Oceans 11
A Teaching Resource
Volume 1

Foreword

Oceans 11 curriculum was developed by the Nova Scotia Department of Education as part of a joint project with the federal Department of Fisheries and Oceans. This curriculum reflects the framework described in *Foundation for the Atlantic Canada Science Curriculum*.

Oceans 11 satisfies the second science credit requirement for high school graduation.

Oceans 11 includes the following modules: Structure and Motion, Marine Biome, Coastal Zone, Aquaculture, and Fisheries.

Oceans 11: A Teaching Resource, Volume 1 is intended to complement the curriculum guide, *Oceans 11*. The sample activities in this resource address the outcomes described in *Oceans 11* for the three compulsory modules: Structure and Motion, Marine Biome, and Coastal Zone.

Oceans 11: A Teaching Resource, Volume 2 is intended to complement *Oceans 11*. The sample activities in it address the outcomes for the modules Aquaculture and Fisheries. Teachers may choose to do one of these units or to divide their class into groups that focus on a unit.

Contents

Defining the Coastal Zone

Defining the Coastal Zone, Teacher Notes

Coastal Zone Properties and Structure

Coastal Zone Properties and Structure, Teacher Notes

The Importance of Coastal Zones to Humans

The Importance of Coastal Zones to Humans, Teacher Notes

Human Influences on Coastal Zones

Human Influences on Coastal Zones, Teacher Notes

Nova Scotia's Coastline—Just How Long Is It?

Nova Scotia's Coastline—Just How Long Is It? Teacher Notes

Mapping the Coastal Zone

Mapping the Coastal Zone, Teacher Notes

Coastal Zone Variations in Nova Scotia

Coastal Zone Variations in Nova Scotia, Teacher Notes

Global Coastal Zone Variations

Global Coastal Zone Variations, Teacher Notes

Coastal Zones and Society

Coastal Zones and Society, Teacher Notes

Overharvesting of Marine Resources

Overharvesting of Marine Resources, Teacher Notes

Oil, Water, and Then What?

Oil, Water, and Then What? Teacher Notes

Study of a Contaminant

Study of a Contaminant, Teacher Notes

Coastal Zone Management

Coastal Zone Management, Teacher Notes

Problem Solving and Coastal Zones

Problem Solving and Coastal Zones, Teacher Notes

Structure and Motion

Introduction

This module approaches the topic of the structure and motion of the oceans from a global perspective. However, this global view is integrated with frequent, relevant local examples. Also, you can relate most of the globally introduced concepts directly to the nearest coastline to your school. The module looks at the ocean basin (bodies of water, structure of the Earth, isostasy, physiography, continental drift, sediments) and ocean dynamics (properties of water and seawater, tides, currents, and waves). Interaction between the ocean and its environment (atmosphere, watershed, ice, humans) are dealt with in some regard, but the purpose of this module is to allow your students to develop an understanding of the ocean as an integrated, dependent system, not just the sum of all the isolated parts.

The activities in this module provide students with key background information while allowing them to construct their own explanations and understandings of many of the concepts introduced. While the scientific principles may be straightforward, there are ample opportunities for students to appreciate that the ocean is a complex, integrated system and that we are still developing our understanding of it. The concept of time and the changes that the ocean displays over time permeates this module. This develops the understanding that the ocean is not constant, but dynamic and ever changing.

The activities in this resource are intended to supplement the activities included in the curriculum guide.

Materials

- access to the Internet (optional)
- atlases
- balance
- bathymetric chart of a local area
- beakers (50 mL)
- brine solution (1830 mL of fresh water and 70 g of salt)
- card stock
- coil spring
- coloured pencils
- fresh water
- glue stick
- graph paper
- hydrometer
- information sheets (relevant to activity)
- metre sticks
- *Ocean Mapping* video (V1680)
- paper
- pen
- pencils
- *Plate Dynamics* video (23457)
- predrawn graph paper
- research access video
- resource books from various sources (oceanography, library resources, dictionary)
- ruler
- scissors
- seawater
- shoe box
- Slinky
- stopwatches
- string
- video graphic organizer
- world map

The Ocean Industry in Nova Scotia

Questions

- What ocean-related occupations are there?
- How can these occupations be categorized?
- What impact do ocean-related industries have on the economy of Nova Scotia?
- What contributions have Canadians made?

Background Information

At no point in Nova Scotia are we more than 50 kilometres from the coast. The First Nations peoples of Nova Scotia lived their lives in balance with the ocean and its resources. Today, hundreds of years later, we are looking at their sustainable-use practices.

Industry in Nova Scotia has traditionally relied on the ocean for either resource harvesting or transportation. The vast numbers of fish that were to be found off of the east coast of Canada are legendary. As Nova Scotia became more heavily populated, trade and commerce rose in importance. Shipbuilding, shipping, and trade all became mainstays of our economy. Forest harvesting also flourished in relationship to the demand for timber.

In the early nineteenth century, the demand for wooden vessels diminished, but the fishing and commercial activities along and off our coasts continued to play a major role in the development of the province. This has resulted in the importance and vitality of our coastal communities to this day. More recently, however, these communities have had to search for ways to diversify their economic bases. Today, we look at the ocean and our coastal areas, in a different way. Gone are the days when we can harvest the ocean's resources and pollute its waters without a thought for their current and future health.

Ocean industries in Nova Scotia today range from the traditional and familiar to the new and exciting. The combination of traditional knowledge of our ocean and its resources and the wealth of current expertise, technology, and knowledge that exist in Nova Scotia makes this a vibrant and economically important sector. Remote-sensing technologies, advances in aquaculture techniques, ecotourism opportunities, and ocean research are just a few examples of Nova Scotian ocean industries that are world leaders.

Procedure

Group the list of ocean-related industries given below into the following categories:

- uses ocean resources
- uses the ocean as a transport medium
- knowledge-based industry

Within each category, indicate whether the industry is science- or technology-based or both.

After you have categorized the industries, choose two industries. Write a list of both positive and negative impacts on your two choices. Include evidence to support your positive and negative impact information.

Nova Scotia’s Ocean Industries

- Commercial fisheries
- Aquaculture
- Oil and gas development
- Ocean research
- Ecotourism
- Remote sensing
- Shipbuilding
- Recreational fisheries
- Government
- Military
- Consulting
- Marine insurance
- Recreational activities (other than fishing)
- Port management
- Fish processing
- Ocean mapping
- Shipping
- Safety equipment and training

The Ocean Industry in Nova Scotia
Teacher Notes

Outcome

Students will be expected to

- identify oceans and related water areas in the world and describe related science- and technology-based careers (OSM-1)

Background Information

This activity should help students broaden their awareness of ocean-related careers. It will also encourage them to think about the difference between science and technology.

Assessment

Choose an ocean-related industry and explain where science or technology has an effect on two of the following:

- society
- environment
- economy
- politics
- jobs (employment)

Design a chart (flow chart, Venn diagram, etc.) for your answer.

When Humans and the Ocean Meet

Question

What connections can be made among human activities and oceans from various points of view?

Procedure

In groups of two or three, choose a scenario (six scenarios are listed below). You and your group will be given one class to organize yourselves and begin preparation for the presentation. You will have small amounts of time during the module to finish up your project. Group members will have to complete their parts on their own time. This task is ongoing. Define the role of each person in your group and keep a logbook.

FEDERAL AGENCY You are a federal government agency. You are responsible for making important decisions regarding the captive fisheries for Atlantic Canada and for making recommendations about the quotas for specific fish populations, possible closure of certain fisheries, types of ocean physiography associated with the various types of fish, fishing boundaries, who can fish within the boundaries, financial assistance for people losing income as a result of your decisions, and the penalties for those who do not comply with your agency's regulations. You must submit a final report on your group's recommendations for the local fisheries.	**ENVIRONMENTAL** Your group has been hired to be responsible for environmental cleanup of the coastline of Nova Scotia. You have to come up with a sustainability plan to clean up and manage the coastline. Areas of concern that must be addressed are definition of a coastline; who is responsible for the pollution and clean-up of various regions; what type of physiography you will be faced with as you clean up the water surrounding Nova Scotia; where to start this monumental clean-up; land-based pollution; ocean-based pollution; storage and removal of various pollutants such as oil, toxic materials, radioactive materials, solid waste (trash), and raw sewage; how to maintain this clean-up when completed; and the penalties for those people or companies who disregard your decisions.
ELEMENTARY PLAY You are responsible for writing and performing a short play that will give elementary students an understanding of the nature and type of water waves. Your play must have at least three characters and must discuss in some form the following information: wave types, factors affecting wave size, standing waves, rogue waves, tsunamis, and transverse and longitudinal waves. The play should be no more than five minutes in length.	**OCEAN FLOOR** Your group is responsible for writing an information text with illustrations about the physiography of the ocean floor in the North Atlantic with regard to diving on ship wrecks in the various physiographic locations. You should look at the various types of technology needed to dive at each depth. This text is intended for elementary students, so the reading level should be geared toward this age group (5–11 years of age).

FIELD TRIP	EXPLOITATION OF THE OCEAN
Your group is responsible for planning a field trip to the location of your choice. Money is no object! The location can be anywhere in the world. You must come up with activities to fill the day once you have reached your destination. When you choose your destination, keep in mind all the activities that your group needs to complete. You must submit a list of activities, supplies needed, an itinerary, a list of learning objectives for the participants of this field trip, and a final evaluation method of your choice so the students who participate on your field trip can be evaluated on their learning.	Your group is responsible for finding information about the exploitation of the ocean. With three different scenarios and evidence, report your findings. You may wish to decide your own category for exploitation or you may choose one of the following: disasters, ocean-related inconsistencies, folklore, or historical stories. Check with your instructor to ensure that the angle of your critique is acceptable.
Any other great idea generated by your group that your teacher okays!	

Self- and Peer-Evaluation Rubric for Small-Group Projects

Scoring for each criterion: Always—2 points, Sometimes—1 point, Never—0 points.

	Always	Sometimes	Never
Contributed information and ideas to discussion			
Questioned the ideas of others constructively			
Showed respect for the ideas of others			
Listened to others without interrupting			
Helped involve everyone in the discussion			
Contributed to project			
Did expected share of the work			
Got along with all group members			
Was present for all group-work time			

Complete an evaluation form for everyone in your group, including yourself.

When Humans and the Ocean Meet
Teacher Notes

Outcome

Students will be expected to

- identify and describe wave motion found in the marine environment and in everyday situations (OSM-5)

Background Information

This project should be at the end of this module and revisited at the end of the Oceans 11 course, as the topics require the students to integrate the knowledge they gain from the other modules. It could be assigned at the start of the Structure and Motion unit so they can work through their topics during the module.

Evaluation

As a class, design the rubric. One possible presentation rubric follows, where 1 = least, 5 = most.

Sample Rubric

Content					
Showed command of the material	1	2	3	4	5
Supported assertions with evidence	1	2	3	4	5
Used adequate and appropriate visuals	1	2	3	4	5
Presented a balance of opinions from multiple perspectives	1	2	3	4	5
Organization					
Presented a clear line of reasoning	1	2	3	4	5
Avoided needless digressions	1	2	3	4	5
Style					
Seemed confident and relaxed	1	2	3	4	5
Showed appropriate enthusiasm	1	2	3	4	5
Spoke clearly	1	2	3	4	5
Had good posture and eye contact	1	2	3	4	5

Used appropriate gestures, tone, volume, and delivery rate	1	2	3	4	5
Overall Impression					
Innovative	1	2	3	4	5
Appropriate	1	2	3	4	5
Effective	1	2	3	4	5

Bodies of Water

Questions

- What criteria are used to determine the type of a body of water?
- Where are bodies of water found in the world?

Procedure

1. Below you will find bodies of water located all over the Earth. With a partner, locate these bodies of water in an atlas and label them neatly on a world map provided by your teacher.

Atlantic Ocean	Pacific Ocean	Indian Ocean
Arctic Ocean	Bering Sea	Red Sea
Baltic Sea	Gulf of St. Lawrence	Black Sea
Bay of Bengal	Persian Gulf	Bay of Biscay
Tasman Sea	Hudson Bay	South China Sea
Caribbean Sea	Gulf of Alaska	Timor Sea
Mediterranean Sea	Coral Sea	Beaufort Sea
Gulf of Maine	Sea of Japan	Caspian Sea
Davis Strait	Arabian Sea	North Sea
Gulf of Mexico	Mozambique Channel	English Channel

2. Bodies of Water (Individual)

Define each of these specific types of bodies of water. By looking at these types of bodies of water in your atlas, make definitions that will distinguish each of these bodies of water from the others. You may want to look at size, surrounding land masses, or location when defining these bodies of water. Use a graphic organizer for your work.

Oceans	Seas
Bays	Straits
Gulfs	Channels

[insert graphic: Frayer.eps]

3. Bodies of Water (Class)

Now that you have constructed your own definition of these types of bodies of water, work as a whole class to construct a shared understanding of them. Through discussion and sharing of your own understanding of each type, try to come to some consensus so that a class definition can be constructed. After a class consensus has been reached, record the definitions of the types of bodies of water.

Oceans	Seas
Bays	Straits
Gulfs	Channels

Bodies of Water
Teacher Notes

Outcome

Students will be expected to

- identify oceans and related water areas in the world and describe related science- and technology-based careers (OSM-1)

Background Information

The purpose of this activity is for students to think about how a body of water receives its designation (ocean, bay, and so on) and to become more familiar with the locations of various bodies of water.

Bathymetric Profile Sketching

Questions

- What are the characteristics of contour mapping using bathymetric charts?
- How is a two-dimensional cross-section of a transect of a bathymetric chart constructed?

Introduction

The ocean floor can be divided into recurrent features called *physiographic provinces*. These provinces are distinguished from one another by depth, general slope of the surface, composition of the surface, and relief.

A *bathymetric chart* shows water depths below chart datum (a normal lowest-tide measurement designated on the chart as zero elevation) in the form of contour lines. A contour line connects regions of the ocean floor with the same depth. Taking a transect (straight path) across a section of ocean and plotting the contour intervals on a graph will give you a cross-sectional elevation of the ocean floor directly below the transect line.

Materials

- bathymetric chart of a local area
- ruler
- graph paper
- pencil

Procedure

1. Using a ruler, draw a transect (straight line) from a point on the coastline across the continental shelf, slope, and rise to the abyssal plain.

2. Decide on an appropriate scale to convert kilometres on the chart to millimetres on the ruler.

   (1 mm = 1 km or 1 mm = 10 km)

3. On your graph paper, establish a vertical axis for depth in metres. Remember that numbers should increase down the graph starting at sea level, which would be 0 metres in depth. The horizontal axis represents the distance along the transect in kilometres. Adjust your scale so that the entire piece of graph paper is used. If you wish, use several pieces of graph paper so you get a more realistic elevation of the ocean floor.

4. Label the graph. All graphs need a title (be specific). The axes must be labelled, and units that are represented must be stated.

5. Place a piece of paper starting at your starting point (the coastline). Using the scale that you decided on (e.g., 1 mm = 1 km), transfer the depth information of the bathymetric chart contour lines to your graph paper.

6. Connect the depth points on the graph to construct the profile drawing.

7. Label the continental shelf, shelf break, slope, and rise on your graph.

8. Calculate the vertical exaggeration of your drawn profile.

[insert graphic: VE formula.eps]

$$\frac{\text{horizontal scale}}{\text{vertical scale}} = \text{vertical exaggeration}$$

9. Calculate the maximum gradient of the continental shelf, slope, and rise. Express this gradient as 1 metre vertical distance over a certain number of metres horizontal distance. What this means is how many metres you have to travel horizontally along the shelf or slope or rise to drop 1 metre in elevation.

Bathymetric Profile Sketching

Name:

A. Information

Fill in the Information: Student Notes

BATHYMETRIC PROFILE SKETCHING		
The ocean floor can be divided into recurrent features called *physiographic provinces*. These provinces are distinguished from one another by depth, general slope of the surface, composition of the surface and relief.		
Continental margin		
Shelf	Slope	Rise
Abyssal floor	Oceanic ridges	Ocean trenches
A bathymetric chart		

B. Research

- Research the amount of the Atlantic Ocean floor that the margin makes up.
- Research information about the difference(s) between the Atlantic floor and the Pacific floor. Talk about the reasons. This difference is due to their different origins.

C. Analysis

1. What are some of the topographical features (relief of the ocean floor) of the ocean floor that can be seen on your bathymetric chart?

