ARCTIC MARINE SCIENCE CURRICULUM

MODULE 2

ECOLOGICAL PRINCIPLES

TEACHER'S GUIDE

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MODULE 2

TEACHER'S GUIDE

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RECOMMENDED RESOURCES

Print

Castro, Peter and Michael Huber. Marine Biology. Toronto, ON: Wm.C. Brown, 1997.

Ehrlich, Paul R., and David S. Dobkin and Darryl Wheye. The Birder's Handbook, a field guide to the natural history of north american birds. New York: Simon and Schuster, 1988.

Grace, Eric, et al. Sciencepower 10. Toronto, ON: McGraw-Hill Ryerson, 2000.

Groot, C. and L. Margolis, editors. Pacific Salmon, life histories. Vancouver: UBC Press, 1991.

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Longhurst, Alan. Ecological Geography of the Sea. San Diego: Academic Press, 1998.

Pielou, E.C. A Naturalist's Guide to the Arctic. London: The University of Chicago Press Ltd, 1994.

Pielou, E. C. Fresh Water. Chicago: The University of Chicago Press, 1998.

Ritter, Bob, et al. Nelson Science 10. Scarborough, ON: Nelson Thomson Learning, 2001.

McDonald, Miriam, Lucassie Arragutainaq, and Zack Novalinga. Voices from the Bay. Ottawa, ON: Canadian Arctic Resources Committee Environmental Committee of Municipality of Sanikiluaq, 1997.

Smith, Robert Leo, and Thomas M. Smith. Elements of Ecology, 4th edition. San Francisco: Benjamin/Cummings Science Publishing, 2000.

Thorne-Miller, Boyce. The Living Ocean, understanding and protecting marine biodiversity. Washington, DC: Island Press, 1999.

Thurman, Harold V. Introductory Oceanography. Ohio: Charles E. Merrill Publishing Company, 1975.

Webber, Herbert H. and Harold V. Thurman. Marine Biology. New York, NY: HarperCollins, 1991.

Young, Steven B. To The Arctic, an introduction to the far northern world. US: Wiley Science Editions, John Wiley and Sons, Inc. 1989.

Websites

Referenced throughout Module.

Great site for the breakdown of the Arctic Oceans Ecozones
http://www.cprc.uregina.ca/ccea/ecozones/marine.html

Canadian Arctic Profiles
This web site provides information on a variety of topics relating to the Canadian Arctic. The site is dynamic and the range of topics and the depth of treatment will be augmented over time under the auspices of the Digital Collection Program of Industry Canada.
http://collections.ic.gc.ca/arctic/english.htm

Canadian Polar Continental Shelf Project
Gives information about on-going research projects in the Canadian Arctic.
http://polar.rncan.gc.ca/home_e.html

Cape Parry Migratory Bird Sanctuary Home Page
http://collections.ic.gc.ca/sanctuaries/nwt/parry.htm

DFO
DFO Marine Habitat and Science Division Website
http://www.ios.bc.ca/ios/mehsd/hottopics/default.htm

Environment Canada
Marine and terrestrial ecozones. Good general information is found here.
http://www.ec.gc.ca/soer-ree/English/vignettes/marine/marine.cfm

Geological Survey of Canada (GSC)
Provides good Canadian landscape images
http://sts.gsc.nrcan.gc.ca/clf/home.asp

Minerals Management Service – Alaska OCS Region
Environmental studies section
http://www.mms.gov/alaska/ess/index.htm

Marine Habitat Main Page – USGS (science for a changing world)
http://abscweb.wr.usgs.gov/research/seabird&foragefish/marinehabitat/home.html

Natural Resources Canada
Earth Sciences Sector – Information Resources links to Canadian government Science Sites.
http://collections.ic.gc.ca/sanctuaries/nwt/parry.htm

NOAA
The National Oceanographic Data Center (NODC) is one of three NOAA environmental data centers, and serves as a national repository and dissemination facility for global ocean data.
http://www.nodc.noaa.gov/

