

Unit 4
WATER USE AND THE
ENVIRONMENT

Suggested Time: 18 hours

Introductory Comments

There are a great number of activities such as portfolios, journals, newsletters, website postings, etc, that can be integrated throughout this unit and following units. It is not intended that students would do every suggested activity. For example, where it is suggested that students be divided into groups to research and present on a topic, not all students would need to be involved in that activity. Groups could be assigned specific topics to research so that over the course of the unit, all students would have an opportunity to work as a group to research and present of various topics. Teachers could identify the particular activities and projects in which they would like their students to engage and determine a set number of these written activities for each student to engage in over the course of the unit. (Likewise, individual students could be assigned topics to research and then present to the class.) Thus, rather than have every student complete each of the written activities, part of the student's assessment could require that each student/group complete a set number of tasks that could be included in a portfolio/newsletter/website. This could then be compiled for the entire class in the form of a newsletter, website, class display, etc. Where possible, students should be engaged in at least one long term project or activity throughout the unit or the whole course. This could be an individual or group project.

For topics that contain a great deal of factual information, it would be very helpful for students to use the "mind mapping" technique (refer to Appendix) to help them summarize and consolidate this information. References and suggestions for how students could create the mind map will be made throughout this unit. As students become more proficient with the use of mind maps they should be encouraged to create their own without teacher suggestions. Teachers could have students create one mind map for the entire unit or a series of small maps for discrete sections. It is important that students refer to their notes and text when completing their mind maps to ensure the map is completely accurate (i.e. this is a learning strategy and is not appropriate for use as an assessment technique). Teachers should note that mind maps are most effective when students create them from scratch and when color and sketches/picture are used along with their written text. In the absence of colored pencils, etc, teachers could supply students with one of several different colored highlighters. While individual students would create their own mind maps, the teacher could a "class mind map". Several sheets of large paper or poster board could be posted on the wall. The teacher could add to the class mind map each day as a summary of the day's lesson or at the beginning of the next class as a bridge between the current and previous lesson. Student mind maps could be used in Think-Pair-Share activities in which each student explains their mind map to their partner.

Teachers could use rubrics and/or checklists to assess student products and learning. Refer to Appendix for samples.

Fresh Water Sources

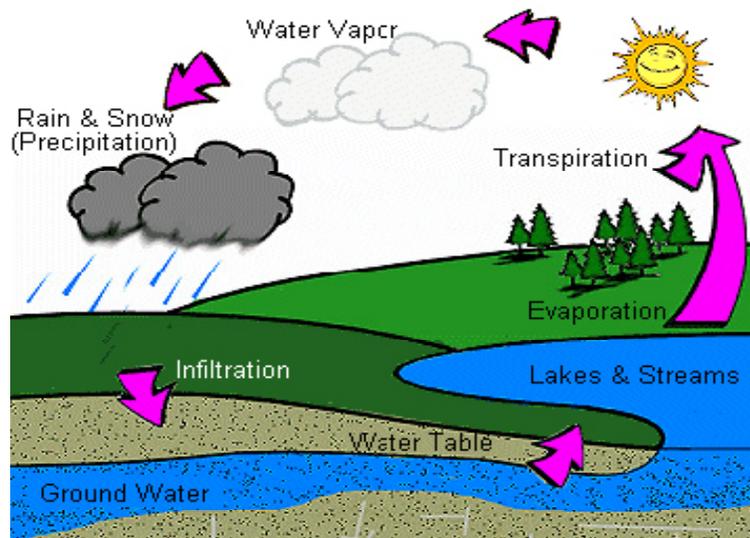
Outcomes

Students will be expected to

- 4.01 identify the water cycle as an important process. Include:
- (i) evaporation
 - (ii) condensation
 - (iii) precipitation
 - (iv) movement of surface and ground water (runoff)

Elaborations – Strategies for Learning and Teaching

Teachers should treat this as a brief review as students will have encountered this concept in previous science courses. Teachers can use the diagram below with labels omitted from the diagram for students to supply. Many of the concepts in this section can be addressed during the review of the water cycle diagram.



Teachers could ask students to think about where water goes once it evaporates from a common surface like a window that has steamed up or the pavement after a rainfall. Students could imagine themselves as a water droplet and document the journey from evaporation back to rainfall. Alternatively, teachers could have students put out a glass of water in the classroom or lab and observe the change in the volume of water over a few days and then explain where the water is going and what will eventually happen to it.

Fresh Water Sources

Tasks for Instruction and/or Assessment

Portfolio

Complete the first two columns of the K-W-L chart below. Complete the third column at the end of the topic.

What You Know About the Water Cycle	What You Would Like to Know About the Water Cycle	What You Learned About the Water Cycle

Performance

Students could create an audio-visual that describes the main features of the water cycle. All student products could be placed in their portfolio, published in a newsletter, or posted to a website.

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Fresh Water Sources (continued)

Outcomes

Students will be expected to

4.02 recognize that water is a finite resource

4.03 describe the interconnectedness of fresh water and salt water

4.04 compare fresh water and salt water relation to quantity and quality

4.05 list the sources of fresh water.
Include:
(i) ground
(ii) surface
(iii) ice (glaciers/icebergs)

4.06 define watershed

Elaborations – Strategies for Learning and Teaching

Students should recognize that all the water that currently exists on Earth is all the water that has ever been here and is all the water that will ever be here (unless we bring it in from another planet)

This can be addressed using review of the water cycle. Teachers should ensure that students understand that water continually moves from one body of water (or one organism) to another. Teachers could have students brainstorm where fresh water originates, how it moves on land, and ultimately where it ends up. Students could apply this concept to a consideration of the interconnectedness of fresh and marine water in their local area.

Students should understand that even though Earth is covered by approximately 70% water, only 2.5% is fresh water. Of this fresh water, less than 0.1% is drinkable. Quality of water is determined by a variety of factors, including taste, smell, and colour. Teachers should note that most of fresh water available on Earth is tied up in ice; 69% in ice, 30% in ground water and 1% in surface water.

Teachers could use a diagram of an aquifer system that shows the watershed and the underground aquifer system. As a general discussion, students could begin by discussing the obvious difference between ground water and surface water using specific examples like wells and ponds. Teachers could ask students which they think is the largest source of fresh water. Using a sponge analogy, teachers could remind students that the ground itself acts much like a sponge and would therefore be more likely to hold vast amounts of water.

Teachers could use a topographical map of the local area to show the watershed for their community. Topographical maps are located on the Government of Canada's Atlas of Canada website.

Fresh Water Sources (continued)

Tasks for Instruction and/or Assessment

Journal

Describe the significance of the statement below, “The water that dinosaurs drank is the same water that is in the ice in restaurants.”

Which, in your opinion, will be a more valuable human resource in the year 2100, oil or fresh water? Explain.

Performance

Write a story titled, “The Fantastic Voyage”, which describes the experiences of a water droplet as it falls to Earth as precipitation and returns as part of a cloud. Your story should illustrate a complete understanding of the water cycle.

Paper and Pencil

Students could write a newspaper article or letter to the editor which summarizes and discusses the community’s use and impact on the local water resource.

Portfolio

Identify settlements in NL that developed around fresh or salt water systems. Write a brief history or short story about the settlement paying particular attention to the role drinkable water played.

Identify areas of your daily consumption in which you are wasting water and suggest ways to conserve water or eliminating the wasteful activities. Share your results with the class.

Presentation

Research how your community makes use of its water systems. Students could consider, for example, how their community maintains and increases drinkable water supplies. Alternatively, students could also consider how waste water is treated or not treated by local communities. This information could be displayed as a table.

Use the Internet to research water supply issues worldwide and how the area has addressed the shortage. Evaluate the sustainability of the solution. Share your results with the class.