2. What would you say is vertical exaggeration?

3. What is gradient?

4. Why, do you think, would you have a more accurate chart if you had more contour lines of smaller depth intervals?

5. Would your profile of the continental margin look exactly like your cross-sectional transect? Explain.

6. What would the profile look like if the horizontal and vertical axis were the same scale?

7. Is the continental shelf really flat as we are told?

Bathymetric Profile Sketching
Teacher Notes

Outcome

Students will be expected to

- analyze the basic structure of Earth's waters using evidence and information to support your findings (OSM-2)

Background Information

You can modify this activity to suit the bathymetric charts that you have. A photocopy of the same chart works equally well.

If all profiles are drawn with the same scales, you can compare every profile quite quickly to a master profile.

See the activity on mapping the ocean floor.

Notes on continental slopes and rises may include general slope features, submarine canyons, and submarine fans.

Information Sheet

Sample Bathymetric Profile Sketching

<table>
<tr><td colspan="3">Bathymetric Profile Sketching: Sample Notes

The ocean floor can be divided into recurrent features called physiographic provinces. These provinces are distinguished from one another by depth, general slope of the surface, composition of the surface and relief.</td></tr>
<tr><td colspan="3">Continental margin
subdivided into three parts: shelf, slope, and rise</td></tr>
<tr><td>Shelf
Relatively shallow (0–200 m). Its shallowness, proximity to land, and economic importance make the shelf the most studied of the provinces.
Varies greatly, being virtually absent off the west coast of the Americas to a maximum of 700 km off Siberia in the Arctic Ocean.
Relatively flat with a general gradient of 1 to 500 (a drop of 2 m/km).</td><td>Slope
Distinguished from the shelf by a sharp change in gradient: shelf break.
Angle of the slope is quite gentle, averaging less than 5 °.
Diagrams of ocean basins are misleading, portraying the slope as a steep embankment caused by the scale of the drawing.
Continues to an average depth of 3600 m.
Edges of the shelf and slope are cut by grooves called submarine canyons.
The Hudson Canyon is famous in the western North Atlantic.</td><td>Rise
Mainly composed of sediments derived from the continent’s shelf and slope.
Typically, continental rises are more developed off the mouths of large rivers.</td></tr>
<tr><td>Abyssal floor
Deepest part of an ocean basin other than the trenches worldwide.
An average depth of almost 4000 m.
On the bottom of the ocean it is perpetually dark (except for bioluminescence), near freezing, and at unimaginable water pressure.</td><td>Oceanic ridges
A more or less continuous chain of underwater mountains found in all ocean basins.
Thousands of kilometres wide and extends an average height of 2400 m from the abyssal floor.
In some places the ridge protrudes above sea level, forming islands (Azores, Iceland).
The Mid-Atlantic Ridge bisects the Atlantic Ocean basin.
Ridges form where two</td><td>Ocean trenches
Deep, elongate troughs in the abyssal floor with a depth of over 6000 m.
Trenches form when two crustal plates collide and one subducts beneath the other.
Most trenches are found in the Pacific Ocean and are closely associated with the Pacific Ring of Fire.</td></tr>
</table>

	crustal plates diverge and new crust is added by volcanic activity.	

A bathymetric chart A bathymetric chart shows water depths below chart datum (a normal lowest-tide measurement designated on the chart as zero elevation) in the form of contour lines. A contour line connects regions of the ocean floor with the same depth. Taking a transect (straight path) across a section of ocean and plotting the contour intervals on a graph will give you a cross-sectional elevation of the ocean floor directly below the transect line.

Information Sheet

CONTINENTAL SLOPES AND RISES: SAMPLE NOTES

A. General Slope Features

- Slopes are narrower, averaging about 20 km wide, and steeper, averaging about 4.5°, than the continental shelves.
- On average they begin at about 133 m, and their base ranges from about 1400 m to about 3000 m.
- Characteristically, they are cut by submarine canyons.
- Slope processes include slumping, faulting, contour currents, and turbidity currents.
- Surface sediments are finer grained than those of the shelf.
- Some of the fine-grained sediments pass over ("by pass" concept) the shelf to be deposited in deeper waters.
- The eastern North American continental slope is about 60 percent mud, 25 percent sand, 10 percent rock and gravel, and 5 percent carbonate composed of shells and lime muds.

B. Submarine Canyons

- These are V-shaped valleys that resemble river canyons.
- They may be as large as the Grand Canyon of the Colorado River, examples being the Monterey Canyon off California and the Hudson Canyon some 130 miles south of New York City.
- The Hudson Canyon is even steeper than the Grand Canyon.
- These canyons, which often start on the continental shelf, have winding courses and emerge onto the continental rise, where they have distributer channels with levees like a river.
- On the upper continental rise, they often form deep-sea fans, indicating that sediments have been or are being transported from the shelf and slope onto the rise and out onto the abyssal plains in still deeper water much farther away.
- These canyons are erosional, cutting into the continental margin, and are often associated with present-day rivers on the adjacent coast.
- Apparently, when sea level was much lower during the ice ages, these rivers flowed out across the shelf.

C. Turbidity Currents

- Sediment-laden waters must flow turbulently down the canyon as density currents that pick up speed and erode the canyon walls. These currents are called turbidity currents.
- When they reach the gentler slopes of the upper continental rise, they must slow down, spread out, cut distributer channels, and deposit their sediment loads.
- These sedimentary deposits are poorly sorted (mixed grains of many sizes) and graded (average size decreases upwards). They are called *turbidites* and may be up to several metres thick. On the abyssal plains far out from the continental margin, they will be thinner and lack the coarse bottom layers.
- Turbidity currents are probably initiated by earthquakes, storms, and slumping of sediments on over-steepened slopes.
- On the Grand Banks south of Newfoundland in 1929, an earthquake in the Laurentian Channel area that registered 7 on the Richter scale initiated a turbidity current.
  - Many sea-floor communication cables connecting Europe with North America twisted and were broken by slumps and turbidity currents.
  - Marine geologists in 1952 calculated current velocities up to 55 km/h.
  - In the late 1950s coring and sea-floor mapping revealed that the turbidite spread out for a distance of about 700 km.

D. Continental Rise Features

- These are depositional topographic features gently sloping at about a half a degree or less

E. Submarine Fans

- Sediments on these submarine fans are deposited primarily by turbidity currents.

toward the abyssal plains. ▪ They range from about 100 to 1000 km in width and parallel much of the length of the continental slope. ▪ The eastern North American continental rise is about 250 km wide and about 2000 km long. It extends from Labrador to Newfoundland and then from Nova Scotia to Georgia. ▪ Elsewhere in the world continental rises occur along the older, tectonically inactive continental margins. For example, they occur along the eastern side of South America, but not along the western side where a deep-sea trench is located.	▪ Thicknesses are known to be as much as 12 000 m along eastern North America. ▪ In many ways, continental rises resemble the coalescing alluvial fans found in places like Nevada and Arizona. ▪ Dramatic examples are the Indus Fan, which forms the rise south of the mouth of the Indus River west of northern India, and the Ganges Fan, south of the mouths of the Ganges and Brahmaputra rivers east of northern India. ▪ Surfaces of continental rises contain distributer channels emanating from the base of submarine canyons that cut the adjacent continental slope. These channels may have levees built up along their sides like river channels on land.

Name:

A. Information

FILL IN THE INFORMATION: STUDENT NOTES

CONTINENTAL SLOPES AND RISES	
A. General slope features	B. Submarine canyons
C. Turbidity currents	
D. Continental rise features	E. Submarine fans

Water Facts

Name:

Questions

- What is unique about water?
- What are the properties of water?

Procedure

In a group of two or three, discuss the facts about water. Answer the questions below and report your findings on the sheet provided. Other references may be used also.

1. If water froze like other liquids, how would this affect (a) skating on a pond? (b) plants and animals living in a lake during the winter?	2. What makes glaciers flow?
3. Explain why the temperature of the water near the bottom of a very deep, ice-covered lake is about 4 °C?	4. Many small aquatic insects walk on water. How?
5. The temperature of inland regions fluctuates greatly from day to night, but the temperature stays about the same in coastal regions. Using examples or evidence, tell why.	

6. On a very hot summer day, the sand feels very hot on your bare feet while shallow pools feel much cooler. Explain why.	7. Power outages in the winter often result in many homes having ruptured water pipes. How does this happen?

Water Facts
Teacher Notes

Outcome

Students will be expected to

- identify, collect data, and describe the unique properties of water (OSM-3)

Background Information

A sample sheet follows, giving some facts that may be useful for the student activity.

Information Sheet: Water Facts
Water is truly a remarkable substance. It is the only substance that is found abundantly on the Earth's surface in all three states. Water is really amazing stuff. Many of its unusual properties are produced by strong hydrogen bonds that cause water molecules to stick to each other and to stick to many other compounds. What most of us consider normal behaviour for water is most unusual for nearly all other substances. **Note:** If a molecule of water were the size of a baseball, a drop of water would be the size of the Earth. Water information includes the following: ▪ Water has unusually high freezing and boiling points for its molecular mass. ▪ Water is a liquid at room temperature; where similar compounds are gaseous. ▪ Water is known as the universal solvent because it can dissolve large quantities of many different kinds of substances. ▪ Water has the highest surface tension of all liquids. ▪ Water has a low viscosity (i.e., it flows easily), which doesn't change appreciably with temperature (compare to molasses, which is very viscous at low temperatures). ▪ Pure water has its maximum density at 4 °C. ▪ Nearly all substances contract when they freeze; water expands 9 percent when it changes from water to ice. It becomes less dense as it approaches its freezing point (0 °C). That's why water freezes from the top down, unlike most liquids, which freeze from the bottom up. ▪ The change in temperature of a substance when heat is added or removed is called **sensible heat** because it can be measured on a thermometer. Whenever a substance changes state, heat is added or removed without a change in temperature. This is called **latent heat**. (latent = Latin "to be hidden"). a) Except for ammonia, water has the highest latent heat of fusion (melting or freezing). b) Water has the highest latent heat of evaporation. ▪ Water is very transparent for a liquid. ▪ Increasing pressure raises the melting point of nearly all solids; increasing pressure lowers the melting point of ice.
Add your own information.

Comparing Densities of Fresh Water and Seawater

Name:

Question

How do the densities of fresh water and seawater differ?

Materials

- Information sheet on salinity
- 50 mL beakers
- a hydrometer
- a balance
- 2 L brine solution (1830 mL of fresh water and 70 g of salt)
- 2 L fresh water
- 2 L seawater

Procedure

Obtain 40 mL of each liquid and, using a hydrometer, measure the specific gravity or density of

- fresh water
- seawater
- brine solution

Return the water to the container from which it was taken.

Analysis

1. How does the specific gravity of the brine solution compare to the seawater?

2. Describe two ways of making the brine solution more saline.

3. Assuming that the total amount of salt in the oceans is constant, describe several natural processes that can change the salinity of a body of water.

4. What makes you float better in seawater than you do in fresh water?

5. Do lakes freeze before the sea? Explain why.

6. Many people have made this observation: “I went for a swim in Florida and I float better than I do in Nova Scotia” (in the sea). Suggest a reason why.

7. Give two reasons why the most dense water in the Atlantic forms near Antarctica.

8. Suggest a reason to explain why salt is being mined in the Sahara Desert.

<table>
<tr><td colspan="2">INFORMATION SHEET: SALINITY</td></tr>
<tr><td colspan="2">Name:</td></tr>
<tr><td>Salinity is defined as</td><td>Examples of salinity:
Red Sea:
Fresh water:
Dead Sea:
Brackish water:</td></tr>
<tr><td colspan="2">What do the salt and gypsum deposits in Nova Scotia tell us about our past?</td></tr>
<tr><td>Salt as a commodity? Give examples.</td><td>Reverse osmosis: a technology used for:
____
____
____
________________________________</td></tr>
<tr><td>What effect does salt have on the freezing point of water?</td><td>Give two methods of determining salinity.
1.
2.</td></tr>
<tr><td colspan="2">Note: If the oceans dried up, there would be enough salt to cover the entire planet with a layer 45 m thick.</td></tr>
</table>

Comparing Densities of Fresh Water and Seawater
Teacher Notes

Outcome

Students will be expected to

- identify, collect data, and describe the unique properties of water (OSM-3)

Background Information

SAMPLE ANSWERS

Salinity is the amount of dissolved solids in the water. The salinity of the oceans averages 3.5 % by weight. Instead of parts per hundred (%) oceanographers prefer parts per thousand (‰) (e.g., 3.5 % = 35 ‰). The salinity of the Red Sea is 41 ‰ because of high evaporation, little precipitation, and river run-off. Fresh water averages 10 ‰, while the Dead Sea has a salinity of 240 ‰. Water with a salinity of 17 ‰ is called *brackish water*. Table salt in the form of sodium and chlorine ions accounts for 87 % of the salinity of seawater. Seawater contains at least a trace of most elements found in the Earth's crust.

Throughout geologic time, the continents have uplifted and subsided, and sea levels have fluctuated. Many areas that are above sea level today were once covered with oceans. The salt and gypsum deposits of Nova Scotia attest to such a past.

Salt has always been a very valuable commodity to mankind. Its antiseptic and preservative powers have long been known. Perhaps more importantly, salt keeps our body chemistry in balance. Salt has always been used as currency, and the word "salary" is derived from the word "salt" (e.g., "to earn one's salt"). Today many tropical tribal societies still use salt as currency.

Technologies to desalinate seawater have been around for a while. Most use a process called reverse osmosis. At first, such technology could produce enough water for only a few people. Now, large ocean-going cruise ships and entire towns can be economically supplied with fresh water using this technology.

Although, in general, the properties of pure water are only slightly affected by the salinity of seawater, some are notable. The most obvious is the effect of salinity on the freezing point. Salt lowers the freezing point of water. When ice forms in seawater, the salt is extruded from the ice, leaving a more salty water beneath the ice. Consequently, seawater has no fixed freezing point. Salinity also affects the density of water. Seawater is more dense than fresh water; an increase in salinity results in an increase in density.

One direct method of determining salinity is by evaporating all the water from a sample and weighing the salt. Most salinometers measure the electrical conductivity of the water. The higher the saline, the higher the conductivity.

Another indirect method of determining salinity is by measuring the specific gravity of a sample using a hydrometer. A hydrometer measures the relative buoyancy of a liquid compared to the buoyancy of pure water. If a sample is more dense than pure water, the hydrometer will float higher (more of the hydrometer is out of the water). The reverse is also true.

The Effects of Depth on Temperature, Salinity, and Density

Name:

Question

What is the relationship between depth and each of the following: temperature, salinity, and density?

Materials

- resource books from various sources (oceanography, library resources, dictionary)
- graph paper (3 sheets)
- pencil
- pen
- ruler

Procedure

Using the data included here, and suitable graph paper, plot the following three graphs:

- Depth versus Temperature (y versus x)
- Depth versus Salinity
- Depth versus Density

Place temperature, salinity, or density on the x-axis and the depth variable on the negative y-axis since the depth is going below sea level (0 m).

The following data represent actual measurements taken at a particular location in the Atlantic Ocean.

VARIATION OF TEMPERATURE, SALINITY, AND DENSITY WITH DEPTH

Depth (m)	**Temperature (°C)**	**Salinity (‰)**	**Density (g/cm^3)**
0 (Surface)	17.6	34.8	25
100	16.9	34.2	25.2
200	11.8	34.1	26
300	9.6	34.1	26.2
400	7.7	34	26.4

600	5.9	34	26.7
700	5	34.2	26.9
800	4.4	34.3	27.1
1000	3.6	34.4	27.2

Note: Average salinity of ocean water is 3.45 parts per thousand (3.45 ‰).

Analysis of the Effects of Depth on Temperature, Salinity, and Density

1. For each of the three graphs, state the relationship between the two variables. For example, in the first graph, does temperature increase or decrease as depth increases?

2. Why do you think salinity and temperature are highest at the ocean's surface?

3. Which has the greatest effect on density, salinity or temperature? Why do you think that?

4. Do you think these experimental data were collected near the equator or far from it? Why do you think that?

5. Do you think these experimental data were collected close to the coast or far from it? Why do you think that?

6. Define:

- Halocline

- Pycnocline

- thermocline

The Effects of Depth on Temperature, Salinity, and Density

Teacher Notes

Outcome

Students will be expected to

- identify, explain, and show how ocean currents’ Coriolis effect, and thermohaline currents are related (OSM-4)

Background Information

Students should use the reference books available in the classroom to find the following definitions:

- **Halocline**—The zone of the ocean in which salinity increases rapidly with depth
- **Pycnocline**—The middle zone of the ocean in which density increases rapidly with depth, temperature falls, and salinity rises
- **Thermocline**—The zone of the ocean in which temperature decreases rapidly with depth

Identification and Location of Major Global Surface Currents

Question

Where are the major global surface currents?