NOW – The North Water Polynya Study
Is an international study site. There is good reference material for the teacher and advanced students.
http://www.fsg.ulaval.ca/giroq/now/scien.htm

Nunavut Research Institute
This is a link to the research studies at the institute for those looking for more detailed information.
http://pooka.nunanet.com/~research/docs/98compendium.htm#_Toc487013545

Ocean98
The home page for Ocean98. This site offers some good general information about the world's oceans.
http://www.ocean98.org/fact.htm#H

Parks Canada
Parks Canada Home Page
http://www.parkscanada.pch.gc.ca/np/np_e.htm

Good introduction to Canada's Arctic Marine Environment – part of the Canada's National Marine Conservation Areas System Plan
http://parkscanada.pch.gc.ca/nmca/nmca/arctic/index.htm

The Bridge
Teachers will find a selection of the best online resources for marine science education. This site has been built by educators and scientists.
http://www.vims.edu/bridge/index.html

University of Guelph
This site has good overview information about the Arctic environment and ecozones.
http://www.arctic.uoguelph.ca/environments/sidemarine.htm

INTRODUCTION

This module reviews and builds upon ecological understandings that students have acquired in previous grades, and applies these understandings to a marine ecosystem context. This module will not only incorporate traditional knowledge as a part of students' understanding the structure and function of marine ecosystem, but will develop an awareness and appreciation for the values and beliefs that accompany that knowledge.

E Check For Understanding

Have students read the quotes in the student guide and answer the questions provided. The quotes emphasize the values and beliefs that aboriginal people hold towards the land and ask students to begin thinking about their own values and the values of their family and community. Care should be taken when discussing values to ensure that students treat all people's values with respect. Teachers should be aware that their personal values may not coincide with the values of the community. When this occurs, a dialogue should occur between teachers and students where both value systems are respected.

Students should have an opportunity to travel on the land with elders to see how these values are put into action. Valuing the land and treating it with respect should be an ongoing theme throughout this course and will have bearing on the issues discussed in Module 5 - Human Use and Governance. These values are represented in numerous Northern Aboriginal curricula, such as *Inuuqatigiit* and *Dene Kede*, as well as in *The Common Curriculum Framework for Aboriginal Language and Culture Programs Kindergarten to Grade 12 (June 2000),* developed as part of the Western Canadian Protocol for Collaboration in Basic Education.

1.1 FLOW OF ENERGY THROUGH AN ECOSYSTEM

SLO 2-01:	Explain the components of an ecosystem
SLO 2-02:	Define ecological terms such as geological systems, autotroph, trophic levels, and food chain.
SLO 2-03:	Describe the predator prey relationship that exists in an Arctic marine ecosystem.
SLO 2-04:	Organize organisms by trophic level.
SLO 2-05:	Describe and illustrate a food chain and food web of an Arctic marine ecosystem.
Essential Question:	***What relationships exist between organisms in an ecosystem and how does energy flow between these organisms?***
Recommended Time:	2-3 classes

FOOD CHAINS AND FOOD WEBS

Activating

It is important to activate prior knowledge about ecology from previous grades. This can be done in a number of ways, using strategies such as KWL (what do students know, want to know, and what do they learn), concept mapping, or word splash. A word splash has been provided in *Appendix 1* and the accompanying text in *Appendix 2*.

Word Splash Strategy Description: A word splash is a collection of words or key terms (*Appendix 1)* from textual material that students will be reading or hearing *(Appendix 2).* Students examine the words and try to predict what they will read or hear. These predictions can be recorded by connecting related terms with a line and writing on that line what the relationship is, or by recording a number of statements using the terms on a separate page.
Example: **plants** are **producers** who use **sunlight** as a **source of energy**

Personal Food Chain

Ask students to create food chains using what they had for supper the previous night. The food chain should ultimately include the sun. *For Example: Macaroni and Cheese*

sun → wheat (flour) → macaroni
sun → grain → cow → cheese
hiqiniq → nuna → Tuktu

Lab 1 - Food Chain Field Work (Refer to Lab Manual)

Have students use the template provided in the Lab Manual to make field observation of different areas in the community to collect data for the generation of food chains. This field work should be carried out earlier in the cluster, and can be repeated at a later point. Data/observations should be added to the Community Profile book.