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Watersheds and Watershed Management

Outcomes

Students will be expected to

- 4.07 list the functions of a watershed. Include:
- (i) water collection
 - (ii) water purification
 - (iii) water storage
- 4.08 identify the types of fresh water ecosystems. Include:
- (i) lakes/ponds
 - (ii) rivers/streams
 - (iii) wetlands
 - (iv) estuaries

Elaborations – Strategies for Learning and Teaching

Teachers could use the analogy of a sponge to illustrate the collection and storage properties of the watershed. In nature, the vegetation and soil acts as the sponge store the water and slowly release it into rivers, streams, lakes, and ponds. Municipalities regulate development within watersheds to maintain sufficient vegetation which maintains the “sponge effect.” Purification of the water occurs when the water percolates through the soil, eventually collecting in aquifers underground. The water from springs and drilled wells originate from an aquifer.

Teachers may wish to explain that in Newfoundland and Labrador we do not follow the accepted “rules” of naming bodies of water as lakes or ponds. In most areas of the world, the depth of the water is the main criteria for classifying a body of fresh water as a lake or a pond. For rivers and streams, the width and flow rate are the key determinants.

In Newfoundland and Labrador, most people will refer to any wet area with vegetation as a “bog”. However, depending on the depth of water, the amount and type of vegetation, wet areas may be categorized in a variety of ways. For example: fen, marsh, bog, swamp, etc. Categorization is based on the varying amounts of water, flow rates, vegetation types, etc Wetland is a more general term and may be defined as an area that is regularly saturated by surface water or groundwater and is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions (e.g., swamps, bogs, fens, and marshes).

The term “fen” normally refers to a body of nutrient rich water in which plants grow and die without fully decaying.

Estuaries are very unique ecosystems and are very important because of the diversity of plant and animal life forms. They form as a result of the intersection of a fresh water body with a salt water body such as where a river or stream enters a salt water system. As a result, the water in this area has a lower salt content than the rest of the salt water system and thus permits some organisms adapted to salt water ecosystems and organisms adapted to freshwater ecosystems to coexist. The salinity of water in an estuary varies depending on a variety of factors (e.g. tide, run off, etc).

Teachers could take this opportunity to have students, in cooperative learning groups, categorize local aquatic ecosystems. This could lead to classroom discussions/presentations about each groups categorization schemes.

Watersheds and Watershed Management

Tasks for Instruction and/or Assessment

Portfolio

Collect and display local articles relating to development activities and how they impact watershed areas.

Interview

Students could interview a resource person (i.e. municipal person responsible for the community's water supply, provincial official, environmental group member, etc) to discuss how various activities and developments can affect the local watershed.

Paper and Pencil

Create a pie graph to illustrate the relative amounts of fresh water to salt water and drinkable water to non-drinkable water. Research the Internet to locate information that distinguishes the percents of drinkable and non-drinkable water as well as a breakdown of where the drinkable water is located on Earth.

Presentation

Research the impacts of your community activities on water sources. Recreational uses like boating and ATV (quads and snowmobiles) could be considered. Describe possible impacts of these activities on the water cycle. Compile this information into a formal presentation for the local council.

Journal

Calculate the cost of one liter of bottled water versus one litre of gasoline. What are your thoughts concerning the relative costs of gasoline and water?

How does the ground act like a sponge? What effect does this have on water quality and quantity?

Resources/Notes

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Water Quality

Outcomes

Students will be expected to

4.09 define riparian zone

4.10 describe the importance of riparian zones. Include:

- (i) wildlife habitat
- (ii) buffer zone

4.11 define water quality

Elaborations – Strategies for Learning and Teaching

Teachers could use a variety of graphics to illustrate a riparian zone and then relate this to a local situation. Buffer zones are legislated in Newfoundland and Labrador to protect bodies of water from development. For example, normal bodies of water require a 20 m buffer zone. Situations in which there is pesticide storage may require 100 m or more. Teachers could have students research the various requirements in Newfoundland and Labrador for buffer zones around bodies of water. Further to this, students could conduct research of the Walkerton E. coli tragedy and how the implementation of riparian zones could reduce these incidents in the future.

Teachers should include a reference to the use of Water Quality Index (WQI) as a determination of water quality. Various biological factors such as coliform and fecal coliform [reference Walkerton ON], water-borne parasites such as Giardia and Chemical factors (e.g. acidity, dissolved oxygen) that are used to determine WQI and hence, water quality.

Teachers can refer to the Government of Newfoundland and Labrador, Department of Environment and Conservation website for more specific information on water quality index as well as access to a WQI calculator. Teachers could have students use this calculator to determine the WQI of various bodies of water in the local area. The results of these calculations can be shared with the class and used to write letters to the editor or for publication in newsletters or posted to websites.

Teacher should have students complete the Core Lab: Water Quality Testing.

Teachers could have students complete the case study “Real Water Quality (RTWQ) monitoring at Voisey’s Bay.”

Water Quality

Tasks for Instruction and/or Assessment

Paper and Pencil

Why are riparian zones important for aquatic ecosystems near mining activities?

Why are riparian zones important for aquatic ecosystems near hydroelectric development?

Students could research a local wetland area for ecological significance and predict impacts on this wetland if a residential development were permitted to take place.

Performance

Teachers could have students select an area in their community that has special significance to them. Students could choose a variety of methods such as poetry, poster, art work, presentation, etc, to express their appreciation for this special area.

Teachers could have students investigate various areas of the province that have ecological reserves which protect habitat for threatened or endangered species (e.g. Pine Marten, Piping Plover, Red Wine Caribou herd in Labrador, etc). Students could discuss the value (both economic and ecological) of protecting this area.

Teachers could have students research the provincial guidelines for water quality as it relates to various intended uses. This can be shared with the class.

Paper and Pencil

Use the Water Quality calculator on the Department of Environment and Conservation website to determine the Water Quality Indicator (WQI) of various bodies of water in your area. Use these results to write a letter to the editor of a newspaper.

Interview

Interview an employee of a municipal water treatment facility to gain an understanding of water treatment and spread of water borne parasites.

Portfolio

Create a drama that describes the health and societal impacts of heavy metal poisoning. For example, the drama might revolve around the death of a child due to heavy metal poisoning. Characters could include the child's parents, siblings, town representatives, government representatives, media, etc.

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Core Lab" Water Quality Testing"

Water Quality (continued)

Outcomes

Students will be expected to

4.12 identify physical, biological, and chemical impacts on water quality

4.13 evaluate the impacts of human activities on the water resources. Include:

- (i) personal use
- (ii) community use
- (iii) global use

Elaborations – Strategies for Learning and Teaching

Students should understand that municipal water supplies undergo regular testing for coliforms. If coliforms are found then mitigation strategies are taken such as increasing chlorination to kill these bacteria. The amount of chlorine that can be used to do this is limited to aesthetic quality of the water (e.g. taste and smell). If coliform counts can not be killed off with acceptable levels of chlorine, boil water advisories are put in place.

Students could complete the mini Lab Activity “ How does Light Affect the ph of an Aquatic Ecosystem.”

Teachers could arrange for a field trip to a municipal water treatment facility or for a guest speaker to present on the local situation.

Students should be aware that naturally occurring metals such as arsenic, mercury, antimony, lead, and cadmium can have a significant affect on human health. Each of these metals will have negative health impact and in high concentrations can lead to death. In hydroelectric development projects, for example, the reservoir tends to release naturally occurring mercury and arsenic into the food chain. Subsequently, this will impact the amount of fish a person should consume on an annual basis from this reservoir. Teachers may want to refresh student’s understanding of bioaccumulation and refer to the previous study of Minamata disease.

Teachers could have students track their family and individual water usage of water for a week. Students could identify areas of their daily consumption in which they are wasting water and then suggest ways to conserve water or eliminating the wasteful activities.

Students could consider how their community disposes of sewage and the possible impacts this could have on the local aquatic ecosystems. Specifically, students should consider domestic and industrial demands and their effects on water resources.

Teachers can reference Environment Canada’s website for graphics to assist in teaching global water usage. Teachers could have students suggest reasons for the varied water consumption globally.

Water Quality (continued)

Tasks for Instruction and/or Assessment

Presentation

Using a map of the world, show where people drink untreated water (e.g. coloured dots, etc).

Journal

Write a reflective entry referring to the number of times you may have consumed untreated water in Newfoundland and Labrador. Was this a safe practice? Would you continue this practice? Why or why not?

Performance

Create a poem, song, or dramatization that differentiates between the various freshwater ecosystems. Present your creation to the class.