Materials

- world map
- paper
- pencils
- red and blue coloured pencils
- information sheets

Procedure

The ocean surface currents are primarily wind driven and reflect the global wind patterns. In general, surface currents are relatively shallow and fast flowing and mainly affect the surface of the oceans. Surface currents form large elliptical cells of circulation called gyres.

1. Fill in your information sheets using various resources.

INFORMATION SHEET: CURRENTS	
Ocean bottom currents	Atmospheric and oceanic circulation
The Gulf Stream	Global wind patterns
Coriolis effect	

[insert page-size graphic of world map; labelling the continents and oceans]

2. On a world map, label the following by name. You can use the resources in the classroom to help you label these.

North Atlantic Current	East Australian Current
North Equatorial Current (Atlantic)	Canary Current
South Equatorial Current (Atlantic)	Gulf Stream
West Wind Drift	North Equatorial Current (Pacific)
California Current	South Equatorial Current (Pacific)

3. Outline the warm-water currents in red. Outline the cold-water currents in blue. Add more if you wish.

Identification and Location of Major Global Surface Currents

Teacher Notes

Outcome

Students will be expected to

- identify, explain, and show how ocean currents' Coriolis effect, and thermohaline currents are related (OSM-4)

Materials

- atlases
- access to the Internet (optional)

Background Information

INFORMATION SHEET: CURRENTS—SAMPLE NOTES

Ocean bottom currents

- Thermohaline currents result from changes in the densities of different water bodies.
- The surface currents mainly affect the upper water column and there is little vertical mixing.
- The water slowly moves from surface to bottom.
- Slow, gradual churning brings life-giving oxygen to the fauna of the abyssal floor.
- The Atlantic has two main sources of thermohaline currents: North Atlantic bottom water and Antarctic bottom water.
- ______________________________

Atmospheric and oceanic circulation

- The atmosphere and the oceans of the Earth are in constant motion.
- Global patterns of wind and ocean currents exist.
- Factors such as the distribution of the continents and oceans have a significant effect.
- Seasonal changes in the sun's declination produce variations.
- The atmospheric and oceanic patterns of the southern hemisphere mirror those in the northern hemisphere, being similar in shape but opposite in direction.
- ______________________________
- ______________________________
- ______________________________

The Gulf Stream

- First reported in 1513 by Antonio Alaminos while serving as chief pilot for Juan Ponce de Leon.
- Fastest major surface current on Earth.

Global wind patterns

- Uneven heating of the Earth's surface produces three large cells of atmospheric circulation in both the northern and southern hemispheres.
- This region is the intertropical convergence

INFORMATION SHEET: CURRENTS—SAMPLE NOTES

- Tropical: clear, blue, nutrient-poor, and hot water.
- Spawns huge eddies of tropical water called warm rings. These warm rings are several hundred kilometres wide, tracked by infrared satellites.
- ______________________________
- ______________________________
- ______________________________

Coriolis effect

- First described by Gaspard Gustave de Coriolis in 1844.
- An apparent deflection in the paths of objects moving over the Earth.
- This force is a result of the spin of the Earth.
- In the northern hemisphere, the Coriolis effect causes high pressures to rotate clockwise and low pressures (storms, hurricanes) to rotate counterclockwise.
- The opposite is true in the southern hemisphere.
- The Earth spins fastest at the equator and proportionally slower toward the poles.
- ______________________________
- ______________________________

zone.

- The great rain forests of the Earth are associated with this zone.
- A high pressure area of fair weather and light winds is known as the "horse latitudes."
- The world's great deserts are associated with this region.
- Most of the air descending over the horse latitudes is drawn toward the equator, forming the trade winds.
- The Bermuda-Azores high intensifies in summer, strengthening the trade winds.
- The Icelandic low intensifies in winter, strengthening the westerlies.
- All of the global winds are influenced by the Coriolis effect.
- Although the intertropical convergence zone migrates north and south with the seasons, it is never found south of the equator in the Atlantic Ocean.
- Hurricanes form only in the North Atlantic.
- ______________________________
- ______________________________

Surface Currents of the North Atlantic

Questions

- What currents exist on the surface of the North Atlantic?
- Explain ocean currents.

Materials

- access to the Internet (optional)
- atlases

Procedure

Research and display information about the surface currents of the North Atlantic.

INFORMATION SHEET: OCEAN CURRENTS

Surface Currents of the North Atlantic

Teacher Notes

Outcome

Students will be expected to

- identify, explain, and show how ocean currents' Coriolis effect, and thermohaline currents are related (OSM-4)

Materials

- atlases
- access to the Internet (optional)

Background Information

INFORMATION SHEETS: OCEAN CURRENTS
▪ Primarily wind driven. ▪ Reflect the global wind patterns. ▪ Surface currents are relatively shallow and fast flowing. ▪ Surface currents form large elliptical cells of circulation called gyres. ▪ Two broad currents that flow from Africa toward South America: the North and South Equatorial currents. ▪ As the North Equatorial Current approaches South America, it veers northward toward Florida. ▪ Most of the South Equatorial Current veers southward. ▪ The bulge of South America causes part of it to flow into the Caribbean, eventually joining the North Equatorial Current to form the Gulf Stream. ▪ Some of the North Atlantic current curves poleward and warms the shores of Scandinavia, Iceland, and even Greenland. ▪ The East Greenland current rounds Cape Farewell and creeps up the West coast of Greenland. ▪ The large subtropical gyre of the North Atlantic is like a huge whirlpool. ▪ Near its centre, large rafts of floating seaweed form the Sargasso Sea. ▪ Sargassum, or gulfweed, is a marine alga.

Adrift on the Gulf Stream

Question

How are these words related?

Materials

- atlases
- research access video
- *Adrift on the Gulf Stream* video (22801)

Procedure

Watch the video. Write a few sentences connecting each word to the next. Continue this process until all the words are connected.

- Columbus
- Gulf Stream
- The Welcome
- Nansen bottles
- Gyre
- Uses of Gulf Stream
- Satellite temperature probes
- Oceanographers
- Derelicts (abandoned boats)

Adrift on the Gulf Stream

Teacher Notes

Outcome

Students will be expected to

- identify and describe wave motion found in the marine environment and in everyday situations (OSM-5)

Background Information

The video *Adrift on the Gulf Stream* (22801) is available through the Media Library at Learning Resources and Technology at lrt.EDnet.ns.ca. The program describes the course of the Gulf Stream gyre in the North Atlantic Ocean. This gyre carries more heat from the tropics to the North Pole than any other current, affecting climate in Europe and weather along the North American coastline. Twenty-first-century oceanographic instruments are increasingly sophisticated. Scientists now use instruments such as expendable bathythermographs, which radio temperature readings to ships; inverted echo sounders and acoustic tomography transceivers, which measure sound waves to determine water movement; and satellites to read ocean-surface heat, wind patterns, and biological productivity. With the data these instruments collect, we are beginning to understand the ocean—its depth, its life, and its movement.

Wave Properties

Question

What are the basic wave characteristics that are common to all types of waves?

Procedure

1. Fill in with appropriate information.

<table>
<tr><td colspan="2">CHARACTERISTICS OF WAVE MOTION
Name:
Characteristics are the same for water waves, light waves, and sound waves.</td></tr>
<tr><td>Types of waves
1.

2.</td><td rowspan="2">Frequency and wave speed
▪ Waves of high frequency will have ...
▪ Waves of low frequency will have ...
▪ The universal wave equation is ...
▪ ______________________________
▪ ______________________________</td></tr>
<tr><td>What happens to the wave when it meets a
▪ rigid medium?
▪ new medium?
▪ ______________________________</td></tr>
<tr><td colspan="2">When a wave passes into a new medium, what happens to its wavelength? its frequency?</td></tr>
</table>

Materials

- a Slinky
- small piece of string
- coil spring
- metre sticks
- stopwatches

Procedure

2. Follow the instructions for each section to discover the wave characteristic that is outlined for each section. Answer the questions for each section.

TRANSVERSE AND LONGITUDINAL WAVES

While one student holds one end of the Slinky, stretch it along the floor until it is about 0.75 m long. Practise shaking the end of the Slinky sideways until a clear pulse moves along its length. Several pulses together will form a transverse wave train. Notice the direction in which the pulses travel and the direction in which the coils of spring move.

- Describe the transverse wave and give two other examples of transverse waves.
- Record your results in picture and written formats. Compare and contrast transverse and longitudinal waves.

The speeds of all waves of the same kind in a given medium are the same.

Generate a transverse pulse in the coil. Keep the stretch in the coil constant. Find the speed of the pulses. Do they seem to travel at the same speed? Now, generate another series of pulses but make them larger or smaller than the previous set. Try to estimate the speed of the waves in this pulse. Do they seem to be travelling at a constant speed?

- Determine the speed of the waves in the Slinky using the metre stick and stopwatch. Do they seem to be moving at a constant speed?

WAVELENGTH AND FREQUENCY

Shake the spring back and forth rapidly to generate wave trains in the spring. The wavelength of a wave in the spring is the distance from a crest on one side of the spring to the next crest on the same side. The frequency of the wave is the same as the frequency at which you shake the spring. Try shaking the spring regularly but slowly and then regularly but rapidly. Observe the wavelength of the waves.

- Compare the wavelengths of high-frequency and low-frequency waves.
- The speed of any wave in any medium is equal to the frequency of the wave times its wavelength ([***insert graphic: wavelength.eps***]). All the waves that were generated in the spring travel at the same speed. Compare the types of wavelengths.

INTERFERENCE WAVES

Practise sending pulses from both ends at the same time. Try this and closely observe the pulses when they come together and also after they pass through one another. Try pulses of the same and different shapes.

- What happens when they pass each other?

Reflected Waves

Investigate how to make reflected waves. Record your results.

Water Motion in a Wave

Hold the free end of a rope that is tied to a post and make a wave. It is the wave, not the rope, that leaves your hand and travels to the post. Similarly, when a wave travels through water, the water molecules are temporarily disturbed but they return to their original position once the wave has passed. A wave transfers energy, not matter.

The water molecules travel in circular orbits, and the diameter of the orbit of the surface molecules is equal to the wave height. The diameter of the orbits decreases in size with depth until there is no disturbance caused by the surface wave. This point is termed **wave base** and has a depth of about half a wavelength.

In theory, the water molecules return to their original point of departure; however, in reality, they drift slightly downwind with each passing wave. This is called a **wave-drift current**.

As a wave enters shallow water, the motion of the water molecules is affected. The waves decrease in wavelength, slow down, and bunch up. The wave height decreases at first but then increases quickly. If the ratio of wave height to wavelength exceeds one to seven, the wave will become unstable and break.

The size of a wind wave depends on three factors:

- **Fetch**—the total uninterrupted distance the wind has blown over
- **Intensity**—the strength of the wind
- **Duration**—the total time the wind has been blowing

As each of these factors is increased, the size of the wave will also increase.

Wave Properties
Teacher Notes

Outcome

Students will be expected to

- identify and describe wave motion found in the marine environment and in everyday situations (OSM-5)

Background Information

<table>
<tr><td colspan="2">INFORMATION SHEET: WAVE PROPERTIES</td></tr>
<tr><td>Wave Constituents

▪ Crest—the highest point of a wave
▪ Trough—the lowest point of a wave
▪ Wavelength—the distance between two adjacent crests or two troughs
▪ Wave height—the vertical distance between a crest and the next trough
▪ Wave period—the time it takes for two successive crests or troughs to pass through a point (measured in seconds)
▪ Wave frequency—the number of waves passing through a point in a second

Question: What happens to the pitch of a singer's voice when you turn up your MP3 player?

Answer: No change to the pitch; the sound is louder.</td><td>Diagram</td></tr>
<tr><td>Description of Water Motion in a Wave

▪ A wave transfers energy, not matter.
▪ Water molecules travel in circular orbits.

Example: Hold the free end of a rope that is tied to a post. Make a wave. What happens?</td><td>The size of a wind wave depends on

▪ Fetch—the total uninterrupted distance the wind has blown over
▪ Intensity—the strength of the wind
▪ Duration—the total time the wind has been blowing</td></tr>
<tr><td>Seismic Sea Waves

▪ Tsunamis
▪ Caused by the movement of the Earth's crust
▪ Mainly occur in Pacific Ocean
▪ Examples: 1883, 1946, 1964, 2005</td><td>Ocean Waves

The surface of the ocean is usually affected by waves of different periods, travelling in different directions. The wave with the longer wavelength will overtake and pass through the shorter, slower waves. A wave can pass through another wave and</td></tr>
</table>

INFORMATION SHEET: WAVE PROPERTIES	
	come out basically unaffected. However, when the two crests coincide, a new, higher crest is formed—but only temporarily. The superimposition of two waves passing through each other can produce a very large freak wave called a "rogue wave." Given the right conditions, a combination of waves can form a temporary crest that is four times the average height of the waves. Such rogue waves could be responsible for the disappearance of large ships.

Waves, Beaches, and Coasts

Question

How are waves, beaches, and coasts related?

Materials

- video graphic organizer
- *Waves, Beaches, and Coasts* video (23449)

Procedure

Watch the video. Fill in information on your sheet.

[insert graphic: Waves-Beaches.eps]

Waves, Beaches, and Coasts
Teacher Notes

Outcome

Students will be expected to

- identify and describe wave motion found in the marine environment and in everyday situations (OSM-5)

Background Information

The video *Waves, Beaches, and Coasts* (23449) is available through the Media Library at Learning Resources and Technology Services at http://lrt.EDnet.ns.ca. The program demonstrates the effects of waves on coastal landforms. It would be a good introduction to a discussion of waves.

All about Tides

Questions

- What are the different types of tides?
- How are tides created?

Procedure

In groups, discuss tides and record your information.

<table>
<tr><td colspan="2">ALL ABOUT TIDES

Name:</td></tr>
<tr><td>What causes tides?</td><td>Types of Tides
lunar
solar
semidiurnal
spring
neap
slack</td></tr>
<tr><td>Explain: “eccentricity of the Moon’s orbit and the Earth’s tide”</td><td>Tidal Wave

Imagine the whole North Atlantic Ocean as a basin full of water. As you are lifting one side of the basin, slowly lean forward to create a wave system that rotates in a counterclockwise manner as if you were panning for gold. Every 12 h 25 m this tidal wave sweeps around the North Atlantic.

Tidal Stream

If you anchored a boat in the open ocean, which was only subjected to the motion of tides, the boat would not only rise and fall, but also revolve around the anchor once every 12 h 25 min. This model obviously excludes all other factors such as wind, waves, and surface currents. The tidal stream is a current produced by action of the tides.

Tidal Bore

A tidal bore is a rushing wall of water caused by the flood tide. The two main factors that produce a bore are a tidal range of at least 6 m and a funnel-</td></tr>
</table>

	shaped river mouth. Bores happen in many places: Asia, France, England, the Amazon River, and the Bay of Fundy.
Terms ▪ standing wave ▪ progressive wave	

Notes

1. The greatest tidal range in the world (16.3 m) was recorded at Burntcoat Head, Cobequid Bay, in the Bay of Fundy.

2. The Bay of Fundy's natural rhythm is in phase with the pulse of the tides. So, every 12 h 25 min the tidal wave scoots up the bay, and the slosh at its head produces some of the highest tides in the world. The mass of water is so great that the crust of the Earth depresses and uplifts with the cadence of the tides.

3. The largest bore in North America is the bore of the Petitcodiac River near Moncton, New Brunswick. Its maximum height of a couple of metres is in no way comparable to the awesome tidal bores of the Fu-Ch'un River, China, and the Amazon River, Brazil.

METEOROLOGICAL EFFECTS

Tides tables do not take into account the effect of weather on the tides. High pressures will depress sea level, and the tides will not rise to the predicted height. Low pressures will have the opposite effect. More importantly, prolonged, strong onshore winds coupled with a low barometric pressure can produce large storm surges. Maximum surges in Atlantic Canada are about 2.5 m. Along the coast the storm surges of hurricanes usually account for more damage than the damage produced by the strong winds. The wind also affects the strength and duration of the tidal stream.

All about Tides

Teacher Notes

Outcome

Students will be expected to

- identify and describe tide theory and types of tides (OSM-6)

INFORMATION SHEET: ALL ABOUT TIDES	
	Definition
▪ High water	The highest point of an individual tide (high tide).
▪ Low water	The lowest point of an individual tide (low tide).
▪ Tidal range	The vertical difference (in feet or metres) between a high water and the succeeding low water; the rise and fall of the tides.
▪ Perigee	The point on a satellite's orbit closest to a planet (Greek: around Earth).
▪ Apogee	The point on a satellite's orbit farthest from a planet (Greek: away from Earth).
▪ Aphelion	The point on a planet's orbit farthest away from the sun. The Earth is at aphelion in early July (Greek: away from sun).
▪ Perihelion	The point on a planet's orbit closest to the sun. The Earth is at perihelion in early January (Greek: around sun).