Food Web and Food Chains

An analysis of the Hudson Bay Food Web provided in the student guide will allow students to appreciate the complexity of ecosystems and the interactions of organisms within them, and to identify key ecological components.

Have students:

1. Create a list identifying examples of predators and prey from the food web provided.
2. Extract examples of food chains from the food web provided and label them according to trophic levels: producers (first trophic level), primary consumers (second trophic level), secondary consumers (third trophic level).
3. Identify any food webs included that are found in their local environment; emphasis should be placed on marine environments as many students are more familiar with terrestrial environments. Links can be made between the two. Food webs should be completed in English, Inuktitut, Inuinaqtun or other language. Encourage bilingualism.
4. Add other food webs representing their local environment (this information should be recording in the Community Profile book for the class, initially recording baseline data and in later years allowing comparisons to take place).

Assessment Suggestion: After identifying local food webs, have students create visual displays of one of the webs for display in the room. The animals for the posters can be obtained from Internet clip art, but student artwork will add uniqueness to their visual displays. Students may also choose to create 3-dimensional models of food webs; mobiles work well, with English on one side and a second language on the second. Mobiles can be made in the shape of the organism. Local terms for the organisms contained should also be included. Students may include the scientific name for the organisms, although this is not necessary at this point (students will be addressing taxonomic classification in module 3). The following peer assessment tool could be used to have each student assess the work of another student. Often this type of assessment is blended with a teacher assessment. Peer assessment is an important tool that helps students recognize important elements of assignments and develop the ability to make judgments of how well a piece of work meets the requirements set out.

PEER ASSESSMENT RATING SCALE - FOOD WEB PROJECT

CRITERIA	FAIR		GOOD		EXCELLENT
• Clear representation of organisms found in the food web	1	2	3	4	5
• Trophic levels clearly indicated	1	2	3	4	5
• Creative, engaging visual representation • Local terms for organisms included and accurate	1 1	2 2	3 3	4 4	5 5
Constructive Comment:					

Observing Food Chains (Includes Lab 2, Refer to Lab Manual)

A graphic way in which students can visualize a food chain is to study it directly. During the spring, local ponds and creeks will contain numerous examples of aquatic/marine life that can be transported to school for class observation. The sample of water collected can be either freshwater or seawater, depending on what is available in your community, and should contain weeds and a selection of invertebrates and vertebrates. The complexity of the food chain is, of course, dependent on the number and variety of organisms within the water sample, therefore a number of collecting trips may be better than one. As well, student interest is directly proportional to the number of species that they can find in the water. Ideally, water samples should be transferred to an aquarium with an air bubbler to extend the life of all organisms collected. If there are any giant water bugs in your water, be sure that the tank has a top on it as they can fly and will do so after eating many of the other organisms in the tank!

This is a good opportunity to carry out a microscope activity. Lab 2 provides a familiarization activity for students. If time or equipment availability do not allow for the use of microscopes at this time, students will have other opportunities to do so in Module 3.

Assign students into groups so they can take turns identifying organisms and keeping track of how many there are in the tank from day to day. An additional assignment is to have them sketch a picture of the organism and place the picture at the top of a column so all students in the group know what species is being counted. Depending on the class, observations can occur daily or every two days, etc. As time passes, predation occurs and the number and type of organism changes. This activity always generates much discussion amongst students. After several weeks have passed, students can use their data to establish a most probable food chain for the organisms in the water sample.