Presentation

Research your local area and identify aquatic ecosystems that would be vulnerable to impacts of forestry activities. This information can be presented to the class as a newsletter article, poster, or website.

Paper and Pencil

Why are riparian zones important for aquatic ecosystems near forest harvesting activities?

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Fresh Water Ecosystems

Outcomes

Students will be expected to

4.13 evaluate the impacts of human activities on the water resources. Include:

- (i) personal use
- (ii) community use
- (iii) global use

(continued)

4.14 identify the impact of forest harvesting on aquatic ecosystems. Include:

- (i) siltation
- (ii) temperature variation
- (iii) flooding and erosion

Elaborations – Strategies for Learning and Teaching

Teachers should make students aware that the amount of drinking water in many countries is shrinking. Like oil, the economic importance of water could be a growing concern for many countries like Canada. Canada has large reserves of drinking water and as much as 9% of the world's renewable drinking water. On a global political level, this could place Canada (and Newfoundland and Labrador) in a very prominent position.

Teachers could also have students brainstorm what the world would be like if only certain countries, like Canada, had the remaining few large quantities of drinking water. Students should take into account sustainability issues as they discuss sources of available drinking water. For example, how do other countries address these issues? Students could assess the possible political and environmental consequences related to solving shrinking drinking water issues. Students could write newspaper articles or short stories in which they address these issues. These could be published in the school newsletter or in an Environmental Science 3205 newsletter/website.

Teachers should ensure students understand that most forestry operations in NL involve clear cutting which creates the possibility of greater runoff. As a result, the maintenance of a buffer zone is very important to reduce the impacts to aquatic ecosystems. The buffer zone maintains a natural riparian zone which is important to maintaining a healthy aquatic ecosystem. Provincial legislation governs all forestry operations and stream crossings. Specific guidelines are in place to minimize the impacts of these operations. Teachers could have students research the various guidelines that are in place and then report their findings to the class.

Teachers should discuss the increased siltation due to tree harvesting and the crossing of streams. Removal of trees that surround a river or pond will result in a temperature increase of the water. Removal of trees will reduce the “sponge effect” and will result in greater flooding and erosion around aquatic ecosystems.

Fresh Water Ecosystems

Tasks for Instruction and/or Assessment

Presentation

Research your local area and identify ecosystems that would be vulnerable to impacts of cabin development. This information can be presented to the class as a newsletter article, poster, or website.

Students could research a local wetland area for its ecological significance and predict the impacts on this wetland if a residential development were permitted to take place.

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Fresh Water Ecosystems (continued)

Outcomes

Students will be expected to

- 4.15 identify the impact of mining on aquatic ecosystems. Include:
- (i) acid mine waste (pH change)
 - (ii) siltation
 - (iii) chemical pollution (e.g. sulfuric acid)
- 4.16 identify the impact of hydroelectric development on aquatic ecosystems. Include:
- (i) loss of habitat
 - (ii) mercury accumulation in food chains due to flooding
 - (iii) changes to spawning patterns
- 4.17 identify the impacts of urbanization on aquatic systems. Include:
- (i) changes in natural river habitats
 - (ii) natural water quality

Elaborations – Strategies for Learning and Teaching

Teachers could teach this section using the Hope Brook gold mine as an example of how a mining operation can impact an aquatic ecosystem. Teachers could reference the previous text for environmental science which provides background information on this mining operation. Teachers should discuss the changes in pH that result from the leaching of tailings.

Students should be aware that while hydroelectricity is perceived as a “clean” energy supply, the development of these projects does have significant environmental impacts. These include the loss of habitat due to flooding large areas of land, the release of mercury from the underlying soil into the water column, blocking the natural migration of fish, destroying spawning habitats and increasing the downstream water temperature.

Teachers could make reference to several existing hydroelectric development project in Newfoundland and Labrador such as Bay D’Espoir, Gull Island, Churchill Falls, and Star Lake when discussing the environmental impacts. Teachers could also discuss potential developments in NL such as the Lower Churchill to bring in the human issues and concerns (e.g. loss of traditional lands for hunting, etc).

Eutrophication occurs as a result of fertilizer and animal waste runoff. Chemical pollution will occur from pesticide runoff. If there is farming activity in the local area, students could investigate how the farming practices used to prevent damage to aquatic ecosystems.

Teachers should ensure that the impacts of increased public access, road salt runoff and hydrocarbon runoff from vehicles are discussed. Students could investigate the level of these threats in their local area. They could share this information with their community by means of letters written to the editor, articles for newsletters, informational posters, presentations, etc, and include in their portfolio.

Fresh Water Ecosystems (continued)

Tasks for Instruction and/or Assessment

Interview

Interview members of a local environmental conservation group to investigate the importance of maintaining wetlands in and around the local community. What measures are being taken by the group to ensure that the wetlands are being maintained?

Paper and Pencil

How do farmers in Newfoundland and Labrador prevent damage to nearby aquatic ecosystems?

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Drinking Water Treatment

Outcomes

Students will be expected to

- 4.18 list the main sources of drinking water in Newfoundland and Labrador. Include:
- (i) surface water
 - (ii) well water (dug and drilled)
 - (iii) “spring” water
- 4.19 outline the risks involved in drinking untreated water. Include:
- (i) E-coli
 - (ii) giardia
 - (iii) hepatitis
 - (iv) parasitic worms
- 4.20 identify the main components of the multi-barrier approach to ensure safe drinking water.

Elaborations – Strategies for Learning and Teaching

Teachers could begin this section by asking students to identify as many potential sources of drinking water as possible. For example, they could include the possibility of icebergs for providing available drinking water or the desalination of ocean water. Students should recognize that while desalination is possible, it is not economically viable for Newfoundland and Labrador. However, students could briefly research some countries in the middle east that utilize this means of obtaining drinkable water and the costs associated with it.

Teachers could refer to the Newfoundland and Labrador Department of Conservation’s website.

Teachers should relate this to the dangers of drinking water from streams and ponds in wilderness areas. Students could investigate the various ways used to treat water that is taken from a natural system for drinking. Students could share what they learn with the class and create information posters/presentations to share with others in the school. Previously, it was thought that as long as water was flowing, it was safe to drink. We now know that any body of water can contain water-borne pathogens. Students could use the Internet to investigate the mortality rates of people who are exposed to untreated drinking water.

Students could read the Enviro-focus “When Human Error Threatens Water Quality.”

Drinking Water Treatment

Tasks for Instruction and/or Assessment

Presentation

Research one method of water treatment and present as a newsletter article, poster, or website.

Interview

Interview an employee of a municipal water treatment facility in your community to gain an understanding of the water treatment process used by the community.

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Drinking Water Treatment (continued)

Outcomes

Students will be expected to

- 4.21 identify the phases of treating municipal water. Include:
- (i) pre-treatment
 - a. screening
 - b. flocculation and sedimentation
 - (ii) treatment
 - a. chlorination
 - b. ozonation
 - c. ultraviolet light
 - (iii) post treatment
 - a. fluoridation
 - b. water softening

Elaborations – Strategies for Learning and Teaching

Teachers should point out that pre-treatment and post treatment are very expensive, so many municipalities omit these steps. Both of these steps may have little effect on water safety for drinking.

Students could investigate the phases of water treatment that are used in their community. The results could be shared via letters to the editor, newsletter articles, posting to website, etc.

Pre-treatment will remove excess organic material and will thus reduce the potential for producing THM's (trihalomethanes).

As an activity to demonstrate the effectiveness of using flocculants, students could use substances such as gelatin or Kitosol 40 to clarify a sample of water with high turbidity. They could use two equal samples, leaving one to settle on its own to compare the rates of clarification.

Students should recognize that pre-treatment of drinking water includes clarification using screens and alum sedimentation.

Students could use water purification tablets as a scale example of the chlorination of water. Teachers could use either chlorine based or iodine based tablets.

Ozonation is very difficult to replicate, however, students could be encouraged to research the number of bottled waters available that have been purified by ozonation. Alternatively, where possible, a person associated with local water bottling companies could be invited to explain the ozonation process.