Touched by the Tide

Name:

Question

What is affected by the tides?

Materials

- *Touched by the Tide* video (23161, V1048)

Procedure

Watch the video and record information in the chart provided. Discuss as a group.

[insert full page graphic: Tide.eps]

Touched by the Tide
Teacher Notes

Outcome

Students will be expected to

- identify and describe tide theory and types of tides (OSM-6)

Background Information

The video *Touched by the Tide* (V1048/23161) is available through the Media Library at Learning Resources and Technology Services http://lrt.ednet.ns.ca. The waters of the Bay of Fundy rock back and forth, pushed into continual motion by the twice daily pulse of the Atlantic tide. The result is the highest tides in the world and a diversity of shoreline habitats that support a wonderful array of plant and animal life. Near the mouth of the bay, upwelling currents create marine pastures, which attract great whales. Puffins and razorbills nest on rocky islands. In upper parts of the bay, there are broad expanses of red mud flats, which are surprisingly productive feeding areas for shorebirds and fish. Tidal bores force their way up rivers, reversing the flow of water and conducting schools of fish toward freshwater spawning areas. Fundy's salt marshes were once the largest in Canada, but most have been diked for agricultural use. Fundy's marshes, mud flats, and rivers have provided harvest for the region's human populations, from the Mi'kmaq on through 350 years of European settlement.

Reading Tide Tables

Questions

- What is a tide table?
- What types of information can be obtained by reading a tide table?

Material

Canadian Tide and Current Tables

Procedure

Select the reference port closest to your school. Your group will be assigned a particular month of the year. Graph the heights of tides (m) for that month: *x*–axis: days of the month (1 to 31); *y*–axis: the heights of tides; for 0 (chart datum) to the maximum height of tide in your area.

Tide Rise or Fall—Rule of twelfths

1st hours's rise or fall = 1/12 of range

2nd hour's rise or fall = 2/12 of range

3rd hour's rise or fall = 3/12 of range

4th hour's rise or fall = 3/12 of range

5th hour's rise or fall = 2/12 of range

6th hour's rise or fall = 1/12 of range

Example: If high water is 6.0 m and the following low water is 0.0 m, how much will this tide fall below high water in 2 hours.

Range: 6.0 m

In the first hour tide falls 1/12 of 5.0 m = 0.5 m

In the second hour tide falls 2/12 of 5.0 m = 1.0 m

Total = 1.5 m

Reading Tide Tables

Teacher Notes

Outcome

Students will be expected to

- identify and describe tide theory and types of tides (OSM-6)

Background Information

Canadian Tide and Current Tables can be purchased from marine supply stores, most commercial bookstores, or a government bookstore. This book gives yearly predictions by month. Select the reference port closest to your school. Assign each student a particular month of the year. Graph the heights of tides (m) for that month: x–axis: days of the month (1 to 31); y–axis: the heights of tides; for 0 (chart datum) to the maximum height of tide in your area.

Fisheries and Oceans Canada and the Canadian Hydrographic Service co-sponsor a website that gives tide information for periods of time from 3 to 30 days. You may wish to talk about how to read tide tables.

Marine Biome

Introduction

This topic is an exploration of the marine biome from a broad, holistic ecosystem perspective. Connections between and within the natural environment, including human interactions, are emphasized through various activities.

Initially, ocean life is approached from a global perspective emphasizing the vastness and dynamic nature of the marine biome and its connection to freshwater systems. The focus is then narrowed to a local perspective, emphasizing that interactions occurring at a global scale also occur at the local level. Students will analyze how a coastal area functions in time (daily, seasonal) and space, considering biotic (trophic levels, etc.) and abiotic factors (temperature, salinity, currents, etc.). The majority of time in this topic is spent on close examination of a local ecosystem. A field trip to a local coastal area (rocky beach, sandy beach, mud flat, or salt marsh) provides students with an opportunity for primary data collection and analysis as well as reflection of their own connections to the ocean. The life history and structural and behavioural adaptations of a few representative organisms from different trophic levels are studied.

The marine biome is explored from a broad ecosystem perspective. Various activities are done to explore this topic and the connections to the ocean.

In Nova Scotia, every school is near a body of water. A field trip is critical to seeing, doing, and thinking about the sustainability of our environment.

Materials

- beakers (500 mL, 750 mL)
- charcoal
- clipboard
- cotton balls
- crayfish
- dichotomous classification key
- dissecting tools
- dissecting tray
- filter paper
- jars with "pollutants"
- large funnel
- magnifying glass or dissecting microscope
- nylon mesh
- pen
- plastic apron
- plastic gloves
- resealable plastic bag (large)
- ring stand
- rubber bands
- sand
- several species of North Atlantic fish, real or diagrams, numbered for identification
- stirring stick or rod
- water

Marine Communities Project

Name:

Question

What sorts of communities do marine organisms form?

Procedure

Organisms are distributed throughout the marine biome in specific communities—groups of interacting producers, consumers, and decomposers that share a common living space. The location of each community and the types of organisms that make up this community depend on the physical (abiotic) and biological (biotic) characteristics of that living space.

Communities are dynamic, adjusting and adapting as their residents respond to environmental fluctuations. The relative number of species and individuals in a community depends in part on whether their environment is relatively easy and free of stressors or relatively hard and full of potential limiting factors.

Your job as a group of marine biologists is to choose one of the predominant marine communities listed below, research this community, and present your findings to your fellow marine biologists (your classmates). Be creative with your presentation. In groups of three or four, choose a marine community and inform your teacher of your choice.

The marine communities are the following:

- Rocky shore intertidal
- Rocky shore subtidal
- Mud flat
- Estuary
- Deep sea floor
- Hydrothermal vent
- Sandy beach
- Cobble beach
- Salt marsh
- Mangrove forest
- Open ocean
- Coral reef

Your group research and presentation must include the following terms.

- abiotic
- adaptation
- aphotic
- autotroph
- biomass
- biotic

- carnivore
- carrying capacity
- commensalism
- community habitat
- competition
- consumer
- decomposer
- ecosystem
- efficiency
- fauna
- flora
- food web
- food chain
- food pyramid
- herbivore
- heterotroph
- human impact
- interconnected
- mutualism
- niche
- nutrients
- parasitism
- photic
- pollution
- population
- predation
- producer
- productivity
- run-off
- scavenger
- sewage effect
- symbiosis
- trophic level

Give examples where appropriate as well as diagrams and sketches.

Marine Communities Project

Teacher Notes

Outcome

Students will be expected to

- explain the marine biome and describe the biodiversity of ocean life and determine interconnections that exist within the marine biome (MBIO-1)
- compare representative marine organisms and communities (MBIO-2)

Background Information

Allow 150 minutes of class time for this project (90 minutes to research and 60 minutes to present). This project can be assigned at the beginning of the unit and come due at the end of the unit.

Give time for research, and then you can use the small amounts of time that are occasionally left before you start a new activity for your students to work on their presentations. This activity builds the bridges for students as they begin to understand that the ocean is made up of many different communities that exist in harmony. If a stress is introduced to one community, it may have an effect on other communities. Everyone (organisms in the ocean, local residents, organizations) plays an important role in their local ocean community and can have an impact on this community whether they choose to or not.

Marine Biome Size and Productivity

Questions

- How large is the marine biome compared to the terrestrial biomes?
- How large is the productive part of the ocean in relation to the size of the total biome?

Procedure

As you complete the steps of the activity, fill in the chart included with your instructions. Follow each step carefully. In groups of two, one group member is to be responsible for the apple, the other for the paper plate. All members of the group are to fill in their own charts.

THE EARTH AS AN APPLE

Cut an apple into four quarters.

Three of the quarters represent the world's water and, therefore, are not available for agricultural purposes.

Take the remaining quarter, which represents the Earth's land surface, and divide it into four pieces. You will now have four pieces, each of which represents 1/16th of the Earth's surface. Three of these should be discarded, since they represent the land that is too cold, too mountainous, too dry, too wet ... for agriculture.

Take the remaining 1/16th of the apple and divide it into two pieces, each one representing 1/32nd of the Earth's surface.

Discard one of these. This is the land that has already been converted for urban land uses or for infrastructure uses (transportation), and it also includes the land that may not support agriculture except for very extensive uses (land that is too rocky, too dry, or with soil too poor to support agricultural uses).

Remove the peel from the remaining 1/32nd. This represents that magical 8–12 inches of topsoil that is available for agricultural production.

Apple Representation

Portion of Paper Plate or Apple	What the Section Represents	% of the Whole Earth
Entire apple	The Earth	100% or 1/1
1/4 apple	The land	
3/4 apple	The ocean (approximately)	
1/8 apple and ½ remaining apple	Unproductive region of ocean + 1/2 of leftover apple from 1 and 2	

Portion of Paper Plate or Apple	What the Section Represents	% of the Whole Earth
4 × 1/32	Four major upwelling areas of the ocean	
1/96	Surface ocean waters that allow light penetration—photic zone	
3 × 1/96 = 1/32	Most productivity of ocean occurs here. Humans live right next to these areas.	

Analysis

1. What did the relative size of these important areas show you about the places on our planet that are the most susceptible to human damage?

2. What do you feel was the purpose of this exercise?

3. What can you do to preserve this area that is close to you?

Marine Biome Size and Productivity
Teacher Notes

Outcome

Students will be expected to

- explain the marine biome and describe the biodiversity of ocean life and determine interconnections that exist within the marine biome (MBIO-1)

Background Information

Many terms that are part of the Marine Communities Project your students are working on will be unfamiliar to them and are introduced in the following notes. Food chains and webs are the basic foundation for the marine biome, and a good understanding of these concepts is important. Feeding or trophic relationships are reviewed here—most students will have encountered these terms in Science 10. You can look at abiotic factors affecting marine life here as well as biotic factors.

The marine biome is the largest biome on the planet. It covers approximately 71 percent of the Earth's surface. It varies in depth to more than 11 km. Dissolved minerals make up 3.5 percent of the sea water solution, and most of this (2.7 percent) is common salt or sodium chloride (NaCl). About 97 percent of our planet's water is found in this biome.

Biologically, this is the planet's most important biome. More than 90 percent of all photosynthesis occurs here, and 95 percent of all organisms live here. The marine biome moderates the climate of the Earth, which prevents extreme surface temperatures from occurring. Water that evaporates from the ocean surface provides the rain that falls on land. (Why is this rain fresh, not salt water?)

Terrestrial life is made possible because of this biome. The ocean even maintains the proper concentrations of atmospheric gases such as oxygen and carbon dioxide. Our oxygen-rich atmosphere may have been produced by the first marine algae some 3.5 billion years ago. Many scientists also believe that life began in this biome and eventually evolved to live on land.

The simplest imaginable feeding relationship, one in which each species eats only one species of prey and is eaten by only one species of herbivore, omnivore, or carnivore, is termed a **food chain**. The marine biome is much more complex than this and has many interconnected food chains combined to form a **food web**. Many typical food chain diagrams are available. Present several to students for examination and discussion. Because of the great diversity of life that exists in this biome, the interactions between living things and their non-living environment are complex and varied. One type of interaction is a feeding, or **trophic**, relationship. Many trophic relationships can be explained in terms of **trophic levels**, which are arranged in **trophic pyramids** or **food pyramids**, to show the relative **biomass levels** (total mass of all organisms at each level). The number of organisms at the bottom of the food pyramid is very great, and this number of individuals decreases significantly as you move up through the other trophic levels. The relative size of the individuals are extremely small at the lower trophic levels but get increasingly larger as you go up through the trophic levels. Have students design a trophic food pyramid.

In the trophic pyramid, the first level is composed of phytoplankton. These are small, floating, plant-like organisms that are capable of photosynthesis. Phytoplankton are called **primary producers**, or **autotrophs**. The second level is composed of zooplankton, another type of small, floating organisms. Because they are not capable of photosynthesis, they must feed on other organisms (phytoplankton) in order to survive. Many zooplankton are called **primary consumers**, or **heterotrophs**, or **herbivores**.

The next levels comprise increasingly larger organisms but fewer in total number. They are called **secondary consumers**. They are also heterotrophs but can also be called **carnivores** (meat-eaters) and **omnivores** (eat both meat and plants). Secondary consumers feed on primary consumers—small fish and larvae eating zooplankton. This continues until the top consumers (or top carnivore) are reached. The top carnivore is an organism that usually does not have an organism that preys upon it.

A trophic pyramid or food chain is a very simplified way of looking at a specific feeding relationship. This simplification can lead to the misconception that phytoplankton are eaten only by zooplankton, or that one kind of fish eats only one other kind of fish. However, in the ocean, many individual food chains interconnect to form complex food webs. Most organisms in the marine biome eat a variety of foods. Have students pick a particular fish, such as herring, and draw a food web that traces the specific feeding relationship to the adult stage.

Freshwater or Marine—What's the Difference?

Name:

How are freshwater ecology and marine ecology alike?
How are freshwater ecology and marine ecology different?
Write a statement to compare and contrast the two types of ecology.

Freshwater or Marine—What's the Difference?
Teacher Notes

Outcome

Students will be expected to

- compare characteristics of the open ocean and coastal zones referencing terms and impact on local ecosystems (MBIO-3)

Background Information

SAMPLE NOTES

FRESHWATER	MARINE
▪ Inland fresh waters of the Earth represent less than 1 percent of the world's water. ▪ Includes lakes, ponds, streams, rivers, and wetlands. ▪ Estuaries are also considered freshwater environments. ▪ Extent and types of animal and plant life found in fresh water are dependent on the size of the body; the depth, velocity, and temperature of the water; the climate of the area; and often the surrounding human activities. ▪ Animals in freshwater habitats include beaver and otters, along with a wide variety of fish. ▪ Freshwater plants include those that grow in shallow water (often called *wetlands*) and along the water's edge. ▪ ______________________________ ▪ ______________________________ ▪ ______________________________ ▪ ______________________________	▪ More than 70 percent of the Earth is covered by oceans, which are rich with animals and plants. The majority of life exists above a depth of 200 metres, and most of it is sustained by animal and plant life forms called plankton. Plankton thrive on the recycled nutrients locked in the bodies of dead animals, and released by bacterial action. Upwelling currents, wind-driven waves, and storms bring the nutrients to the surface. ▪ The marine environment includes the tidal zone, shallow water, and the deep ocean. ▪ In the *tidal zone* (or shoreline) community, various animals and plants have adapted to the daily ebb and flow of the tides. They have adapted to different types of shorelines, such as sandy or rocky. ▪ *Shallow water* marine environments may often be the sites of coral reefs, which are communities of simple colonial organisms called *polyps*. ▪ It is estimated that coral reefs support many of the world's fish species and possibly close to one million animal species in total. But there are also many organisms that keep the reef going. ▪ The coral reef is able to support such a diversity of life because of plentiful food, hiding places, and shelter. All the creatures in the reef are members of the reef's extensive food chain—a self-sustaining, natural recycling system. ▪ Variety of species is not the same at all coral

	reefs, and certain species can only be found in specific locations. ▪ In the deep ocean, beyond the continental slope and rise, the little or no sunlight means that organisms must have special adaptations to survive. ▪ The abyssal zone is home to many unusual species, the most rare of which is the coelacanth (pronounced “seel-uh-kanth”). ▪ • ______________________________ ▪ • ______________________________ ▪ • ______________________________

Marine Regions of Canada

Question

How do the marine regions of Canada differ from coast to coast to coast?

Background Information

There are five distinct marine regions surrounding Canada:

- the Pacific Marine
- the Arctic Archipelago
- the Arctic Basin
- the Northwest Atlantic
- the Atlantic Marine

Using a map of Canada, indicate the regions.