Recipe for an Ocean

Brainstorm with the class to create a recipe for an ocean! Students will need to think about what abiotic and biotic factors would be needed to make the ocean as true to life as possible. Try to include as many of the local organisms in the list as possible. When a long enough list has been made, students should begin to make all the necessary connections with the organisms in their list. As the connections increase, students quickly see the importance of each species to the success of the ecosystem. Ask students to discuss the links between ocean and land as well.
An extension of this activity would be to have them pass a ball of string around to make the connections more graphic. After a while the web will get so congested that it will be hard to pass the ball of string around. Do not cut the string. When the web is complete, have one student try to move away from the rest of the organisms in the web. Discuss this effect on the remaining species in the web.

E Check For Understanding

1. What is the source of energy for an ecosystem? *(Sun)*
2. How does this energy enter the ecosystem? *(Sun's energy is converted into chemical energy by green plants through photosynthesis.*
3. Distinguish between producers and consumers. *(Producers make their own food using energy from the Sun. Consumers must obtain food energy by eating producers.)*
4. Why is looking at food chains helpful when studying an ecosystem? Why does a food chain present an incomplete picture of the interactions within an ecosystem? *(food chains help us identify and study relationships and the flow of energy through an ecosystem; however, the simple linear relationship does not accurately represent the complex web of interrelationships that exist in real-life. Also, the chain does not represent the fact that one organism can be at different trophic levels at different times.)*
5. Suppose that volcanic eruptions send tonnes of particles high into the atmosphere. The particles create clouds of dust that filter out part of the sunlight for a period of one year. Explain what might happen to various organisms in an ecosystem following this event. *(All organisms would be affected. Producers would probably die off, causing many herbivores and carnivores to die from starvation.)*

ENERGY FLOW

Student Guide

Have students read the section on energy flow in the student guide.

Assessment Suggestion: A Word Cycle strategy can be used as a formative assessment to gauge students' understanding of concepts up to this point and to determine where additional teaching needs to take place. This strategy involves students making appropriate connections between key terms. The Word Cycle is provided in *Appendix 4* and a rubric is provided below.

Scoring Rubric

SCORE	CRITERIA
3	All connecting phrases succinctly and accurately explain the relationships between/among them
2	Most connecting phrases accurately explain the relationships between/among the terms
1	Several connecting phrases are missing or show a lack of understanding of the relationships between/among them

ECOSYSTEM PRODUCTIVITY

E Check For Understanding

1. Why are the rainforest, the coastal marsh, and the field of grain the most productive ecosystems in the table provided? (*Estimated Net Productivity of Certain Ecosystems (in kilocalories/m2/year. they have the best conditions for growth of organic matter - e.g. nutrient availability -and therefore a lot of organic matter which holds energy.)*
2. Referring to the table again, why is there such a difference in productivity between the open ocean, the ocean close to shore, and the coastal marsh? *(The photic zone differs for each of these three areas - with the coastal marsh having the highest potential for photosynthesis to occur and the open ocean the least. Thus there are differences in the amount of organic matter produced.)*
    a) What is the main producer in the Arctic Marine ecosystem? *(Phytoplankton)*
    b) What type of organism is the most numerous herbivore in the Arctic Marine ecosystem? (*Zooplankton*)
3. Why is the productivity of the Arctic Ocean less than that of oceans elsewhere on Earth? *(Productivity is reduced because of the limited time period each year when there is open water for phytoplankton to photosynthesize).*

The source of information on productivity found in the student guide is a website that serves as an **online biology textbook** by J. Kimball

(http://www.ultranet.com/~jkimball/BiologyPages/W/Welcome.html)

This website contains alphabetized lists of biological terms (the index/glossary) with links to discussions, often illustrated, of a wide range of biological topics. Some of the information on the website was drawn from the sixth edition of the author's text **Biology** published in 1994 by Wm. C. Brown. This is an excellent reference.