Adjusting the fluoride to an optimal level in the water supplies of these communities can help prevent tooth decay. Thousands of communities worldwide have reduced rates of tooth decay and improved oral health among their residents through water fluoridation.

When water contains a significant amount of calcium and magnesium, it is called hard water. Hard water is known to clog pipes and to complicate soap and detergent dissolving in water.

Drinking Water Treatment (continued)

Tasks for Instruction and/or Assessment

Presentation

Research one method of water treatment and present as a newsletter article, poster, or website.

Interview

Interview an employee of a municipal water treatment facility in your community to gain an understanding of the water treatment process used by the community.

Resources/Notes

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Drinking Water Treatment (continued)

Outcomes

Students will be expected to

- 4.21 identify the phases of treating municipal water. Include:
- (i) pre-treatment
 - a. screening
 - b. flocculation and sedimentation
 - (ii) treatment
 - a. chlorination
 - b. ozonation
 - c. ultraviolet light
 - (iii) post treatment
 - a. fluoridation
 - b. water softening
- (continued)

Elaborations – Strategies for Learning and Teaching

Water softening is a technique that serves the removal of the ions that cause the water to be hard, in most cases calcium and magnesium ions. Iron ions may also be removed during softening.

The best way to soften water is to use a water softener unit and connect it directly to the water supply.

Ozone is a relatively unstable molecule of oxygen that readily gives up one atom of oxygen providing a powerful oxidizing agent which is toxic to most water borne organisms. It is a very strong, broad spectrum disinfectant that is widely used in Europe. It is an effective method to inactivate harmful protozoans. It also works well against almost all other pathogens. Ozone is made by passing oxygen through ultraviolet light or an electrical discharge. To use ozone as a disinfectant, it must be created on site and added to the water by bubble contact. Advantages of ozone are that it does not form any dangerous by-products and does not add any taste or odour to the water. One of the main disadvantages of ozone is that it leaves no disinfectant residual in the water. Ozone (O_3) has been used in drinking water plants since 1906 where the first industrial ozonation plant was built in Nice, France. The U.S. Food and Drug Administration has accepted ozone as being safe; and it is applied as an anti-microbiological agent for the treatment, storage, and processing of foods.

UV radiation is very effective at inactivating pathogens, as long as the water has a low level of colour so the UV can pass through without being absorbed. The main drawback to the use of UV radiation is that, like ozone treatment, it leaves no residual disinfectant in the water.

Because neither ozone nor UV radiation leaves a residual disinfectant in the water, it is sometimes necessary to add a residual disinfectant after they are used. This is often done through the addition of chloramines a disinfectant. When used in this manner, chloramines provide an effective residual disinfectant with very little of the negative aspects of chlorination.

Where possible each of the following strategies could be tested by students directly through supervised activities or by teacher demonstrations. With a variety of water samples, each process could be administered and then the aesthetic value of the water reassessed. With reverse osmosis, students may have to visit a local water supply store for a demonstration.

Drinking Water Treatment (continued)

Tasks for Instruction and/or Assessment

Paper and Pencil

Create a Venn diagram that illustrates the similarities and differences between using ozonation, U-V radiation, and chlorination for treating water.

Why have many municipalities stopped using fluoridation as a post-treatment process in water treatment?

Journal

Should municipal water treatment plants be responsible for reducing tooth decay? Explain.

Resources/Notes

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Drinking Water Treatment (continued)

Outcomes

Students will be expected to

4.22 describe alternate methods of water treatment. Include:

- (i) boiling
- (ii) carbon filtering
- (iii) distillation
- (iv) reverse osmosis

Elaborations – Strategies for Learning and Teaching

With respect to chlorination, students should recognize that taste and smell of water is affected when chlorine is added. Students could assess drinking water (i.e. tap water) for odour and taste. They should also understand that there are potential health impacts associated with chlorination such as the creation of trihalomethanes (THM's) when organic solids exist in the water. These are molecules that result when chlorine reacts with suspended organic matter. THM's have been linked to high incidences of inflammatory bowel diseases. Scientific studies indicate that THM's are linked to miscarriages and fetal malformations and may also be associated with an increased risk of stillbirths. Epidemiological studies funded by Health Canada concluded that 14 to 16 percent of bladder cancers in Ontario may be attributed to drinking water containing relatively high levels of chlorination by-products. Despite these potential health impacts, students should be aware that when drinking water is not treated the other health risks increase significantly and can be more immediate.

Teachers could access the CBC “For Teachers” homepage and search the 9-10 and 11-12 lesson plans under “science” for activities on a related topic “fluoridation”.

Boiling: Water is heated to 100° C for at least 5 minutes to inactivate/kill microorganisms that normally live in water at room temperature.

Carbon filtering: Charcoal, a form of carbon with a high surface area, absorbs many compounds including some toxic compounds. Water passing through activated charcoal is common in household water filters and fish tanks.

Distillation: Boil water to produce water vapour, which contacts a cool surface where it condenses as a liquid. Because the solutes are not normally vaporized, they remain in the boiling solution. Distillation does not completely purify water, because of contaminants with similar boiling points and droplets of unvaporized liquid carried with the steam. However, 99.9 % pure water can be obtained by distillation.

Reverse osmosis: Mechanical pressure is applied to an impure solution to force pure water through a semi-permeable membrane. Reverse osmosis is theoretically the most thorough method of large scale water purification available, although perfect semi-permeable membranes are difficult to create. Unless membranes are well-maintained, algae and other life forms can colonize the membranes.

Drinking Water Treatment (continued)

Tasks for Instruction and/or Assessment

Performance

Choose a position to debate the following question, “Bottled water is better than tap water”. Research information about the costs, process, and contaminants associated with bottled water and tap water.

Paper and Pencil

Why have many municipalities stopped using chlorination in water treatment?

Presentation

Research one of the mitigation strategies (boiling, carbon filtering, distillation, reverse osmosis) and assess its relative effectiveness in preventing the formation of THMs. Present your findings as a letter to the editor, newspaper article, poster, or website.

Resources/Notes

Wastewater

Outcomes

Students will be expected to

4.23 list sources of wastewater.

Include:

- (i) municipal
- (ii) industrial

4.24 indicate the impacts of untreated wastewater on freshwater and marine ecosystems

Elaborations – Strategies for Learning and Teaching

Teachers could begin this section by asking students to give their definition of “wastewater”. Students could then be encouraged to list as many sources of wastewater as possible. Examples of municipal sources of wastewater include sewage, storm runoff, and grey water (dish and wash water). Note that storm runoff carries road salt, oil residue, tire particles, and pet wastes.

Examples of industrial sources of wastewater include fish plants, pulp and paper production, and refining processes.

Students should recognize that treating effluent helps to remediate large quantities of water by removing chemicals/suspended solids/bacteria and re-oxygenating. Students could research the type of effluent treatment (if any) their community uses. The results could be shared via letters to the editor, newsletter articles, posting to website, etc., and included in their portfolio.

Teachers should refer back to an earlier discussion on the eutrophication that may result from improper waste disposal from cabins as a way of introducing this topic. While those effects are generally limited in scope (to a lake or river), the effects on coastal ecosystems are much wider in scope. Students could use the Internet, newspapers, or news magazines to find examples of how untreated effluent has affected coastal ecosystems.

Although marine aquatic ecosystems have the ability to deal with small amounts of effluent, many intertidal zones around coastal communities do not have adequate tidal flow to dissipate the excess organic matter. Since the effluent is left untreated, inorganic materials remain as non-biodegradable pollutants. Such items wash up on the beaches. Depending upon the location, teachers could take students on a field trip to a marine ecosystem and record the amount and types of non-biodegradable pollutants. Photographs could be taken and published in local papers along with student commentary.

Coastal cleanup events could be organized in conjunction with groups such as Ocean Net. Ocean Net has chapters throughout NL and their website contains a wide array of resources applicable to this topic. Students could read the Enviro-focus “The Sewage Situation in St. John’s.”

Wastewater

Tasks for Instruction and/or Assessment

Presentation

Research the type of effluent treatment used in communities throughout Newfoundland and Labrador. This information can be presented to the class as a newspaper article, poster, or website.