MARINE REGIONS OF CANADA: SAMPLE NOTES	
The Pacific Marine ▪ Located along the Pacific coast of British Columbia. ▪ The coastal edge of the region is predominantly heavily forested mountains with numerous fjords. ▪ Famous for undersea volcanoes and earthquakes caused by the geological forces of the terrestrial tectonic plate sliding over the Pacific plate. ▪ Water temperatures of the Pacific Marine area vary only about 7 °C over the entire year, making it a transition zone between the cold Arctic waters and the temperate waters of the mid-latitudes of the Pacific Ocean.	**The Arctic Archipelago** ▪ Stretches eastward from Mackenzie Bay in the Beaufort Sea, following the northern continental shelf around Baffin Island, and then southward to include Hudson Bay and James Bay. ▪ Known for various states of sea-ice cover: icebergs, some areas of year-round ice, polynyas (areas of open water surrounded by sea ice), glacier edges. ▪ Daylight extremes: the short cool summers of the Land of the Midnight Sun to the long, cold, dark winters with almost no daylight at all. ▪ Range for seabirds and water fowl, seals, bowhead and beluga whales, and polar bears.
The Arctic Basin ▪ Constitutes Canada's most northerly jurisdiction. ▪ Covered with 90–100 percent pack ice, the giant ice cap floating on the ocean and slowly rotating in a counterclockwise pattern roughly centred around the North Pole. ▪ Almost no tides in this area. ▪ Extremely cold and dry. ▪ Mammals that can survive the harsh climate (walrus, polar bears, whales, seals).	**The Northwest Atlantic** ▪ Along the eastern coast of Canada to include the west and northeast coast of Newfoundland and the Gulf of St. Lawrence. ▪ Follows the continental shelf offshore from Davis Strait to the Avalon Peninsula in Newfoundland. ▪ Fjords, cliffs, bald rocks, and over 400 000 islands offshore. ▪ Tidal fluctuations can range from 9 to 12 metres in some parts of the area.

▪ Feeding grounds of algae and phytoplankton blooms along the edges of pack ice and polynyas.	▪ Major ocean currents through this region: the Labrador Current brings cold water from the north, the Gulf Stream brings warmer waters from the south. ▪ Provides shelter and food for mussels, lobster, and crab.
The Atlantic Marine ▪ Contains two important fishing areas: the Grand Banks and the Scotian Shelf. ▪ From the Davis Strait into deep water out along the Labrador Shelf and around the Flemish Cap Seamount, around Newfoundland and back to Nova Scotia and the Bay of Fundy. ▪ The Grand Banks are among the most biologically productive marine areas in the world due to the confluence of the Labrador Current and the Gulf Stream on the shallows of the continental shelf.	**Analysis** 1. Compare the adaptations you would expect to see in organisms that live in the Arctic Archipelago to inhabitants of the Northwest Atlantic region. 2. How would features of marine physiography affect on the composition of the biological communities in each of the five regions? 3. Choose one of the organisms that lives in the Arctic Basin and explain how that particular organism functions in this habitat.

Marine Regions of Canada

Teacher Notes

Outcome

Students will be expected to

- compare characteristics of the open ocean and coastal zones referencing terms and impact on local ecosystems (MBIO-3)

Background Information

CHARACTERISTICS OF CANADA'S MARINE REGIONS

Atlantic Marine: Sample Notes	
Landforms	Large southern shelf areas (Grand Banks, Scotian Shelf) as well as the Northwest Atlantic Ocean basin.
Surface materials	Generally ice free except for local pockets of landfast ice and some years of seasonal ice.
Oceanographic characteristics	Includes mostly temperate water masses originating from the south; Gulf Stream offshore and Slope Water Current at the shelf break; mixing zone between cold lower-salinity water from the north and warmer water from the south.
Comparative productivity	A very productive area for many species.
Wildlife	Includes both neritic and oceanic species; important commercial ground fisheries occur on shelves; important commercial species include lobster, scallop, codfish, haddock, hake, pollock, redfish, halibut, mackerel, and Atlantic salmon.
Human activities	Fishing, tourism, natural gas.

Northwest Atlantic Marine: Sample Notes	
Landforms	Primarily continental shelf; generally low coastal relief.
Surface materials	Seasonal ice.
Oceanographic characteristics	Labrador Current exerts strong influence both on shelf and offshore (lower-salinity cold water).
Comparative productivity	Strongly influenced by the Labrador Current and Arctic waters.
Wildlife	Subarctic species in north to boreal species in south; important commercial species include oyster, shrimp, snow crab, haddock, hake, pollock, American plaice, codfish, halibut,

	flounder, herring, mackerel, capelin, and Atlantic salmon.
Human activities	Fishing, tourism.

Arctic Basin: Sample Notes	
Landforms	Limited to the most-northern polar-cap areas.
Surface materials	Mainly permanent pack ice.
Oceanographic characteristics	Affected by easterly winds driving a clockwise circumpolar gyre in basin; no land components.
Comparative productivity	Low biological productivity and diversity.
Wildlife	Polar bear and seals dominant mammals.
Human activities	Few, if any, activities.

Arctic Archipelago: Sample Notes	
Landforms	Limited to “shelf-type” depths; high Arctic islands, Arctic and Hudson Bay coasts; much is rocky coastline, numerous channels and straits; high coastal relief in east, low in south and west.
Surface materials	Seasonal ice; open water 2–3 months in summer.
Oceanographic characteristics	Relatively high freshwater input along northern continental boundary.
Comparative productivity	Higher productivity and abundance of life than permanent ice area.
Wildlife	Intense summer migration into region, generally following the ice-edge retreat; locally high concentrations of marine birds and mammals, including beluga, walrus, seals, polar bear.
Human activities	Oil and gas, limited fishing and hunting.

Pacific Marine: Sample Notes	
Landforms	Pacific Ocean basin and narrow continental shelf; numerous fjords.
Surface materials	Generally ice free except for local pockets of landfast ice (seasonal).
Oceanographic characteristics	General eastward-settling oceanic current (Subarctic Current) with divergence point off the shelf; pronounced seasonal upwelling in the south.

Comparative productivity	One of Canada’s most productive oceanic areas.
Wildlife	Important seasonal migrations of animals between neritic and oceanic areas; important commercial species include oyster, shrimp, five species of salmon, herring, Pacific hake, sablefish, Pacific halibut, clams, Dungeness crab, rockfish, and flatfish species.
Human activities	Fishing, tourism.

Cleaning up a Harbour

Questions

- What are some of the most effective ways to clean up dirty water?
- Can you simulate a large-scale water filtration system by devising a tabletop system that will filter out both visible and invisible pollutants from water?

WATER POLLUTION

Natural Impurities	
Category	Information
▪ suspended particles	
▪ colloidal particles	
▪ dissolved matter	
Human Activities examples ▪ heavy metals ▪ toxic chemicals ▪ oil/chemical spills ▪ untreated sewage	Effects of Polluted Water ▪ health of humans and other animals ▪ unpleasant characteristics ▪ diseases ▪ drinking water from pipes containing lead ▪ nitrates ▪ oil and hydrocarbon pollution

Materials

- jars with “pollutants”
- beakers (500 mL, 750 mL)
- water (500 mL)
- stirring stick or rod
- rubber bands
- nylon mesh
- sand
- charcoal
- cotton balls
- ring stand
- filter paper
- large funnel

Procedure

How can water be cleaned? Design an experiment to show how water can be polluted and then cleaned. What techniques could be used? What makes a cleanup of a water system effective? Fill in the chart with the pollutant represented.

Using any or all of the remaining materials, construct a filter system for the polluted water. Draw a labelled diagram of your filtration system and explain why you are using each component.

Test your filter system by emptying your polluted water into it.

Analysis

1. Would you consider your filtration system successful? Explain.

2. Were you able to remove all impurities?

3. What physical and/or chemical changes took place that would indicate that you accomplished your goal?

4. What kinds of tests could you perform on your filtered water to prove that it had been cleansed?

You may use library or community resources to find the following information.

1. Describe a water purification system that could be used in a municipal area.

2. What is your area’s main source of drinking water?

3. What kinds of tests are done on your water supply to meet health and safety standards?

4. What agency sets the criteria for safety standards?

Pollutants List

Contents of Jar	Pollutant Represented
Wood chips	
Sand	
Dry grass	
Crushed shells	
Bits of fast food containers	
Laundry detergent	
Dish liquid	
Newspaper	
Molasses	
Vinegar	
Nails	
Bits of metal	
Nylon line	
Apple juice and raisins	
Bits of toilet paper	

Cleaning up a Harbour
Teacher Notes

Outcome

Students will be expected to

- explain how a particular organism functions in its habitat (MBIO-5)

Background

Preparation time for the teacher can be extensive if you are using this activity with more than one section of students. Filling the containers takes time, and you should have a separate set for each section taught. The filtration portion of the activity involves simply setting out the equipment for the students to select.

Containers for the pollutants that work well include 50 mL beakers or empty baby-food jars.

None of the "pollutants" used is toxic, so most students should be able to handle the containers without concern. Regardless of the safety of these materials, the filtered water sample should not be consumed.

Pollutants List: Sample Results

Contents of Jar	**Pollutant Represented**
Wood chips	Construction materials
Sand	Run-off from the shore
Dry grass	Lawn clippings from houses near the shore
Crushed shells	Shellfish, food scraps from people
Bits of fast food containers	Garbage tossed into the water or washed into the water by tides
Laundry detergent	Component of waste water
Dish liquid	Component of waste water
Newspaper	Garbage tossed into the water or washed into the water by tides
Molasses	Oil from ships and factories
Vinegar	Acid from factories
Nails	Construction materials from shipyards and houses
Bits of metal	Shipwrecks, construction materials
Nylon line	Fishing boats

Apple juice and raisins	Sewage
Bits of toilet paper	Sewage

Relationships in the Ocean

Part 1: Question

What is a typical feeding relationship in the Bay of Fundy?

Procedure

Research a typical feeding relationship that could be found in the Bay of Fundy. Design a question activity that includes organisms and how they affect others, and reflections on knowledge of communities affecting each other. Your previous knowledge concerning food chains, food webs, predators, prey, and survival of a species might be useful for your resulting display.

Analysis

Display your results.

Part 2: Question

What types of organisms can be found on the beach?

Materials

- clipboard
- pen
- large resealable plastic bag
- cardstock

Procedure

As you find the organisms, you are going to create your own card.

Analysis

1. How difficult was it to identify the organisms?
2. Describe any interconnections that you observed while identifying the organisms.

Relationships in the Ocean

Teacher Notes

Outcome

Students will be expected to

- explain the marine biome and describe the biodiversity of ocean life and determine interconnections that exist within the marine biome (MBIO-1)

Part 1: Background Information

This activity is designed to give your students a first-hand understanding of the organisms and the factors that can affect them in the Bay of Fundy. You may wish to use other water areas in and around Nova Scotia.

Science 7 and Science 10 are background information that students have for typical feeding relationships. No in-depth treatment of these is needed, but the students will explain their results from their previous knowledge and experiences.

Part 2: Background Information

This activity could be part of a larger field trip activity or an activity of its own, depending on the time available.

While on the beach, samples of seaweed could be collected for the Seaweed Survey (aka Algae Analysis) activity.

Some care should be taken when handling specimens. Pollution is far too common and can be hazardous to the health.

The Anatomy of a Crayfish

Questions

- What are the anatomical features of a crayfish?
- What features of a crayfish help it function in its habitat?

Materials

- crayfish
- dissecting tools
- dissecting tray
- plastic gloves
- plastic apron
- magnifying glass or dissecting microscope

Procedure

1. Begin by examining the animals externally and note the following:

- body composed of a rigid *carapace*
- a jointed abdomen
- a large number of legs
- other appendages, including long sensory tentacles, the main claws, a complex of mouth parts, eight walking legs (the leading ones having small claws of their own), *swimmerets* under the abdomen, and a tail fan at its end; there are eyes on short stalks set in protective hollows in the carapace.

2. Break off the claws and some of the other appendages, examining how the skeleton is arranged such that simple joints between the rigid parts allow the animal considerable flexibility.

3. Open the animal by pulling the rearward edge of the carapace upward and forward to reveal

- gills attached to the tops of the walking legs
- a simple gut
- a digestive gland (equivalent to the *fomalley* of a lobster)

4. Remove the abdomen and cut away the shell with scissors. The major mass of meat inside is the crayfish's swimming muscle: contractions bend the abdomen under the rest of the body, flicking water forwards and thus propelling the crayfish backwards. This is an escape mechanism, for use when the animal is in danger.

5. Draw diagrams to identify the major parts of the anatomy of the crayfish.

The Anatomy of a Crayfish
Teacher Notes

Outcome

Students will be expected to

- explain how a particular organism functions in its habitat (MBIO-5)

Safety

Allergies and sensitivities to shellfish are fairly common, so care must be taken that students do not handle the organisms without gloves. Stress the need to thoroughly wash their hands as well as all instruments used.

Background Information

Crayfish can be obtained from biological supply houses; one per student or per pair of students will be required. The students will also need some basic dishes and minimal protective clothing. Dissecting scissors are required, though each class could share a few pairs.

Students should begin by examining the animals externally and should note the following:

- body composed of a rigid *carapace*
- a jointed *abdomen*
- legs
- other *appendages*, including long sensory tentacles, the main claws, a complex of mouth parts, eight walking legs (the leading ones having small claws of their own), *swimmerets* under the abdomen, and a tail fan at its end; there are eyes on short stalks set in protective hollows in the carapace.

They should then break off the claws and some of the other appendages, examining how the skeleton is arranged such that simple joints between the rigid parts allow the animal considerable flexibility.

Opening the animal by pulling the rearward edge of the carapace upward and forward should reveal

- gills attached to the tops of the walking legs
- a simple gut
- a digestive gland (equivalent to the *fomalley* of a lobster)

The abdomen should be removed and its shell cut away with scissors. The major mass of meat inside is the crayfish's swimming muscle: contractions bend the abdomen under the rest of the body, flicking water forwards and thus propelling the crayfish backwards. This is an escape mechanism, for use when the animal is in danger.

Students should draw diagrams to identify the major parts of the internal anatomy of the crayfish.

Follow-up Activities

Other dissections should be done. Starfish, any finfish, and bloodworms are common to Atlantic Canada and would be of interest to students. Other dissections are recommended in the Aquaculture and Fisheries units. The Aquaculture module in the Teaching Resource, Volume 2, contains an experiment on the external anatomy of an oyster. The Fisheries module in the Teaching Resource contains a lab on the external and internal anatomy of a fish.

What’s in a Name?

Questions

- How are the external features of a fish used to determine its species?
- How are scientific nomenclature and classification systems useful?

Materials

- several species of North Atlantic fish, real or diagrams, numbered for identification
- dichotomous classification key

Background Information

A dichotomous key is designed to identify various species by giving two statements (a couplet) that divide a large group of species into two smaller groups according to a particular characteristic: one that has that characteristics, and one that doesn’t. Each statement of a couplet is followed by either a number or a species name. The number directs you to another couplet. You continue to go through the couplets until only one species possesses the characteristic given, at which point you have identified an organism. The name of this organism should follow the statement. An example for the hammerhead shark is done for you on the key. Look this example over to see if you have any questions about the use of a dichotomous key. Try to identify the fish or fish sketches by using the key.

Vocabulary Words for Key	
Placoid scale	Type of scale found in cartilaginous fish such as sharks
Caudal fin	Tail of fish
Dorsal fin	Fin on the back or dorsal side of a fish
Finlets	Small fin-like growth between tail and dorsal and anal fins
Adipose fin	Small fleshy fin between the caudal and dorsal fin

Procedure

Use the dichotomous key on the next page to help you classify the species of each fish. Fill in your identification and the reasons for that identification on the worksheet that follows.

Analysis

Copy the table below, extending it for the number of species that you have to identify. After identifying your type of fish, fill in your identification and write out the sequence of steps that you followed to arrive at that identification. An example has been completed for you.

Identification	Sequence of Steps		
Example:	#1	Body like a snake?	2 (no)
Hammerhead Shark		Body not like a snake?	3 (yes)
	#3	Both eyes on the same side and body flattened?	4 (no)
		Eyes on opposite sides and body not flattened?	5 (yes)
	#5	Does the fish have placoid scales?	6 (yes)
		Does the fish not have placoid scales?	7 (no)
	#6	Does the fish have a pointed head?	Dogfish Shark (no)
		Does the fish not have a pointed head?	Hammerhead Shark (yes)

Identification	Sequence of Steps

FISH TAXONOMIC KEY		
1.	Body like a snake? Body not like a snake?	Go to 2 Go to 3
2.	Mouth beak-like? Mouth not beak-like?	**Eel** **Lampreys and Hagfish**
3.	Both eyes on the same side of body and flattened? Eyes on opposite sides and body not flattened?	Go to 4 Go to 5
4.	Tail forked? Tail not forked?	**Halibut** **Flounder**
5.	Does the fish have placoid scales? Does the fish not have placoid scales?	Go to 6 Go to 7
6.	Does the fish have a pointed head? Does the fish not have a pointed head?	**Dogfish Shark** **Hammerhead Shark**
7.	Is the fish body a full moon shaped with a little caudal fin? Is the fish body not distinctly moon shaped and has a lightly visible larger fin?	**Ocean Sunfish** Go to 8
8.	Is the fish club shaped like a baseball bat? Is the fish not club shaped liked a baseball bat?	**Wolffish** Go to 9
9.	Is there evidence of a chin barbel? Does the fish have no chin barbel?	Go to 10 Go to 13
10.	Is the caudel fin not notched or only slightly (barely) notched? Is the tail decidedly notched?	Go to 11 Go to 12
11.	Does the fish have three distinct dorsal fins? Does the fish have two distinct dorsal fins?	**Cod** **Hake**
12.	Does the lower jaw extend beyond the upper jaw? Does the lower jaw not extend beyond the upper jaw?	**Pollock** **Haddock**
13.	Does the fish have finlets? Does the fish not have finlets?	Go to 14 Go to 15
14.	Are the dorsal fins distinctly separated? Are the dorsal fins not separated distinctly?	**Mackerel** **Tuna**
15.	Does the fish have a small adipose fin? Does the fish not have a small adipose fin?	**Smelt** **Alewife**

What’s in a Name?
Teacher Notes

Outcome

Students will be expected to

- develop and report appropriate sampling procedures to obtain quantitative data on the abundance of marine organisms at a local coastal area and describe and apply classification systems and nomenclatures to organisms found in the marine biome (MBIO-4)

Background Information

For this exercise, teachers should obtain a number of fish of different species, preferably with not more than one species from any one family. These may best be obtained from a local fish market. (They can be stored frozen and then thawed, if necessary.) Alternatively, pictures or sketches of the different species indicated in the key could be provided for students to use.