1.2 BIOACCUMULATION

SLO 2-06:	Identify contaminants that can be found in an Arctic marine ecosystem.
SLO 2-07:	Define the term bioaccumulation.
SLO 2-08:	Describe the mechanism of bioaccumulation, and explain its potential impact on the viability and diversity of consumers at all trophic levels.
Essential Question:	***How do environmental contaminants affect organisms within an ecosystem?***
Recommended Time:	1 class

IDENTIFYING CONTAMINANTS

Identifying Local Sources of Contaminants

Every community discharges contaminants to the environment. Some of these will be common to all communities and some will be unique. Have students identify sources of contaminants that are present in their community and mark their location on a community map.

The following categories can be used to stimulate brainstorming:

- At home (household cleaning products, vehicle care, pets, septic systems)
- Gardening (including indoor house plants, fertilizers, pesticides)
- Water front properties (shoreline erosion)
- Recreational activities (boating)
- Local industry (garages, grocery stores, artists, construction)
- Local infrastructure (water treatment, road work, sewage disposal)

A class list can be compiled and kept on display in the classroom. Students can add to it as their study of ecosystems progresses.

Pollution Scavenger Hunt

A scavenger hunt can turn a lesson into an exciting game of exploration for students. It can be used to motivate students to gather data from both traditional sources (libraries, newspapers, magazines) as well as from primary sources (resource people, community elders, personal observation). The variety and diversity of information gathered in this activity will help your students identify the environmental issues of concern to their community and provide a springboard for discussion and further investigated of these issues.

1. Create a list of potential resources for students such as non-profit environmental agencies, libraries, elders, enforcement agencies, Sustainable Development, Inuit Organizations, Hunters and Trappers Organizations Department of Fisheries and Oceans persons, the Internet, RCMP persons.
2. Prior to the class session, have students read the pollution overview.

3. To make the hunt a little more exciting, points can be assigned for items that students collect. However, the point system should be discussed before they students start collecting. Another evaluation option would be to use a rubric to provide some sort of motivation if it was necessary and to assign marks.
4. Discuss with students the following questions:
    a. What are some of the pollution issues facing the health of our local community?
    b. What do you know about these issues? Are there solutions to the problems that exist? How can we prevent future problems?
    c. Where would you go to get information on pollution problems?
    d. Create a list on the board of possible sources of information.
5. Explain to students that you would like to create a library of coastal issues information in the classroom. To create this library we are going to go on a scavenger hunt.

This activity can be organized to span several weeks or a few days. Refer to *Appendix 3 - Pollution Scavenger Hunt* for student handouts.

BIOACCUMULATION

Detailed information on contaminants in the Arctic can be obtained from the following website: www.tapirisat.ca This site contains information on monitoring programs that are currently underway. Maps from this website showing transport patterns in the atmosphere and in the oceans are found in *Module 5 - Appendix 6.*

Fact-Based Article

Have students read the section in the student guide on bioaccumulation. To aid students in gaining information from the article "Polar Bears and Pollution" have them use the Fact-Based Article Analysis strategy found in the *Appendix 5.*

Research Project

The topic of contaminants in food chains is of extreme importance in the Arctic. The questions students identify in their Fact-Based Article Analysis can be the basis for a research project.

Guest Speaker/Public Education

If possible, have someone in the health profession talk to students about the health risks associated with consuming animals high on the food chain. Have students assess the level of local knowledge about this topic and, if needed, students can design an education campaign.

Background Information - Contaminants in the Arctic

The principal heavy metals of concern in arctic mammals are mercury, cadmium, lead, and arsenic. The man-made chlorinated organics include PCBs, DDT, toxaphene, chlordane, endosultphins, and lindane. The hydrocarbons recorded in arctic mammals include PAHs and alkane, while radionuclides include cesium, strontium, plutonium, lead, and polonium. The most important source of hydrocarbons and radionuclides in the Canadian Arctic may be ocean dumping off the coast of the former Soviet Union.