Visit a marine or aquatic ecosystem and record the amount and types of non-biodegradable pollutants. Take photographs and video, with commentary, as part of a multimedia presentation.

Performance

Role play a town hall meeting that is debating the cleanup of effluents in community water systems. Students should take the role of mayor, councilors (with different points of view), community leaders, parents, and students.

Resources/Notes

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Page 498-500

Wastewater Treatment

Outcomes

Students will be expected to

- 4.25 describe the disposal and treatment methods for municipal and industrial effluent. Include:
- (i) treatment plants
 - (ii) lagoons (containment system)
 - (iii) constructed wetlands
 - (iv) septic systems
 - (v) out houses
- 4.26 identify the importance of marine ecosystems to Newfoundland and Labrador. Include:
- (i) estuaries
 - (ii) intertidal
 - (iii) subtidal/littoral
 - (iv) continental shelf
 - (v) deep ocean

Elaborations – Strategies for Learning and Teaching

Field distribution systems provides containment and settling for solids. They are typically used in areas where municipal systems are unavailable. Tile fields can be used to disseminate and distribute liquid wastes. Soil organisms are used to breakdown remaining wastes and suspended solids. The use of these is based on size and location where municipal systems are not available.

Lagoons are containment systems that are often used in conjunction with engineered or constructed wetlands. They enable solids to settle while at the same time oxygenating systems are used to increase rates of decomposition (e.g. Pasadena).

Reeds are often used to remove heavy metals from the settled solids. Municipal Treatment plants have different levels of treatment (primary, secondary, tertiary).

Students could read the Eco Spotlight “Four Factors in Environmental Decisions Making.”

Large estuarine systems and salt marshes are recognized for their important ecological function and societal value. These areas provide habitat and nursery grounds for commercial and recreational fin fish and shellfish activities. Marshes absorb energy from storms and protect the land from hurricanes. Many of these important ecosystems are threatened by multiple human stresses as well as natural disturbances like hurricanes and storm surges.

Estuaries are considered good indicators of marine health because of their close proximity to land where many ocean bound pollutants originate. Monitoring plant and animal life in these zones give scientists signals to environmental degradation. Some estuaries can act as toxin collectors as sediments capture these poisonous substances. This spells trouble for the life forms in the estuary. However, if estuaries are flushed often by tidal currents, pollutants move into deeper waters affecting life there by spreading the toxic effects of pollutants over a much broader area.

The intertidal zone of Newfoundland and Labrador is quite extensive and varied since it covers approximately 17,542 km². Because of its proximity to human settlements and activities it is, like estuaries, very sensitive to land and marine pollutants. The intertidal zone is also a very productive marine zone despite many daily and seasonal fluctuations in abiotic factors like salinity, temperature and nutrient availability. In Newfoundland and Labrador, these zones play an important role in the burgeoning aquaculture industry. Students could read the Enviro-focus “Elegrass.”

Wastewater Treatment

Tasks for Instruction and/or Assessment

Paper and Pencil

Create a Venn diagram that illustrates the similarities and differences between three treatment methods for waste effluent.

Presentation

Research the issues around the development of municipal treatment facilities and present the results of your research with the class as a newspaper article, poster, or multimedia presentation.

Performance

Role play a town hall meeting that is debating the development of a municipal treatment facility. Students should take the role of mayor, councilors (with different points of view), community leaders, parents, and students.

Resources/Notes

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Marine Ecosystems

Outcomes

Students will be expected to

4.26 identify the importance of marine ecosystems to Newfoundland and Labrador. Include:

- (i) estuaries
- (ii) intertidal
- (iii) subtidal/littoral
- (iv) continental shelf
- (v) deep ocean

(continued)

Elaborations – Strategies for Learning and Teaching

The sub tidal or sub littoral zone extends from the intertidal to the continental slope. This area is also referred to as the shelf zone and in Newfoundland and Labrador, the Grand Banks represent this area. The Grand Banks are one of the world's largest and richest resource areas, renowned for both its valuable fish stocks and petroleum reserves. Situated off the southeast coast of the Island, the Grand Banks are actually a series of raised submarine plateaus with a water depth ranging between 36.5 and 185 metres. The relative shallowness of the water allows extensive marine animal and plant life to flourish on the bottom. As well, the warm waters of the Gulf Stream pass over the southern portion of the Banks in winter but cover almost all of the Grand Banks in summer.

Students could also consider the importance the ocean played on Newfoundland and Labrador settlement by humans as far back as the ancient indigenous peoples like the Maritime Archaic, the Paleo-Eskimo, the Beothucks, to the more recent Inuit, Innu, Métis and Mi'kmaq and finally European settlers has been directed by the food resources available from the ocean. Today, economically the ocean is a very important contributor to the economy of our province and as such, still directs much of the settlement even though the 1992 moratorium on cod fishing has led to a dramatic decline. Since much of our history of settlement has been directed by proximity to ocean resources, our social and cultural identity is strongly linked to it as well.

Teachers should emphasize the role of resource management in the sustainable development of our ocean resources. These ocean resources are now driving an oil exploration and extraction industry as well as world-leading educational and technological centres. However, it is important that we have policies, laws, and management practices that address the environmental, social, and economic needs of today while ensuring that future generations are also able to meet their needs.

Teachers could engage students in class discussions or debates which address the theme of sustainable development of our ocean resources.

Marine Ecosystems

Tasks for Instruction and/or Assessment

Paper and Pencil

Students can complete the following table.

Marine Ecosystem	Importance for Ecosystem	Organisms Present
Estuaries		
Intertidal		
Subtidal littoral		
Continental shelf		
Deep Ocean		

Performance

Write a newspaper article to explain the importance of one of the marine ecosystems in your locality and why it should be protected.

Resources/Notes

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The Fishery

Outcomes

Students will be expected to

- 4.27 describe the present state of the world's fishery. Include:
- (i) levels of exploitation
 - (ii) resource dependence

- 4.28 list the major issues facing the world's fisheries

- 4.29 define fish stock and fish population

Elaborations – Strategies for Learning and Teaching

Teachers could begin this topic by providing students with an overview of the present status of the global fishery. Although economic and social connections are inherent in every decision we make that affects the environment, teachers should limit this direction of the discussion to ensure sufficient time to address the other outcomes.

Teachers could have students consult the United Nations Food and Agriculture Organization (FAO) for the most recent data on the Global fishery. This data will provide many useful graphs that communicate the levels of exploitation and dependence.

Students will find it interesting that of all the food stuffs consumed by human beings, fish is one of the few that is still harvested from the wild. Teachers should have students refer to the Land and sea episode entitled, "Hanging On". This video reveals the current state of the fishing in the gulf of St. Lawrence and the challenges that face it.

There are many pressures facing the global fishery. Like most resources, it is due to demand from rising global population. This is followed by:

- climate change
- pollution
- habitat loss

Students should be able to define and distinguish the difference between these terms.

The Fishery

Tasks for Instruction and/or Assessment

Presentation

Research the history of Newfoundland and Labrador fishing and its importance to the economy. Present your findings to class.

Performance

Write an article that explains why fisheries are declining due to pollution, habitat loss and climate change.

Groups could research the roles that provincial and federal governments play in fisheries management and then present a role play to class on the conflict that can arise between local fisher people and the legislation they must work under.

Resources/Notes

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Land and Sea episode “Hanging On”

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Page 512-513

The Fishery - Management

Outcomes

Students will be expected to

4.30 list the significant events in the history of the cod fishery in Newfoundland and Labrador that have impacted on fish stocks

4.31 describe the role of international agencies in fisheries management.

Include:

- (i) International Commission for the North Atlantic Fisheries (ICNAF)
- (ii) Northwest Atlantic Fisheries Organization (NAFO)

4.32 describe the role of the Provincial and Federal governments in management of our fisheries

Elaborations – Strategies for Learning and Teaching

The traditional fishery in Newfoundland and Labrador was the cod fishery. Our history, settlement patterns, and culture have much of its roots in the fishery. Teachers could use a time line to show student the significant events. Include:

- for 5000 year native peoples depended on the resources of the sea
- the discovery of Newfoundland by John Cabot in 1497
- in 1578 there were over 400 ships taking part in the fishery
- in the 1950's factory freezer trawlers were introduced
- cod stocks begin to decline in the 60's and 70's
- in 1992 the cod moratorium is declared
- diversification into other species

Teachers should show the Land and Sea episode entitled, "When the Stages were Full". This episode reveals what the fishery was like at its peak in relation to the community of Change Islands. Today, the people of the community are striving to harness and/or sustain as many features as possible of this industry and/or way of life.