The class should be rotated through the species provided, such that each student encounters each of the species once during the exercise. For each species, they should examine the external anatomy. Based on their observations, they should then identify the fish using the dichotomous key provided. To ensure that the key is used, even by students who can identify the species by sight, they are required to detail the sequence of steps they followed in the key to arrive at the identification they made of the fish.

Following the activity, it would be useful for students to receive the following notes so they will be aware of the scientific nomenclature associated with the common names they used for identifying the fish.

Fish Classification

Phylum Chordata: At some point and time during their life cycles, all chordates have four distinct structures:

- notochord
- dorsal notochord (nerve chord)
- gill slits
- tail

This phylum can be divided into Lower Chordates and Higher Chordates, depending on the level of development of the notochord.

- Lower CHORDATES
  - Subphylum Urochordata (sea squirts): Notochord is only developed in the tail
  - Subphylum Cephalochordata (lancelets): Notochord is only developed in the head

- Higher CHORDATES
  - Subphylum Vertebrata (animals with backbones)

Vertebrate classes of fish:

- **Agnatha:** Jawless fish (hagfish and lampreys)
- **Chondrichthyes:** Jawed, cartilaginous fish (sharks, rays, and skates)
- **Osteichthyes:** Jawed, bony fish (over 90 percent of all fish species)

Fish can also be subdivided based on habitat and migratory behaviour:

- **Pelagic**—fish that live offshore in the ocean water above the ocean floor (tuna and herring)
- **Benthic**—fish that live most of the time on the ocean floor (cod and flounder)
- **Anadromous**—fish that migrate from seawater to fresh water to spawn (salmon and shad)
- **Catadromous—**fish that live in fresh water and move to seawater to spawn (eels)

Marine Biomes Activity Ideas

- **Introduction:** Human interaction with marine biomes (futures wheel)

- **Discussion:** What is a marine organism? Discussion of the following may be included: Tuna? Crab? Polar bear? Seagull?

- **Discussion:** Marine biomes: Define. How many are there? What is the decision criteria?

- Marine biome group research project. This may include such topics as mud flats, mangrove forest, deep-sea floor (excluding vent community), coral reef communities, hydrothermal vent communities, and estuary (salt marsh).

- **Group discussion:** Paradox of the plankton

- Plankton experiment: perhaps phytoplankton/zooplankton examination and/or a computer simulation

- **Group activity:** Food web effects of overharvesting of wild species. May include building a food web for the Scotian Shelf or tracing the effects of large declines in cod and haddock on the rest of the members of the community.

- **Group activity:** Effects on food webs of changes in abiotic factors such as
  - Human nutrient input
  - Red tides change in occurrence over time. Causes? Predicted outbreaks?
  - Increased productivity
  - Changes in species composition
  - Global climate change
  - El Niño—Biological repercussions for marine communities

- Video *Shores of Life* (V1047/23160) may be used to illustrate diversity and to reinforce the concepts of biotic and abiotic factors

- **Model:** Set up and maintain a model ecosystem such as a commercial algal cultures (Chlamydomnas) and/or water from ocean or lake/pond.

- **Activity:** Polar/temperate/tropical open-ocean food web comparison
  - compare/contrast
    - nutrient availability (annual cycle)

- diversity
- biomass
- annual cycles in biomass/productivity

- **Activity:** Coastal/open-ocean environment comparison based on questions such as, How are they different? What causes the coastal environment to be a more productive fishing area? Why do right whales stay close to the eastern seaboard of North America?

- **Individual assignment/project:** Research on the niche of a marine species. Pick a species and do a research project on its ecological niche

- **Whole class activity (compare and contrast):** Terrestrial versus marine food webs. May include dialogue such as Joe eats a burger and Sally eats a tuna sandwich.

- **Field trip:** Nova Scotia's coastal zone is amazing, and each of our bodies of water has a coast of its own. Nova Scotia has different bodies of water close to every area. Each student should investigate a marine shoreline, draw it, list relevant happenings, make a model, and give a public report on their private science in some public presentation (class, video, poster session, etc.).

Coastal Zone

Introduction

An understanding of coastal zones is particularly important to those living in coastal regions. They are direct stakeholders in the process and outcomes of this resource and will undoubtedly participate in the process of coastal zone management at some level during the course of their lives. The protection of the oceans is an important part of Canada’s growth. Economic, recreational, cultural, and social factors are integral in the discussion of the oceans. Canada has the largest coastline in the world, so it is important to look at our coastal zones and what happens there. Stewardship is key to maintaining our waters. Other factors include coastal zone management, pollution, over-fishing, and global warming.

This module familiarizes students with coastal zones, with issues facing coastal zones, and with the integration of coastal zones. In the process, students will improve their skills in research, negotiation, debate, compromise, and tolerance.

Throughout the module, issues should be considered first at the local level and subsequently at the regional or global level as appropriate. The rationale is to capture students’ attention by dealing first with issues or topics of which they already have some knowledge and that they consider relevant. As students study these issues, they will begin to make opinions and some may state that most issues cannot be dealt with in isolation and require co-operation on a regional or global level.

Materials

- article analysis frame
- atlases (world and regional)
- bristol board
- Canadian encyclopedia
- chart
- clear tape
- Inspiration software, if available
- Internet access
- library access
- map of Nova Scotia or Atlantic Canada (unlabelled, 8 ½" × 11")
- markers
- metre sticks
- *Nova Scotia Doers’ and Dreamers’ Travel Guide*
- Nova Scotia maps (tourist and provincial)
- Nova Scotia travel brochures
- old magazines that can be cut up
- paper
- pen
- posters produced during Coastal Zone Variations in Nova Scotia
- printer access
- reference books
- roll of newsprint or flip chart paper
- rulers
- scissors
- string
- various articles or information sheets (from various sources)
- Video, *Fisheries Futures* (29 minutes) (V1728)

Defining the Coastal Zone

Questions

- What makes a coastal zone?
- What are some facts about Canada's coastlines?
- What are the subsystems in the coastal zone?

Materials

Reference books

Procedure

Discuss the topic.

Analysis

Fill in the graphic organizer on the following pages.

MARINE SUBSYSTEM **The marine subsystem consists of the oceanic component of a coastal zone. In short, it is the part that is under salt water.**		
Characteristics	Resources and Uses	Challenges

COAST SUBSYSTEM

The coast subsystem is the relatively narrow and dynamic transitional zone between the marine and terrestrial subsystems. It includes the littoral zone (between low- and high-tide marks) and the supralittoral or saltwater spray zone.		
Characteristics	Resources and Uses	Challenges

TERRESTRIAL SUBSYSTEM **The terrestrial subsystem of the coastal zone consists of land where human or other activity can affect the marine environment.**		
Characteristics	Resources and Uses	Challenges

Defining the Coastal Zone
Teacher Notes

Outcome

Students will be expected to

- discuss the concept of coastal zones and how these vary around the world (CZON-1)

Background

The definition of "integrated coastal zone" is an issue that has been debated by resource specialists, lawyers, bureaucrats, industry representatives, and community groups. The consensus appears to be that the definition of coastal zone should be a functional one. In other words, the definition used depends on the nature of the issue being addressed. For example, in matters relating to the fishery, the term "integrated coastal zone" may refer to an area extending to or beyond Canada's 200-mile exclusive economic zone (EEZ). (Recall Canada's turbot "war" with Spain.) In the case of issues related to aquaculture, a much narrower definition may suffice.

Broadly speaking, the limits of the integrated coastal zone can, depending on the situation, extend from the inland limit of coastal watersheds to the seaward edge of the EEZ. Coastal zones, then, can extend a long way inland. A terrestrial component is included to show that activities taking place within a coastal watershed can directly affect the marine environment through runoff into river systems.

The coastal region is constantly changing due to waves, currents, tides, and rising sea levels. Changes are influenced by local conditions. These conditions have been examined in the Structure and Motion unit and the Marine Biome unit.

The coastal zone is commonly considered to be composed of three subsystems, each with its own characteristics, resources, and set of problems: marine, coast, and terrestrial.

MARINE SUBSYSTEM: SAMPLE NOTES **The marine subsystem consists of the oceanic component of a coastal zone. In short, it is the part that is under salt water.**		
Characteristics	Resources and Uses	Challenges
▪ Water depth, salinity, and temperature ▪ Wave and tide regimes ▪ Water currents and sediment movement ▪ Seabed composition ▪ Diversity of marine habitat types	▪ Exploitation of fisheries ▪ Exploitation of oil and gas ▪ Exploitation for tourism and recreation ▪ Use for navigation ▪ Use for waste discharges	▪ Disturbance and destruction of habitat by fishing, mining, anchoring, dredging, and dumping ▪ Depletion of exploitable plant/animal stocks ▪ Oil spills (both disastrous shipwrecks and routine leakage)

		▪ Spatial conflicts (tourism, fishery, navigation, etc.) ▪ Deterioration of water quality due to waste discharges

COAST SUBSYSTEM: SAMPLE NOTES **The coast subsystem is the relatively narrow and dynamic transitional zone between the marine and terrestrial subsystems. It includes the littoral zone (between low- and high-tide marks) and the supralittoral or saltwater spray zone.**		
Characteristics	Resources and Uses	Challenges
▪ Type of coastal profile (sandy beach, pebble beach, rocky shore, etc.) ▪ Tidal regime and storm surge susceptibility (shoreline topography) ▪ Wind and wave regime ▪ Coastal habitat types (rocky, mud flat, etc.)	▪ Sand and gravel extraction from shoreline ▪ Exploitation for tourism and recreation ▪ Exploitation of forest resources ▪ Use for human settlement ▪ Use for land reclamation (e.g., dike construction to reclaim salt-marsh habitat for agriculture) ▪ Use for port development and related industrial activities ▪ Use for aquaculture	▪ Disturbance and destruction of coastal habitat by mining, logging, settlement, and infrastructural development ▪ Degradation and loss of shoreline due to accelerated erosion ▪ Spatial conflicts ▪ Deterioration of coastal water quality

TERRESTRIAL SUBSYSTEM: SAMPLE NOTES **The terrestrial subsystem of the coastal zone consists of land where human or other activity can affect the marine environment.**		
Characteristics	Resources and Uses	Challenges
▪ Topography ▪ Soil types ▪ Aquifer structure and groundwater resources ▪ Surface water resources ▪ Terrestrial habitats (e.g., forest, barren, wetland)	▪ Use of terrestrial resources (logging, mining, etc.) ▪ Use of freshwater resources (domestic, industrial, irrigation, hydro, and navigation) ▪ Agriculture and aquaculture ▪ Human settlement patterns ▪ Land reclamation ▪ Industry ▪ Infrastructure facilities (power plants, water treatment plants, etc.)	▪ Destruction of terrestrial habitats ▪ Transport of terrestrially generated effluents to the marine subsystem ▪ Increased susceptibility to flooding ▪ Reduction of freshwater availability and quality

Coastal Zone Properties and Structure

Questions

- What are the features of Nova Scotia's coastal zone?
- Are there coastal zones that differ substantially from those of Nova Scotia?
- What effect does the climate have on the coastal zone's structure and properties?

Materials

- reference books
- class discussion
- information sheet
- chart

Procedure

1. Discuss Nova Scotia's coastal zones, various world coastal zones, and climate factors affecting coastal zone structure and properties. Fill in your sheet with your notes.

2. Draw diagrams of a coastal zone. Think of it in three stages: before, during, and after relating it to climate. Label your diagrams. Include a brief explanation of your diagrams. Use the chart provided.

Analysis

INFORMATION SHEET

Nova Scotia's Coastal Zone	**Examples**
Various World Coastal Zones	**Examples**

Climate Factors Affecting Coastal Zone Structure and Properties	**Examples**

Coastal Zone Properties and Structure

Teacher Notes

Outcome

Students will be expected to

- describe and explain the causes and characteristics of major types of coastal zones (CZON-2)

Information Sheet

Nova Scotia's Coastal Zone	**Examples**
There are many variations in coastal zone structure and properties. Nova Scotia's coastal zone can be generally described as having the following features: ▪ Terrestrial subsystem generally has good relief—not too many areas are low lying. ▪ Terrestrial subsystem is generally rocky or composed of glacial deposits. ▪ Freshwater input comes from numerous fairly small, short rivers that do not carry large sediment loads. ▪ Coast subsystem is mainly rocky shore type with some sand beaches and relatively few marshes and estuaries (due to steep relief). ▪ Marine subsystems characterized by a wide trailing-edge type of continental shelf. ▪ Marine subsystems dominated by a mixture of the cold waters of the Labrador Current and the outflow from the St. Lawrence River near shore and influenced by the Gulf Stream out near the edge of the Scotian Shelf.	

Various World Coastal Zones	Examples
In other parts of the world, coastal zones can be found that differ substantially from those of Nova Scotia. For example: ▪ Coastal zones of some tropical areas include coral reefs. ▪ Some coastal zones have much less relief than Nova Scotia's; e.g., Holland, Bangladesh, and the Southern US (Louisiana bayous, Florida mangroves, etc.). ▪ Some coastal zones have more relief than Nova Scotia, such as the west coast of North America and South America and the Norwegian coast (fjords). ▪ Some coastal zones do not have a wide continental shelf like Nova Scotia. For example, the west coasts of Central and South America and the east coast of Japan have very narrow continental shelves that are immediately followed by a deep ocean trench (leading edge of the tectonic plate). ▪ Some coastal zones are dominated by deltas produced by large rivers; e.g., the Mississippi delta and the Nile delta. Variations in coastal zone structure such as those listed above are produced by a combination of geological and climatic factors. Geological factors affecting coastal zone structure and properties fall into two basic categories: those resulting primarily from plate tectonic activity and those resulting from continental topography, rock composition, and soil characteristics. To some degree this distinction is artificial. For example, tectonic movements affect continental topography.	

Climatic Factors Affecting Coastal Zone Structure and Properties	Examples
Climatic factors combined with ocean features such as currents and coastal bathymetric profiles can influence coastal zone structure and properties. For example: ▪ Rainfall patterns can determine the volume of freshwater input to a coastal zone, affecting the presence and size of estuaries, marshes, and so on. ▪ Wind patterns can affect the erosional forces from wind-induced waves that a coastline must endure, and they can determine its suitability for navigation. ▪ Wind-generated ocean current patterns can combine with bathymetry to produce a coastal zone in which deep, nutrient-rich water is forced to the surface (upwelling), thereby creating a very productive ecosystem and, consequently, a productive fishery. ▪ Ocean currents can affect the climate of a coastal zone and therefore its biological productivity or suitability for navigation. (For example, the climate of Europe is moderated by the warm waters of the Gulf Stream, while the coast of Atlantic Canada is kept much colder by the Labrador Current coming south from Arctic waters.)	

The Importance of Coastal Zones to Humans

Question

How are coastal zones important to humans?

Materials

- various resource books
- Internet

Procedure

In groups, discuss the topic and fill in the sheet with your understandings.

HUMANS AND COSTAL ZONES	
What is located near the coastal zone?	
How are humans influencing coastal zones?	What resources are available in coastal zones?
Will the importance of coastal zones increase? Explain your answer and give examples.	
Draw and label a coastal zone.	