The Canadian Arctic receives high concentrations of heavy metals and chlorinated organics, especially in winter, primarily from atmospheric transportation. These chemicals travel to the Canadian Arctic, principally in the form of gas or dust, and they can enter marine and freshwater ecosystems and travel through the food web, eventually reaching marine mammals and the humans who eat them. Mercury concentrations in the muscle and liver tissues of belugas from different regions are increasing. Belugas from eastern Hudson Bay have the highest concentration of mercury in liver tissue compared to belugas from the Arctic as a whole.

Excerpts from:
Proceedings of the Workshop on Traditional
and Contemporary Knowledgeof Nunavik Belugas.
November 1994, Maurice Lamontagne Institute, Quebec.

1.3 BIODIVERSITY

SLO 2-09: Define the term biodiversity.
SLO 2-10: Explain how the biodiversity of an ecosystem contributes to its stability.

Essential Question: ***Why is it good to be different?***

Recommended Time: 1/2 class

Many teenagers want to be like their peers. Students avoid being different but, as we know, being different in nature often ensures survival especially if an animal is in competition with others for the same food. Biodiversity contributes to the stability and survival of species.

E Check For Understanding

Have students read the information on biodiversity and answer the questions provided. The questions in the student guide have been chosen to relate to the wide variety of abilities and interests found in any given class of students. The teacher may not want to assign every question to every student. Questions may involve personal reflection, recall, and discussion with a friend and may contain some research.

The answers have not been provided, as they will vary with local community issues.

1.4 BIOGEOCHEMICAL CYCLES

SLO 2-11:	Define organic compounds.
SLO 2-12:	Illustrate the cycling of matter through the biotic and abiotic components of an ecosystem by tracking carbon.
SLO 2-13:	Illustrate the cycling of matter through the biotic and abiotic components of an ecosystem by tracking nitrogen.
SLO 2-14:	Illustrate the cycling of matter through the biotic and abiotic components of an ecosystem by tracking silicates.
Essential Question:	***What substances are recycled in nature?***
Recommended Time:	1 class

There are essentially three cycles that students should know to understand how organisms interact with their environment and their habitat. The three cycles discussed are: the carbon cycle, which includes oxygen; the nitrogen cycle; and the silicate cycle. Each of these cycles will be treated separately, including the effect of each on the environment and its inhabitants.

The treatment presented here will be as simple as possible, given the limited knowledge of chemistry that students have in grade 10. Note: for an introductory course in aquatic science like this, the discussion will be restricted to processes rather than the chemical reactions of these processes.

Carbon Cycle

Students should know the difference between inorganic and organic compounds. After a number of simple examples have been given, a comparison chart would work well to illustrate the differences between the two.

The stoichiometry of the reactions is not as important as the contents. Cellular respiration carried on by all life produces carbon dioxide. Students should know that carbon dioxide reacts with water and the energy from light to produce a complex sugar and the release of oxygen gas as a by-product. Obviously, if there is no light, then will be no energy for photosynthesis and no replacement of oxygen into our atmosphere.

Nitrogen Cycle

This cycle does not seem as important to students as the carbon/oxygen cycle but without nitrogen, plants will not grow. A research assignment into finding what compounds contain nitrogen would emphasize the importance of this cycle.

Class Activity

Once students have been introduced to all three biogeochemical cycles, they should be able to draw their own diagrams to represent the cycles. It should be emphasized that including some

graphics would make their representations easier to understand and remember. The diagrams should be done in groups on poster-sized paper after the initial planning stages. They can then be put upon the walls for future reference.

The biogeochemical cycles discussed in the Student Guide will be emphasized in Module 4 - Habitats.