Resource management and its role in sustainable development is a theme that runs through this course. Management of the forests, mineral and other renewable and non-Resource management is a theme that runs through this course. Management of the forests, mineral and other renewable and non-renewable resources are governed by laws and sound management practices. Teachers should briefly focus on the two main international bodies, NAFO and ICNAF, in terms of their respective roles in management of the resource. Teachers should ensure that students understand the shared responsibility and that this relationship has both positive and negative impacts.

Students could read the Eco Spotlight "The Eastport Example."

The Fishery - Management

Tasks for Instruction and/or Assessment

Presentation

A timeline can be constructed on fishing in Newfoundland and Labrador showing the areas fished, the cultures that fished from the earliest known records to the present. Present your findings to class.

Performance

Groups could present skits or traditional songs relating to the fishery in Newfoundland and Labrador.

Write an article that outlines the importance of the ICNAF and NAFO in regulating the international fishery.

Resources/Notes

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Land and Sea episode “When the Stages Were Full.”

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The Fishery - Management (continued)

Outcomes

Students will be expected to

- 4.33 describe the role of stock assessment in decision making
- 4.34 list the two primary sources of information used to estimate fish population and biomass. Include:
- (i) commercial fisheries
 - (ii) scientific surveys
- 4.35 describe how the following are used to estimate numbers and biomass of fish:
- (i) Catch per Unit Effort
 - (ii) hydroacoustics
 - (iii) fish tagging
 - (iv) sentinel fishery

Elaborations – Strategies for Learning and Teaching

Teachers could refer back to the shoe box analogy described above when addressing this outcome. In simple terms if we could see the fish and get an accurate population then the majority of the issues related to fisheries management would be solved. However, this is not the case so stock assessment practices are always a contentious issue between the various fishery stakeholders.

To help students to understand the concept of CPUE, teachers could refer them back to the topic of big game management. For example, when moose hunters fill out their licence returns they are asked to indicate how many days they actively hunted. The more days it takes a hunter to find a moose, the fewer moose are in the area. This helps management officials make decision related to the size of the population and helps them determine quota size: increase quotas where populations are large and decrease quotas where populations are small and need to be increased.

Some sonar companies offer demo software of their product. Teachers could search for and use software demos to give students an appreciation for the use for sonar (hydro acoustics) as a tool for estimating biomass and numbers of fish.

To help give students a feeling for the magnitude and difficult of the task, teachers could perform the following demonstration/analogy. Fill a shoe box with a couple of hands full of beans. Walk into class and ask students to tell you the number of beans in the box. Student guesses will vary quite substantially, particularly if you do not give them much change to look closely at the beans. You could This little activity will really begin to drive home some of the challenges associated with managing the fishery. Fishery management scientists are working with populations that cover a very wide geographic area and which are constantly on the move. Making accurate estimations of population size is a very difficult process and requires lots to data.

Depending on available time teachers could do a mark and recapture activity to help students understand how fish populations can be determined using this sampling method. Teachers could refer back to the moose population sampling activity completed in Unit 2 and ask students to discuss the similarities and differences.

The Fishery - Management (continued)

Tasks for Instruction and/or Assessment

Presentation

A chart can be developed by the students to show how biomass of fishstocks are estimated. Photos of each technique with a brief description can be presented to the class.

Performance

A game can be developed by students to show how mark and recapture can be used to estimate fish populations.

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Sustainable Fishing

Outcomes

Students will be expected to

4.35 describe how the following are used to estimate numbers and biomass of fish:

- (i) catch per unit effort
- (ii) hydroacoustics
- (iii) fish tagging
- (iv) sentinel fishery

(continued)

4.36 define sustainable fishing.

4.37 list natural and anthropogenic factors that affect the sustainability of marine resources. Include:

- (i) population status
- (ii) biological characteristics of species
- (iii) environmental changes
- (iv) fishing pressure
- (v) bycatch
- (vi) habitat loss and destruction

Elaborations – Strategies for Learning and Teaching

Teachers should briefly outline how the sentinel fishery works. Teachers should emphasize that this program actively gets fisher persons involved in making a valuable contribution to the understanding and management of the fishery.

Students could read the Eco Spotlight “David and Irene Bath–Sentinel Fish Harvesters.”

Teachers could address this by having students brainstorm what they would do to ensure that the trout stocks in a newly found trout pond could be sustained so that it would provide good fishing for years to come. After the discussion teachers could have students independently write a definition for sustainable fishing and/or contribute to a definition developed by the class.

Population status: Teachers could begin by showing students a food web representing the dominate species in the North Atlantic and ask questions such as:

- what might happen if capelin populations were reduced?
- what might happen if seal population increased/decreased?
- what might happen if cod populations increased?

Biological characteristics of species: Teachers could have students select one of the following species: cod, capelin and turbot. Students would then engage in research to collect information on life cycle, optimum water temperatures and migration patterns for their species. Teachers could then have students discuss how each of these factors might impact on the fishery for these species.

Environmental: Cod is a good example here and there is lots of literature available on the impact of environment on cod growth and survivability.

Bycatch: Teachers should focus students on identifying ways to reduce bycatch. These include:

- mesh size
- selective fishing areas and seasons
- setting bycatch levels
- the Nordmore grate in the shrimp fishery

Sustainable Fishing

Tasks for Instruction and/or Assessment

Journal

Write a letter to the local newspaper explaining why the sentinel fishing is important in your local area.

Presentation

Groups of students can research one aspect of sustainability of marine resources and present their findings in class

Performance

A video can be produced on the importance of the following standards set-out by government related to by-catch. Students could focus on Atlantic cod or Atlantic salmon as examples of preserving these species for future generations.

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Sustainable Fishing - Challenges

Outcomes

Students will be expected to

- 4.37 list natural and anthropogenic factors that affect the sustainability of marine resources. Include:
- (i) population status
 - (ii) biological characteristics of species
 - (iii) environmental changes
 - (iv) fishing pressure
 - (v) bycatch
 - (vi) habitat loss and destruction
 - (vii) pollution and disease
- (continued)

- 4.38 list examples of responsible fishing

- 4.39 describe the environmental impacts of various fishing techniques. Include:
- (i) mobile bottom fishing gear
 - (ii) ghost fishing

Elaborations – Strategies for Learning and Teaching

Habitat loss and destruction: Teachers could have students think-pair-share their answer to the question “what do you think would happen if a causeway was built across the entrance of a narrow cove where fish came each spring to spawn?” Students should be able to draw on both their general knowledge and specific knowledge from other sections/topics in this course to address the role of habitat in sustaining a species. Teachers could use a KWL chart to summarize the overall class understanding of this topic.

Pollution and disease: Teachers could relate to topics already covered on pollution from residential and commercial sources.

Teachers could ask students what they see as the main elements of responsible trout fishing. They will come up with ideas on following catch limits, taking care of the environment, and proper fishing techniques ie. netting vs fly fishing. From here take the discussion to the commercial fishery with focus on fishing gear, fishing practices and training.

Teachers should focus on impacts of these techniques rather than going into a discussion of the actual techniques. Teachers can access videos of bottom trawling through the Internet and use this as a starting point to the topic.

Teachers should address the impact of trawling on deep-sea corals and some of the protective measures that have been put in place protect sensitive sites and species.

When addressing the topics of ghost fishing, teachers could address how biodegradable nets can reduce the impact. Many excellent video clips relating to ghost nets are available on the web through such sources as mefeedia.com and youtube.com.

Sustainable Fishing - Challenges

Tasks for Instruction and/or Assessment

Performance

Students could create a collage to illustrate examples of responsible fishing practices or types of legal fishing gear and practices.