The Importance of Coastal Zones to Humans
Teacher Notes

Outcome

Students will be expected to

- identify and explain sustainability and human use of an environment, including populations and resources, locally and globally (CZON-3)

Information Sheet: Importance of Coastal Zones

The coastal zone is primarily where humans interact with the ocean. Some 60 percent of the human population currently reside within 60 km of a shoreline, and that proportion is expected to rise to 75 percent by the year 2020, Two-thirds of the world's largest cities are located on the coast. Consequently, we can anticipate that development of the terrestrial subsystems of the Earth's coastal zones will proceed at a rapid pace, producing changes to natural coastlines. Harbours are dredged, jetties and wharves built, breakwaters are put in place, and so on. Ship traffic will increase to service larger markets. There will be a higher demand for resources, both marine and terrestrial. Pollution in all its forms can be expected to increase in the short term until improvements in technology and political will combine to reduce the problem.

On the other hand, global climate change may produce a sea-level rise that will threaten many low-lying coastal communities. This may come hand in hand with increased storm severity and frequency. The combination of rising sea level and increased storm severity will produce more severe flooding that will extend further inland than in the past. The US EPA advises that, at present, humans have no choice but to retreat from low-lying coastal areas.

The vast majority of the ocean contains very few resources. Or else it contains resources (like the manganese nodules littering the floor of the Pacific) that are presently inaccessible. Most marine resources—both fossil fuel and exploitable marine species—are found in coastal zones. Similarly, waters suitable for aquaculture are located close to shore.

In many cases the terrestrial subsystem of coastal zones can also be rich in resources. These can include the presence of good farmland or forests made up of valuable timber species (often due to the deposition of silt by rivers) or mineral resources such as the coal found in parts of Nova Scotia.

Finally, tourism is a growing industry in many parts of the world. Coastal zones draw a disproportionate number of tourists. People are drawn to beaches, water sports, yachting, etc. Pristine coastal areas can help to develop a healthy tourist industry.

Clearly, coastal zones are very important places to human society, and in the future their importance will only increase.

Human Influences on Coastal Zones

Questions

- What are five reasons for the deterioration of the coastal environments?
- What are some facts about these reasons?
- What do you think about it?

Materials

Resource information from Internet, books, and discussions.

Analysis

Be prepared to discuss, with examples, the deterioration of the coastal environment. Make a chart, brochure, picture, graphs, or workstations to illustrate the human influence on the coastal environment.

HUMAN INFLUENCES ON COASTAL ZONES	
Issue: Facts: Comments:	Issue: Facts: Comments:
Issue: Facts: Comments:	Issue: Facts: Comments:
Issue: Facts: Comments:	Issue: Facts: Comments:

HUMAN INFLUENCES ON COASTAL ZONES	
1.	2.
3.	4.
5.	**My analysis of this information:**

Human Influences on Coastal Zones
Teacher Notes

Outcome

Students will be expected to

- identify and explain sustainability and human use of an environment, including populations and resources, locally and globally (CZON-3)

Background

We have established the importance of coastal zones to human society both from an economic perspective and as diverse, productive natural communities worthy of preservation. There is, however, clear evidence that the quality of the coastal environment is deteriorating as its use by humans increases. The main reasons for the deterioration of the coastal environments generally are considered to be

- overharvesting of fisheries resources
- habitat degradation or destruction
- pollution
- human population growth
- global climate change

It is a vicious circle. Increased use by humans degrades the coastal zone environment. The degradation of the coastal zone reduces its ability to sustain humans and their economic activities.

Overharvesting of Fisheries Resources

The history and evolution of overharvesting of fisheries resources are complex. Suffice it to say that honest error, local and international politics, greed, and mismanagement all played a role. A detailed examination of how we got to where we are might be of value in preventing future recurrences, but is beyond the scope of this course. Many stocks in our region have been overharvested and are on the point of commercial extinction. Some are even in danger of complete extinction.

The overharvesting of these species has had all manner of repercussions:

- Thousands of fishers and fish-plant workers have been put out of work. Workers in related industries, such as shipbuilding and maintenance, fishing gear manufacturing, trucking, wholesaling, and warehousing have also suffered. Economic repercussions spread throughout affected communities or regions. The people directly affected by overharvesting in the fishery buy fewer vehicles, don't do renovations on their homes, buy fewer new clothes, etc.
- The attention of fishing fleets has shifted to other, usually smaller, species—often at a lower trophic level in the marine food web. In addition to potentially harming the new "victim," this practice can slow down or prevent the recovery of the larger fish. For example, suppose we overfish tuna to the point where catching it is no longer worth the effort. Fishers looking for alternative fish to catch may

then switch to mackerel, but the mackerel is one of the principal food fish for tuna. So catching large quantities of mackerel might delay or prevent the recovery of tuna stocks.

- The overfishing of one fish stock can have negative effects on apparently unrelated species. For example, depletion of cod stocks, combined with a reduction in the annual seal hunt, have led to a large population of seals looking for alternative food sources. Hold a discussion on the affects of seals on fish populations such as Atlantic salmon and cod.

Habitat Degradation and Destruction

In this category we will consider primarily physical destruction and degradation. Environmental degradation due to the introduction of chemicals will be examined under the category of pollution.

Habitat degradation and destruction that takes place in the terrestrial and coast subsystems of the coastal zone is visible and largely familiar to students.

- Filling in wetlands; removal of sand and gravel from shore areas; building piers, houses, and industrial parks; and so on clearly destroy or degrade the habitat.
- Siltation of marshes due to agricultural and forestry practices further upstream clearly degrades habitat.
- Improper disposal of solid trash results in the coastal environment (above and below the waterline) being cluttered with fishing gear, bottles, cans, old tires, etc.
- Beaches covered with people, ATVs, jetskis buzzing around offshore, surfers, and powerboats all could clearly interfere with birds nesting in nearby marshes or on the beach or wanting to feed on the sandy shoreline at low tide.
- Invisible habitat degradation and destruction not necessarily familiar to students consists of damage done to the seafloor by draggers. Damage caused by such fishing practices has been compared to that done by clearcutting of forests. It too is thought to be partially responsible for the slow recovery rates of groundfish stocks. The benthic micro-environment that larval groundfish require in order to thrive has been essentially bulldozed.

Contamination

Marine contamination is defined as the release into the ocean by humans of substances that change the quality of the water and affect the physical and biological environment. There are many types and sources. Most are familiar to students. Some of the key types and sources include

- untreated human sewage, incorporating
  - disease-causing micro-organisms
  - mineral nutrients that provoke phytoplankton growth
  - toxic wastes originating from industrial processes and disposed of in wastewater
- runoff from terrestrial sources, including
  - fecal residue from livestock
  - pesticides, herbicides, and fertilizers
  - petroleum products leaking from vehicles and being washed into storm drains by precipitation
  - road salt

- metals leached from soils by acid precipitation (Why do swordfish contain unacceptably high levels of mercury?)

- seaborne effluent from ships and pleasure craft
  - oil leakage falling into two categories
  - catastrophic oil spills (Exxon Valdez, BP Gulf blowout)
  - chronic leakage of small volumes from ship engines, emptying of ballast tanks and clearing of bilges
  - sewage from ships

Global Climate Change

The annual release of billions of tons of carbon dioxide, methane, and other greenhouse gases since the start of the industrial revolution appears to be leading to a change in the global climate. The Earth's climate is heating up. The late 1980s were characterized by warmer than average weather. The 1990s was the warmest decade in history, despite a cool couple of years after the eruption of Mount Pinatubo in 1992. The eruption injected millions of tons of ash high into the stratosphere, thereby reducing incident solar radiation and cooling the climate. The trend towards warmer weather resumed after the ash from the Mount Pinatubo eruption had settled back to the ground.

The effects of global climate change are difficult to predict. Precipitation patterns may change. Some areas may get a little warmer and others a lot warmer, while some may cool. For example, one of the factors thought to be responsible for the collapse of the northern cod stocks that has affected Newfoundland so severely was a drop in water temperature near the bottom. It is suspected that cold, dense water from melting ice is sinking to the bottom and actually cooling the bottom water to temperatures that are sub-optimal for northern cod. Other potential effects of global climate change on the oceans and coastal zones include

- rising sea levels caused by
  - melting of icecaps
  - expansion of ocean water due to a rise in its average temperature
- changes in current directions and flow rates
- increased incidence and severity of storms
- increased storm damage caused by the combination of rising sea level and higher storm surges produced by severe storms

Human Population Growth

The increased number and density of humans in coastal and inland areas is intensifying all the problems listed above. More people require more space and resources and create more wastes of all kinds.

Nova Scotia’s Coastline—Just How Long Is It?

Questions

- What is a coast?
- How long is the coastline of a province like Nova Scotia in relation to any of its other dimensions?
- What are the principal geographic features of Nova Scotia—particularly from a marine perspective (names and locations of gulfs, bays, straits, rivers, etc.)?

Materials

- roll of newsprint or flip chart paper
- Nova Scotia tourist maps (one per pair of students)
- scissors
- clear tape
- string
- rulers
- unlabelled map of Nova Scotia or Atlantic Canada on regular 8 ½" × 11" paper

Procedure

1. Label your blank map of Nova Scotia, paying particular attention to bays, gulfs, banks, straits, rivers, and other nautical features.

2. Stretch out your “coastline” string and measure its length as accurately as possible using a ruler.

3. Use the scale on the map to calculate the length of Nova Scotia’s coastline.

4. Put your estimate of the length of Nova Scotia’s coastline in a class table.

Analysis

Name:

1. Length of coastline: A = ____________ cm

   Map scale: B = __________ km/cm

2. Length of NS coastline in km = $A \times B$ = ____________ km

3. Using the table on your map, find the distance by road from Yarmouth to Sydney. How many times greater is the length of Nova Scotia's coastline than the distance by road from Yarmouth to Sydney?

4. Briefly write your thoughts about the length of Nova Scotia's coastline. Is it longer or shorter than you had anticipated?

5. What did you do about islands? Did you include them? Should they be included? Explain your reasoning.

6. What does the size of the number that you found for the length of Nova Scotia's coastline imply about the size and importance of the job of managing our coasts?

Nova Scotia's Coastline—Just How Long Is It?
Teacher Notes

Outcome

Students will be expected to

- discuss the concept of coastal zones and how these vary around the world (CZON-1)

Background

After the students have completed the worksheet, the following analysis might be appropriate.

1. Compare estimates produced by different groups. Discuss possible reasons for variations.

2. Discuss the results. Ask questions such as, Are these estimates realistic? Do the numbers seem too large? Compare coastline estimates to other provincial dimensions such as the distance by road from Yarmouth to Sydney. Why is the coastline estimate so much larger? Have students draw conclusions about the importance of coastlines and about the magnitude of the task of managing them.

Mapping the Coastal Zone

Question

What interrelationships exist among coastal zone subsystems?

Materials

- pen and paper
- computers with Inspiration software, if available

Procedure

Construct a concept map using the following terms:

- coastline
- coastal zone
- terrestrial subsystem
- coast subsystem
- marine subsystem
- Nova Scotia
- land
- shore
- water

Students are free to add additional terms they feel are related to the topic.

Begin by placing an important or central term on the page so that the other words can be placed in relation to the first word.

Cluster groups of related words.

Connect the words and explain their relationships to one another.

Analysis

Revise your concept map following the class discussion so that it is as complete and correct as possible.

Mapping the Coastal Zone
Teacher Notes

Outcome

Students will be expected to

- discuss the concept of coastal zones and how these vary around the world (CZON-1)
- discuss the purpose and process of integrated coastal zone management and analyze a coastal zone management structure and the interrelationships found in a local area (CZON-5)

Background Information

Teachers might use concept maps or Think-Pair-Share for this activity. Students might complete the concept map to the best of their abilities individually and then pair with other students to share their thoughts. Each pair then presents their maps to the class.

Any concept-mapping software, such as Inspiration, should be used if available. Most students enjoy the freedom to easily revise their maps that these programs provide.

Compare the concept maps presented and strengthen the connections that students have made. Allow students some time to revise their concept maps to incorporate new ideas that surface in the discussion.

Coastal Zone Variations in Nova Scotia

Questions

- What are the basic types of coastal zone?
- What types of coastal zone structure and variation can be found in Nova Scotia?

Materials

- provincial maps of Nova Scotia
- *Nova Scotia Doers' and Dreamers' Travel Guide* (optional)
- regional atlases
- access to encyclopedias
- access to the Internet
- bristol board
- markers

Procedure

In groups of three or four, find information on the physical structure of your assigned section of the province's coastal zone. The information you gather should include all three coastal zone subsystems (terrestrial, coast, marine). Some key words to watch for in your research would be

- rocky shore
- sandy beach
- estuary
- salt marsh

Produce a poster that summarizes your findings in the form of written text and illustrative material.

Be prepared to present a brief summary of your findings and your poster to the class.

Coastal Zone Variations in Nova Scotia
Teacher Notes

Outcome

Students will be expected to

- describe and explain the causes and characteristics of major types of coastal zones (CZON-2)

Procedure

1. Start the project with a general class discussion. Begin with a statement such as, “The coastal zone around the province of Nova Scotia is not the same everywhere, is it?” Then follow with a question such as, “If you were to classify our coastal zone into major types, what would those be?” Write answers and suggestions on the board. Try to steer discussion to eventually end up with rocky shore, sandy beach, salt marsh, and estuary as major classifications. Place variations such as pebble beach, cliff, etc., as subgroups of the four major classifications.

2. Divide the class into groups of four students and hand out the student instruction sheets.

3. Assign each group a portion of the Nova Scotia coastline. For example:

- the Northumberland Shore from the border with New Brunswick to St. Georges Bay
- Cape Breton Island
- the Atlantic shore from the Strait of Canso to Halifax
- the Atlantic shore from Halifax to Yarmouth
- the Fundy shore from Yarmouth to Amherst

4. Each group must find information on the physical structure of their particular section of the province’s coastal zone.

5. Each group is to produce a poster that summarizes their findings in the form of written text and illustrative material. The information obtained should include all three coastal zone subsystems (terrestrial, coast, marine).

6. Groups should present a brief summary of their findings and posters to the class. After the presentations, take the opportunity to summarize the general characteristics of Nova Scotia’s coastal zone.

Posters could be displayed for the duration of this unit as reference material.

Global Coastal Zone Variations

Questions

- How do coastal zones vary from one part of the world to another? Which ones differ from Nova Scotia's and where can they be found?
- How typical is Nova Scotia's coastal zone when compared to those from other parts of the world?

Materials

- access to world atlases and encyclopedias
- access to old magazines that can be cut up (optional)
- access to computers and the Internet

Procedure

PART 1—COASTAL ZONES OF THE WORLD COLLAGE

Using your assigned coastal zone, find at least six pictures from different parts of the world that will be combined to produce a collage. The pictures can be photos, diagrams, or drawings. If you are downloading images from the Internet, make sure they are free of copyright or obtain permission for their use. Be sure to include all three of the coastal zone subsystems in your pictures. Also include a label indicating which subsystem is illustrated and the place the picture depicts.

PART 2—EXOTIC PLACES

Choose a coastal zone from some "exotic" part of the world. Once your choice has been approved by your teacher, research the exotic place and find out all you can about the structure and properties of its three subsystems. Include information on the origins (geological or "other" in the case of coral reefs) of the particular coastal zone. The results of your research should be put into the form of a brief essay (2–3 pages of typewritten text) illustrated with photos, diagrams, maps, and anything else that helps make the paper appealing. Remember to include a bibliography indicating all information sources and letters of permission for copyrighted images that are used.

Global Coastal Zone Variations
Teacher Notes

Outcome

Students will be expected to

- describe and explain the causes and characteristics of major types of coastal zones (CZON-2)

Background Information

PROCEDURE—PART 1

Write the questions from the student handout on the board and brainstorm answers to them. Record these answers as they are given. Hopefully, the following points will be included in the answers:

- The coastal zones of some tropical areas include coral reef ecosystems.
- Some coastal zones have much less relief than Nova Scotia's; e.g., Holland, Bangladesh, Southern US (Louisiana bayous, Florida mangroves).
- Some coastal zones have more relief than Nova Scotia, such as the west coast of North America and South America and the Norwegian coast (fjords).
- Some coastal zones do not have a wide continental shelf like Nova Scotia's. The west coasts of Central and South America and the east coast of Japan have very narrow continental shelves that are immediately followed by a deep ocean trench (leading edge of tectonic plate).
- Some coastal zones are dominated by deltas produced by large rivers; for example, the Mississippi delta, and the Nile delta.

It will be helpful to students to have these ideas in front of them as they begin to search for images for their collages.

