river, an underground water body, an ocean).

Biodiversity The variety of organisms at all levels of classification and the variety of ecosystems within a specific geographic region and globally.

Biotic elements The living parts of an organism's environment.

Community Interdependent populations of plants and animals that live and interact together in a habitat.

Deforestation The destruction of the world's forests, mainly rain forests, through direct human activity, such as logging and clearing for agriculture and grazing, and through the indirect effects of pollution and acid rain.

Disturbed ecosystem An ecosystem that has been altered by human activity.

Ecosystem A complex system that comprises living organisms and their environment, which interact as a unit.

Endangered species A species that is in danger of extinction in the foreseeable future.

Environment All the biotic and abiotic elements that surround and affect organisms or groups of organisms and influence their survival and development.

Environmental impact Positive and/or negative effects of a human activity or intervention on the environment (e.g., effects on natural resources, biodiversity, or the quality of air, water, and soil).

Habitat The place where an organism lives and that provides it with the food, water, shelter, and space that it needs to survive.

Invasive species A species that is introduced by human activity to an ecosystem not native to that species and that has an adverse effect on the ecosystem.

Life cycle The sequence of developmental stages that an organism passes through in its lifetime.

Mammal A warm-blooded, usually hairy vertebrate animal that breathes air, gives birth to live offspring, and produces milk for its young to feed on.

Natural ecosystem An ecosystem that has not been altered by human activity.

Organism Any form of life composed of mutually interdependent parts that maintain various vital processes (e.g., an animal, a plant, a fungus).

Reptile Cold-blooded, scaly-skinned vertebrate animals that breathe air. Turtles, snakes, and lizards are reptiles.

Species A population of organisms that have many characteristics in common and that can breed with each other to produce fertile offspring. A species is the smallest category of taxonomic classification. Humans, dogs, cats, buttercups, and daffodils are examples of species.

Sustainability A condition or process that can be maintained without interruption, weakening, or loss of valued qualities. Sustainability ensures that a population remains within the carrying capacity of its environment. The term is often used in reference to the ability to meet the needs of the present generation without compromising the ability of future generations to meet their needs.

Terrestrial ecosystem An ecosystem based on land (e.g., a forest, sand dunes, grasslands).

Wetland An area with soft, wet land intermingled with surface water; a marsh. Wetlands are valuable because of the habitat they provide for many animals and plants and their ability to clean up polluted water.