Presentation

Students could create an audio-visual presentation on environmental impacts of ghost nets, mobile bottom dragging, etc.

Paper and Pencil

What are ghost nets? Why are they significant concern in ocean environments?

Suggest measurements to curb the creation of ghost nets and the use of bottom dragging equipment.

Resources/Notes

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Sustainable Fishing - Challenges (continued)

Outcomes

Students will be expected to

4.40 define bycatch

4.41 identify the two types of bycatch. Include:

- (i) commercial species
- (ii) non-commercial species

4.42 outline the research steps required to assess the impacts of seals on their prey. Include:

- (i) determination of energy requirements
- (ii) where seals feed (food sources)
- (iii) population dynamics of prey species

4.43 list the potential environmental impacts on the fishery: Include:

- (i) sea ice
- (ii) ocean temperature
- (iii) salinity

Elaborations – Strategies for Learning and Teaching

Teachers should also clarify that it is not only fish that get caught as “bycatch”. Examples of non-fish bycatch include seabirds, turtles, whales and porpoises.

Given the controversy over the impact of seals on fish stocks, teachers should ensure this topic receives a thorough treatment. Teachers could use the Envirofocus “Challenges to the Analysis of Seal Diet” as the major focus of addressing this outcome.

As enrichment, teachers could have students do a stomach content analysis using an available commercial fish for this activity.

Sustainable Fishing - Challenges (continued)

Tasks for Instruction and/or Assessment

Performance

Write an article and submit it to your local newspaper on how the sealing industry has impacted your local area.

Presentation

Develop a play or skit in which both sides of the sealing debate is presented. Have a local presentation and invite the public to view your play.

Resources/Notes

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Aquaculture

Outcomes

Students will be expected to

4.44 define aquaculture

4.45 describe factors that lead to an increased dependence on aquaculture as the primary source of fish proteins.

Include:

- (i) increase demand
- (ii) reduce pressure on wild stocks

4.46 identify the main species raised in a aquaculture environment in Newfoundland and Labrador

4.47 describe the environmental issues associated with aquaculture operations.

Include:

- (i) impact on wild stocks
- (ii) water pollution

Elaborations – Strategies for Learning and Teaching

Most students will be familiar with the term aquaculture. As an activity teachers could have them to take note of the number of fish species available at the supermarket that have been produced through aquaculture. These will include mussels, salmon, steelhead trout to name a few.

Teachers should identify the main areas in Newfoundland and Labrador where aquaculture is done and what species are involved.

Teachers should have students refer to the Land and Sea episode entitled, “The Crest of the Wave.” This video highlights a Newfoundland example of fish farming (i.e. aquaculture).

Teachers could explain that the main fish being farmed are salmonids though there is a growing cod farming trend. Teachers could have students research the pros and cons of salmonid versus cod farming.

Teachers could provide several examples of incidences where aquaculture sites for fish have had accidental escape of fish and their impact to the local area.

Students could investigate the problem of steel head trout on Atlantic salmon rivers and the future impacts of the invasive species.

Aquaculture

Tasks for Instruction and/or Assessment

Interview

Students could visit a local aquaculture operation to interview the manager or owner to determine the species farmed. Challenges to the operation, potential markets, and initial start-up costs and procedures.

Presentation

Students could research world wide aquaculture operations to identify other species being farmed and where on Earth this occurs. A powerpoint presentation or poster could be used to present their findings.

Journal

What are some of the environmental issues associated with aquaculture operation in Newfoundland and Labrador?

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Land and Sea episode “The Crest of the Wave.”

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Page 551-554

Marine Debris

Outcomes

Students will be expected to

- 4.48 describe how ocean currents cause pollutants to move globally from where they originate
- 4.49 describe how habitat destruction occurs along coastal areas due to human activities. Include:
- (i) resource extraction
 - (ii) pollution

Elaborations – Strategies for Learning and Teaching

Just as ocean currents are the movers of hot and cold waters, they too by default act as distributors of ocean contaminants. Therefore, any land based pollutants such as toxins and solids that enter an ocean-land boundary has the potential to be moved great distances from their origin via the ocean. The rise and fall of tidal waters allow flushing of bays and the subsequent movement of pollutants.

Students could consider the proposed garnet beach mine operation for Northern Labrador and the possible impacts this operation may have on the beaches in this pristine area of the province. The Hutton beaches are located in an uninhabited area about 360 km north of Nain.

Pollution arrives in coastal areas via two primary routes; from shore based activities or by direct dumping into the oceans whereby currents transport the pollution landward. The latter source can be accidental like in the case of oil spills or they can be intentional like bilge water dumping that is prevalent near the south coast of the island of Newfoundland. Ships passing in shipping lanes find the isolation along this route a convenience when illegally disposing of bilge water that often contains contaminants like oil and metals such as copper and lead.

Communities along coastal regions significantly affect the natural habitats that normally exist where oceans and lands meet. This is particularly true when human population densities are high. Teachers could have students compare larger coastal centers (St. John's or Halifax) to smaller communities in terms of how habitats might be affected by sewage disposal, storm run-off, beach erosion/alterations, commercial and residential building developments, and recreational activities.

Marine Debris

Tasks for Instruction and/or Assessment

Performance

Create a game, poem, song, or short play that demonstrates the importance of marine ecosystems in Newfoundland and Labrador. This can be done from an ecological, economic, or historical perspective.

Presentation

Create a poster display with a map of Newfoundland and Labrador showing the Labrador Current and the Gulf Stream. Include the relative water temperatures, direction of flow, pollutants, and early settlements of the province to illustrate settlement patterns.

How could the development of a mine work within the parameters of the newly formed Torngat Mountains National Reserve? What organisms could be affected? How could habitat destruction along beaches be minimized?

Resources/Notes

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Marine Debris (continued)

Outcomes

Students will be expected to

- 4.50 identify negative impacts resulting from marine invasive species. Include:
- (i) tunicates
 - (ii) green crab
 - (iii) oyster thief
- 4.51 list sources of marine debris. Include:
- (i) shipping traffic
 - (ii) land litter carried in rivers and streams
 - (iii) direct dumping of municipal sewage
 - (iv) disposal of garbage offshore (municipal garbage)
 - (v) debris from fishing activities (plastic and lost nets (i.e. ghost nets))
 - (vi) debris from offshore industry (drilling mud)

Elaborations – Strategies for Learning and Teaching

One source of biological pollution is the unintended introduction of new species in local marine and aquatic environments when bilge water is dumped like the zebra mussels in the Great Lakes and the lamprey in Atlantic Canadian waters. In Newfoundland and Labrador, two such species are the lamprey and green crab which have become invasive species. Students could investigate the source of these accidental introductions and their impact on local ecosystems.

Teachers can do a general discussion of these sources. Have students list the sources of debris along with a brief discussion of the affects these may have on the marine ecosystem in Newfoundland and Labrador.

Marine Debris (continued)

Tasks for Instruction and/or Assessment

Presentation

Groups can investigate their local area and present their findings on the types of marine debris found.

Performance

Using a source that details the decay rate of certain marine debris, write an article explaining the long term changes of these pieces of marine debris on the ocean ecosystem.

Resources/Notes

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Marine Debris (continued)

Outcomes

Students will be expected to

- 4.52 identify the impacts of marine debris on the aesthetics and ecology of marine environments
- 4.53 describe mitigation efforts that lessen the impacts of marine debris on the marine ecosystem

Elaborations – Strategies for Learning and Teaching

Teachers could engage students in analysis of marine debris in their area. Teachers could reference the old Environmental Science 3205 guide for ideas of how to get started. (See also ACAP materials and Ocean Net.)

Impacts on aesthetics stem from unsightly litter and garbage along coastlines and floating materials that end up on beaches (e.g. plastics, Styrofoam, wood, ropes, oil). This in turn can impact on tourism (marine eco-tourism such as coastal hiking, sea kayaking etc.).

Ecologically, living organisms face impacts directly on their habitat and possible ingestion of the debris which causes serious debilitations or death. Larger marine mammals, reptiles and fish often become entangled in synthetic ropes and nets and even 6-pack can holders.