PROCEDURE—PART 2

Each student will choose an exotic part of the world; try to avoid duplication of topics as much as possible. Some examples of topics might be

- the east coast of Australia (Great Barrier Reef)
- the Florida Everglades
- the coast of Norway (fjords)
- the Mississippi delta
- Antarctica
- the west coast of South America (Peru, Chile)

Students are to research their particular coastal zone and find out all they can about the structure and properties of its three subsystems. One to two weeks should be sufficient to complete this task.

Coastal Zones and Society

Questions

- What is the role of coastal zones in Nova Scotia's tourism and recreation industries?
- What is the value of coastal zones as natural places and wildlife habitat?

Materials

- *Nova Scotia Doers' and Dreamers' Travel Guide*
- access to old magazines that can be cut up
- Nova Scotia travel brochures
- access to the Internet and a printer
- bristol board
- markers
- metre sticks

Procedure

The class will be divided into seven groups. Follow the procedure appropriate to your group number.

Group 1—"Regular" Tourism

Find the most recent information available on the monetary contribution of "regular" tourism to the Nova Scotia economy. Regular tourism consists primarily of people who admire the scenery from roadsides; stay in hotels, bed-and-breakfasts, or campgrounds; travel in motorhomes or tour buses; play golf; visit Peggys Cove and historic sites. Present your findings in the form of a poster-sized chart or bar graph.

Group 2—Adventure and Ecotourism

Find the most recent information available on the monetary contribution of adventure and ecotourism to the Nova Scotia economy. Adventure tourism consists primarily of people who seek thrills in activities such as surfing, whitewater rafting, and rock climbing. Ecotourism primarily involves hikers, birders, and sea kayakers who explore remote or wild areas and tend to avoid developed areas. Present your findings in the form of a poster-sized chart or bar graph.

Group 3—Commercial Fishery

Find the most recent information available on the monetary contribution of the commercial fishery to the Nova Scotia economy. Present your findings in the form of a poster-sized chart or bar graph.

Group 4—Oil- and Gas-Related Activities

Find the most recent information available on the monetary contribution of oil- and gas-related activities to the Nova Scotia economy. Present your findings in the form of a poster-sized chart or bar graph.

Group 5—Aquaculture

Find the most recent information available on the monetary contribution of aquaculture to the Nova Scotia economy. Present your findings in the form of a poster-sized chart or bar graph.

Group 6—Advertising "Regular" Tourism

Collect advertisements and photos intended to attract tourists to the region. Target people who admire the scenery from roadsides; stay in hotels, bed-and-breakfasts, or campgrounds; travel in motorhomes or tour buses; play golf; and visit Peggys Cove and historic sites. Present these pictures on a poster. Be sure to include the name of the area that is illustrated.

Group 7—Advertising Adventure and Eco-tourism

Collect advertisements and photos intended to attract adventure and ecotourists to the region. Adventure tourism consists primarily of people who seek thrills in activities such as surfing, whitewater rafting, and rock climbing. Ecotourism primarily involves hikers, birders, and sea kayakers who explore remote or wild areas and tend to avoid developed areas. Present these pictures on a poster. Be sure to include the name of the area that is illustrated.

Good sources of advertisements/photos include

- *Nova Scotia Doers' and Dreamers' Travel Guide*
- Nova Scotia travel brochures
- magazines such as *Canadian Geographic*, *Maclean's*, *Canadian Living*, *Reader's Digest*, *Canadian House & Home*, and *Style at Home*

Coastal Zones and Society
Teacher Notes

Outcome

Students will be expected to

- identify and explain sustainability and human use of an environment, including populations and resources, locally and globally (CZON-3)
- discuss the purpose and process of integrated coastal zone management and analyze a coastal zone management structure and the interrelationships found in a local area (CZON-5)

Procedure

1. Introduce the topics of the importance of coastal zones to tourism and recreational potential and the value of coastal zones as natural places and wildlife habitat. You could begin by asking students to consider tourism and recreation and their relation to coastal zones. Ask, "Do you know anyone who has gone south for a winter vacation? Where did they go?" Virtually all replies will be a coastal zone (island or coast). Point out this fact. Ask, "Why don't more people go to Arizona?" or "Anyone planning a vacation to Saskatchewan this summer? No? Why not?" Discussion at this point will focus on the lack of coastal zones.

2. Have the class divide into pairs and consider the questions: "What makes sea coasts such popular vacation destinations?" and "What factors make the ideal seaside holiday destination?" Students should produce a list of reasons and features and explain their choices. They should attempt to consider all possible points of view—not just their own preferences. You could make a list of their responses as the groups read through them. Establish that a clean, appealing coastal zone including large areas of natural, undeveloped coast with healthy wildlife populations is essential if a region hopes to develop its tourist potential. Data on this can be collected from various websites and information pamphlets.

Have the class divide into seven groups and assign each group one of the following topics (detailed descriptions are contained in the student handout):

- "regular" tourism
- adventure and ecotourism
- commercial fishery
- oil and gas activities
- aquaculture
- advertising "regular" tourism
- advertising adventure and ecotourism

The completed posters should be displayed on the walls for reference throughout the rest of the unit.

Overharvesting of Marine Resources

Questions

- How do conflicts exist in fishing?
- Who has a role in the overharvesting?
- What opinions do you have on this? Defend your position.

Material

- Video, *Fisheries Futures* (V1728)

Analysis

ACTIVITY 1

Following the video, complete in your science journal a response to the following questions:

- What conflict exists between inshore and offshore fishing?
- What conflict exists between small-scale fishing by individuals and large-scale corporate exploitation?
- How can these conflicts lead to overharvesting?
- What are your opinions and feelings on these issues?

ACTIVITY 2

These role-playing presentations about the responsibility, concerns, and opinions of various stakeholders should show many views of overharvesting.

Write a reflective piece about the whole activity and your own particular role.

Overharvesting of Marine Resources
Teacher Notes

Outcome

Students will be expected to

- list and discuss human interactions with the processes involved in the coastal zone environment, and describe competing views (CZON-4)
- discuss the purpose and process of integrated coastal zone management and analyze a coastal zone management structure and the interrelationships found in a local area (CZON-5)

Materials

- Video, *Fisheries Futures* (29 minutes) (V1728)

Activity 1: Background Information

The purpose of viewing this video is to introduce students to fisheries issues in the coastal zone, particularly the conflict between inshore and offshore fishing and between small-scale fishing by individuals and large-scale corporate exploitation and to examine how these conflicts can lead to overharvesting of resources.

Activity 2: Background Information

This activity is intended to be run as a dramatic presentation based on role-playing. It is intended that the actual dialogue and progression of the presentation be improvised—not scripted in advance. The whole class should participate in some capacity.

Students playing roles should be given slips of paper on which is summarized information that they have available to them. The roles required are listed below:

- **Four inshore cod fishers:** Fishing has been good and catches steady during the last few years, including this year. These people operate small boats and can’t travel large distances in order to fish.
- **Two offshore fishers:** They are local people who work on-board large vessels owned by a large company. These vessels can travel long distances and work far offshore. The company that owns them has access to many fishing areas. They haven’t noticed any changes in recent catches either.
- **Two fisheries scientists:** Stock assessments indicate that the stock is smaller than previously thought. Calculations indicate that to prevent long-term harm to the population, the annual quota for the region will have to be reduced from 50 000 tons to 25 000 tons for the next three years.
- **Three fish plant workers:** The small local plant processes mainly locally caught cod. There is barely enough work to maintain the current workforce at the plant.

- **One fisheries observer:** His or her job is to monitor fish catches on-board foreign vessels to make sure they don't exceed their quota. In the past, however, when foreign vessels have exceeded their quota, it has been hushed up to avoid creating an international incident and spoiling friendly relations with the country involved.
- **One MP for the region:** The local economy revolves around the fishery. The MP belongs to the ruling party and won the seat by a slim majority in the last election. The government has not been very popular. The next election must be held within the next year and a half. A reduction in quota would be bad for the MP in the short term.
- **One federal minister of fisheries:** The minister's own riding is also a coastal one in the Atlantic region. The minister has the power to actually set the quota and is not bound by the scientists' recommendations. The minister must consider the long-term health of the fishery and the election coming up in the next year or so.
- **Two DFO fisheries enforcement officers:** They are local people and will be required to enforce compliance with fisheries quotas.
- **Community business people**
  - #1 runs a small trucking company. A large part of the business consists of hauling fish to the fish plant and the processed fish to market.
  - #2 runs a boatyard maintaining, repairing, and building boats. Fishing-related contracts are a large part of the business.
  - #3 runs the local car dealership.
  - #4 runs the local real estate office.
  - #5 runs the local hardware business (also supplies nets, fishing supplies, boots, waterproof outerwear, etc.).
  - #6 ... Add additional roles so that every class member is able to participate.

The scenario could be set to unfold in the following manner:

1. Fisheries scientists discuss results of new cod stock assessments.

2. The scientists make their recommendations for next year's cod quota to the minister of fisheries.

3. The minister discusses the recommendations with the local MP and it is decided that a meeting should be held at the community hall to inform the community about the results of the latest stock assessment.

4. The minister, MP, and scientists decide who will present what information at the meeting and what they will say.

Note: Steps 1–3 should take place out of earshot of the majority of the class. Only the characters involved should be present.

The rest of the activity should be set at the community meeting called to announce next year's cod quota for the region. The minister, MP, and scientists will act as a panel. All other community members, each with their own particular knowledge and point of view, are in the "audience."

The announcement is made and then the meeting unfolds spontaneously.

As a follow-up to this activity, students should write a reflective piece about the whole activity and their own particular roles.

Analysis

After the activity has terminated, discuss what went on, opinions, feelings, and so on. Emphasize that this sort of thing has occurred frequently (in a less simplistic way). Current fishery problems have arisen from negotiations involving quotas. Essentially,

- scientists calculate a quota
- fishers find it unreasonable
- a great wailing and gnashing of teeth ensues
- dire threats of bankruptcies and unemployment are made
- politicians feel the pressure and, to soften the impact on themselves and the community, compromise

So a quota of 35 000 tonnes is set. That way the fishing community is somewhat mollified and the scientists have not been completely ignored, but the stock is still overfished.

The scenario repeated year after year eventually leads to the kind of population collapse that we have witnessed time and again over the last few years.

Oil, Water, and Then What?

Questions

- What are the characteristics of oil in seawater?
- What are the effects of oil on marine communities?

Materials

- article or information from your teacher
- article analysis frame

Procedure

Oil spills are one type of ocean pollution that receive a great deal of publicity and are regarded as a very serious problem. As a result of the development of the Hibernia oil and Sable gas fields, there is increased risk of oil pollution in our region. It is important for Maritimers to be well informed about this issue because of these developments.

After reading the information or article given to you, use the appropriate article analysis frame to reflect on the issues it raises and facts it presents.

Oil, Water, and Then What?
Teacher Notes

Outcome

Students will be expected to

- list and discuss human interactions with the processes involved in the coastal zone environment, and describe competing views (CZON-4)
- discuss the purpose and process of integrated coastal zone management and analyze a coastal zone management structure and the interrelationships found in a local area (CZON-5)

Materials

Copies of various articles and information obtained from EBSCO.

Background Information

Do an environmentally friendly oil spill experiment.

An article analysis frame can help students generate questions, list facts, identify key vocabulary, discuss relevance, summarize articles, and graphically represent key concepts.

As an alternative to using the article analysis frames, students could summarize in their own words the following information contained in the reading:

- the principal characteristics of crude oil
- the major causes of oil spills
- the fate of spilled oil in seawater
- the effects of oil on wildlife
- the duration of effects of oil spills on the environment

Study of a Contaminant

Questions

- What contaminants are affecting coastal zones?
- What are the sources?
- Which types of coastal zones are most severely affected?

Materials

- access to the Internet
- access to the library

Procedure

Choose one contaminant that is affecting marine ecosystems. Some examples are DDT, PCBs, any specific heavy metal (e.g., mercury, cadmium), TBT (tributyltin used in marine antifouling paints), nutrients from sewage or fertilizer runoff, or bacterial pathogens in sewage.

Your may use a variety of presentation forms to present your information. Detail the problems posed by your chosen contaminant. Be sure to include information on sources of the contaminant, the types of coastal zones that it affects most severely, and the type of damage the contaminant causes.

Study of a Contaminant
Teacher Notes

Outcome

Students will be expected to

- list and discuss human interactions with the processes involved in the coastal zone environment, and describe competing views (CZON-4)

Background Information

Introduce the topic by discussing the variety of contaminant entering marine ecosystems. Assign or allow students to select a particular contaminant. The more variety in choices, the more interesting and varied responses will be.

Coastal Zone Management

Question

Who are the stakeholders and interest groups that affect and are affected by coastal zone issues?

Materials

- posters produced during Coastal Zone Variations in Nova Scotia
- regional atlases
- Canadian encyclopedia

Procedure

After obtaining the poster you created during Coastal Zone Variations in Nova Scotia, re-form the group you worked with. This time your goal is to determine as many different stakeholders as possible that should be involved in the management of that particular section of coastal zone. Management is very difficult for coastal zones. Be sure to consider groups outside Nova Scotia. Justify all your choices.

Be prepared to present your opinions and justifications to the class.

Analysis

Copy lists of stakeholders created on the board during the group reporting session. List the similarities and differences among groups. Discuss the reasons for the differences in opinion.

Coastal Zone Management

Teacher Notes

Outcome

Students will be expected to

- list and discuss human interactions with the processes involved in the coastal zone environment, and describe competing views (CZON-4)
- discuss the purpose and process of integrated coastal zone management and analyze a coastal zone management structure and the interrelationships found in a local area (CZON-5)

Background Information

Realizing that everyone has difficulty with management of coastal zones is important. Review with the class the basic idea of coastal zone management in Canada, its goals, and philosophy. Review the pivotal role of the Department of Fisheries and Oceans in the process as defined in the *Oceans Act* of 1997.

Reassign student groups to their particular posters from Coastal Zone Variations in Nova Scotia. In this activity, they are to consider once again the same section of coast. But this time their goal is to determine the different stakeholders that should be involved in the management of that particular section of coastal zone. They are to justify all of their choices.

Students should include groups outside the province of Nova Scotia. For example, integrated coastal zone management groups in PEI, St. Pierre and Miquelon, Newfoundland, New Brunswick, and the New England states would have to participate. Also encourage students to include stakeholders from all subsystems of their particular coastal zone.

When groups have completed their tasks, have a reporting session in which each group presents their opinions and justifications. Record each list of stakeholders on the board as each group reports. You could have a member of each group write their list of stakeholders on the board.

Following the reports, students should analyze the list of stakeholders for similarities and differences. They should also discuss the reasons for particular differences. This could be done on paper and handed in or as a class discussion.

Problem Solving and Coastal Zones

Question

How can real coastal zone issues be resolved?

Materials

access to library or Internet

Procedure

After forming a group of two or three, select a coastal zone issue to analyze. Some possible issues include

- Halifax Harbour clean-up
- Threats to the fishery posed by oil and gas exploration off Nova Scotia
- Establishment of size limits for a proposed mussel-farming operation near Tatamagouche (Conflict with tourism—Do residents want their scenic bay to draw tourists or a huge mussel operation to provide employment, etc.?)
- Whale-watching tours in the Bay of Fundy (Whale watching or whale harassment? Should limits be imposed? How to impose limits? What about the tour operators and other tourist-related businesses?)
- Filling in salt marshes to allow building of homes and cottages
- The decline in Atlantic salmon stocks
- The dramatic increase in seal populations and its implications for the fishery
- The integration of aboriginal fishers into the commercial fishery
- Saving the right whale
- Preparing for the projected impact of global climate change

Using your issue as a foundation, produce a comprehensive plan to resolve the issue, using the principles of integrated coastal zone management. Your issue must be addressed within the larger context of the management of the whole coastal zone. For example, solutions such as “shut down the fishery during right whale migrations to prevent entanglements in fishing gear” are not feasible.

Your group should also consider the necessity for interaction with other jurisdictions (local, regional, global) in achieving your resolution. For example, sealing, right whale, and Atlantic salmon management all have important international aspects that must be included.

Your completed action plan will be presented in class for analysis and discussion.

Analysis

Make any adjustments you deem necessary following the class discussion of your action plan. Turn your completed resolution in to your teacher.

Problem Solving and Coastal Zones
Teacher Notes

Outcome

Students will be expected to

- list and discuss human interactions with the processes involved in the coastal zone environment, and describe competing views (CZON-4)

Background Information

This activity could be used as a final evaluation of the Coastal Zone unit. To produce a complete action plan for their particular issue, students should use everything they have been exposed to during the various activities and discussions since they began this unit.

The temptation for students will be to provide simplistic solutions without considering the spin-offs from their solutions. Encouraging groups to produce a futures wheel to analyze the ripple effect of their decisions might help them to understand that there are no easy answers to these issues.