Mitigation efforts reduce the effect of marine debris on the marine environment. Those that utilize designated disposal sites for marine products are addressed in the Fisheries Act (sections that control dumping). Education is another key mitigation effort since it exposes students to the importance of maintaining clean environments and practicing stewardship early in life. This can be done through posters and information illustrating the timeline for breakdown of marine debris so that students recognize the long lasting affects that marine debris has on marine ecosystems. Further to this, students could participate in local community beach cleanups (marine debris activity through world ocean's day). Students could also do research to identify the various legislations around marine debris or on how many larger coastal communities are spending significant monies to clean up their harbours and reduce pollutants like sewage and other effluents.

Marine Debris (continued)

Tasks for Instruction and/or Assessment

Performance

Students can clean-up a local beach or river during Ocean Day.

Write a letter to your local member of parliament or MHA stressing the importance of beach clean-ups or the need to enact legislation on marine debris enforcement.

Presentation

Develop posters that show the types of marine debris and their relative life-span in the ocean.

Resources/Notes

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Oil Spills

Outcomes

Students will be expected to

4.54 describe how oil pollution occurs when oil products escape into the environment

4.55 list sources of marine oil pollution. Include:

- (i) transportation
- (ii) bilge dumping
- (iii) natural seepages
- (iv) offshore extraction
- (v) land-based

Elaborations – Strategies for Learning and Teaching

Land based sources of oil pollution in the marine environment can result from the dumping of used oil into storm sewers, which eventually goes to the ocean.

Teachers should make students aware that oil pollution is simply the spilling of crude or refined petroleum product into the environment. This can happen through natural processes and human activities. Students could research some of the more recent spills of the coast of NL and globally to gain a better understanding of the scope of damage these spills can cause.

Transportation sources of oil pollution in the marine environment can result from tanker accidents. With the increase in commercial tankers around Newfoundland and Labrador, the probability of accidents is increased.

Bilge dumping is defined as a mixture of sea water, petroleum products, and other brackish material that is illegally released from ships.

When oil is extracted offshore, drilling mud that is used to bring drill cuttings to the surface is often spilled into the marine environment. Oil is a component of the drilling mud. Offshore extraction of oil sometimes leads to accidental spills such as a blowout or a leaky valve.

Natural seepages of oil occur when weathering exposes reservoirs allowing the oil to spill out onto the land. This oil can run off the land into aquatic and marine environments.

Mitigation is defined as structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.

This could be a good time to have students do a research project on the mitigation strategies used for oil pollution. As well, students could further research whether the fines levied for oil pollution fit the “crimes”. For many ocean going vessels, it is worth the risk to dump oil at sea than to pay to have it disposed of properly onshore.

Oil Spills

Tasks for Instruction and/or Assessment

Presentation

Research some of the more recent spills of the coast of Newfoundland and Labrador and globally to gain a better understanding of the scope of damage these spills can cause. Present the results of your research with the class as a newspaper article, poster, or multimedia presentation.

The videos “No Second Chance” and “Silent Disaster”, if available could be shown here to introduce the effects on marine birds by oil fouling.

Journal

Reflect on the videos “No Second Chance” and “Silent Disaster.” How did these videos make you feel? Do you think enough is being done to prevent such environmental crimes? Why or why not?

Resources/Notes

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Oil Spills - Impacts

Outcomes

Students will be expected to

4.56 describe the economic impacts of marine oil spills.

Include:

- (i) tourism
- (ii) aquaculture
- (iii) commercial fish and shellfish harvesting
- (iv) adventure activities

4.57 describe the impacts of surface oil on marine waterfowl and mammals

Elaborations – Strategies for Learning and Teaching

Teachers could arrange for guest speakers to discuss the various impacts as they relate to the Newfoundland and Labrador environment.

Teachers should ensure that students recognize that as oil breaks up and disperses naturally, recovery efforts are more difficult. As well, oiling of birds offshore can result when the oil disperses. The birds are then rendered incapable of flight and their feathers lose their insulation capacity. Fouling of intertidal zones and contamination of shorelines occur when oil is brought in by ocean currents and wave action.

While oil does not mix with water it is readily absorbed into birds' feathers. When that happens it decreases the birds' insulation from the cold, as well as their waterproofing and buoyancy. This inevitably leads to their death by hypothermia or starvation. Just one spot of oil can do this, and therefore an oiled bird often becomes a dead bird.

Teachers could use the Envirofocus "The Plight of the Murr" to teach this topic.

Oil Spills - Impacts

Tasks for Instruction and/or Assessment

Presentation

Research the mitigation strategies used for oil pollution. Create a model that demonstrates one mitigation strategy such as booms for containment or absorbents and detergents for cleanup.

Journal

Do the fines levied for oil pollution fit the crimes? Explain.

Performance

Students could engage in a web quest to explore the economic impacts of oil spills. The following web quest can be utilized to complete this task: <http://web.syr.edu/~cwkuria/final.html>.

Students could be assigned to groups to report on the economic impacts of a marine oil spill on their sector. For example, when looking at “tourism” a student could represent a tour boat owner, another could represent a B&B owner, another represent the town council, etc. Each would describe and explain how the oil spill is affecting them economically. The same could be done for aquaculture, and commercial fishing and harvesting.

Resources/Notes

Page 575-576

Marine Oil Spills - Mitigation

Outcomes

Students will be expected to

4.58 describe mitigation strategies for marine oil pollution.

Include:

- (i) preparedness
- (ii) containment
- (iii) recovery
- (iv) disposal

4.59 Identify career opportunities relating to freshwater and marine ecosystems

Elaborations – Strategies for Learning and Teaching

In terms of preparedness, it involves contingency planning, exercising, and training/education by the Environmental Emergencies Section (EES), in the Atlantic Region, which is a multi-disciplinary team which delivers the departmental responsibilities for environmental emergencies in the four Atlantic provinces.

Preparedness also involves prevention measures such as navigational aids for tankers like the Marine Communications and Traffic Services (MCTS). Containment involves efforts to keep oil within a series of deployed booms.

Recovery can include the use of chemical detergents that emulsify the oil. These detergents will chemically interact with both oil and water, thus stabilizing the interface between oil or water droplets in suspension. This makes cleanup of the oil with skimmers and vacuums easier.

Another recovery method uses steam and heat to manually remove the spilled oil. Large steamers heat the oil which is then removed using various absorbent products. This method is time consuming and labour intensive. The type of oil spilled determines the recovery technique used. Once the spill has been cleaned as much as possible, biological remediation technologies may be used to allow the site to remediate naturally. This involves the use of specially designed microbes and fertilizers that will enhance soils and encourage the re-growth of plants.

After the oil is recovered, it's separated from the water, and the oil is disposed of, along with any remaining cleanup materials and other debris. Relatively fresh oil may be re-refined. In other cases the recovered oil is burned.

Sometimes cleanup crews can't get to a slick because the weather is too bad. In these cases, waves re-circulate the oil in the water, and natural processes eventually break the oil down.

Sometimes the oil is burned off the water. It must first be contained to make it thick enough, and then set alight. Studies have shown the resulting smoke plume is an acceptable trade-off under some circumstances.

Students could refer to the Land and Sea episode entitled "A Fisherman's Daughter". This video describes the challenges and rewards associated with pursuing a career as a lobster harvester.

Students could read the Career Spotlights "Dr. Joanne Morgan, Scientist, Fisheries and Oceans Canada", "Garry Stenson, Scientist, Fisheries and Oceans Canada", and "Danny Boyce, Aquaculturist."

Marine Oil Spills - Mitigation

Tasks for Instruction and/or Assessment

Presentation

Research the areas in Newfoundland and Labrador that have been affected by oil spills. Present the results of your research with the class as a newspaper article, poster, or multimedia presentation.

Develop a presentation or display that addresses the economic impacts of marine oil spills. Present the results of your research with the class as a newspaper article, poster, or multimedia presentation.

Performance

Role play a tour boat owner, hospitality owner, town councillor, etc. to show how an oil spill is affecting them economically. The same could be done for aquaculture, and commercial fishing and harvesting.

Resources/Notes

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Land and Sea episode, "A Fisherman's Daughter."