APPENDICES

APPENDIX 1: WORD SPLASH - ECOSYSTEM REVIEW

Look at the terms provided below. They relate to a reading you will do shortly. Try to predict relationships between the terms, and link them with a brief description of the relationship. You will check your predictions by reading the article "Ecosystem Review".

bears **ground squirrels**

abiotic

recycled

interact

broken down **sunlight**

ecosystem

carnivore

biotic **producers**

consumers

abiotic

detritus

plants

herbivore

animals

bacteria

micro-organisms

decomposers

temperature

source of energy

omnivore

hawks

temperature

APPENDIX 2: ECOSYSTEM REVIEW

An ecosystem consists of communities of organisms that interact with one another and with the physical conditions and chemical substances that characterize their environment. All ecosystems have both living (biotic) and non-living (abiotic) components. The biotic community consists of plants, animals, and microorganisms. Green plants use sunlight as a source of energy to produce organic matter from water obtained from the soil and carbon dioxide obtained from the atmosphere. Plants, therefore, are often called producers. In contrast, because animals and most microorganisms cannot utilize solar energy directly they must consume other organisms to obtain energy. Animals and most microorganisms are therefore called consumers.

Consumers fall into one of several categories based on their good sources. A consumer that eats only plants is called an herbivore (plant-eater), whereas a consumer that eats only animals is called a carnivore (flesh-eater). A consumer that eats both plants and animals is called an omnivore (everything-eater). Familiar herbivores include rabbits, ground squirrels, and caribou. Common carnivores include birds of prey (eagles and hawks) and members of the dog family (wolves and domestic dogs). Most humans are omnivores, consuming both plant and animal products, as are bears.

When plants and animals die, they become food for other organisms. Dead plant and animal remains are termed detritus. If the remains are not eaten immediately, they are usually colonized quickly by decomposers such as bacteria and fungi. These organisms utilize detritus as a source of energy and nutrients. During the process of decomposition, complex chemicals are broken down into simpler substances that return to the soil, air, and water where they can again be taken up by green plants and recycled through an ecosystem.

Abiotic components of an ecosystem also include such physical factors as sunlight, temperature, wind and fire. These components play major roles in determining the types and numbers of organisms that reside in an ecosystem.

Source: Ecological Principles
http://xnet.rrc.mb.ca/joycef/ecologic.htm
(Website of Loretta (Joyce) Graham Fogwill, M.Sc., M.Ed., M.P.A. Instructor, Department of Applied Sciences –Chemical and Biosciences Technology, Red River Community College, Winnipeg, MB)

APPENDIX 3: SCAVENGER HUNT

Pollution Issues **Student Overview**

Our immediate environment has changed a great deal since our grandparents lived in our community. Some things may never be the same. What has changed? A frank discussion with one of the local elders will provide some insight into the changes. With modernization or 'progress' comes the problem of pollution. Pollution is anything that enters the environment that has the potential to alter the life cycle, feeding behaviour, or health of plants and animals. The health and future of our community is threatened by pollution. For years now, the environment has been the recipient of our industrial wastes, our sewage, and our litter. We have altered the landscape and polluted our environment to suite our needs for community growth.

Pollution has a tremendous effect on the environment. It alters the quality of life for both plants, animals and humans living in the surrounding regions. Pollution impacts animals of the environment and can cause disease, birth defects, even death in extreme cases. Often the pollutants may interrupt reproductive cycles or alter physiological systems of animals. Pollutants that are washed into the ocean are often carried back to shore by waves and the action of wind. They often remain suspended in the water column affecting the marine life.

Pollution originates from obvious sources such as industrial and commercial enterprises and from human sanitary waste. It also originates from a less obvious source – it is the result of our lifestyles and the quality of life we have come to value. We are great consumers of manufactured products and as such we generate huge amount of waste garbage material. In some cases pollutants are emptied directly into the water around our community, in other cases it seeps through the ground to the same endpoint.

Pollution types are usually categorized into two types: point source pollution and non-point source pollution. Point source pollution is any pollution that can be traced back to an identifiable source. Discharges from industrial plants or the effluent from a sewage treatment plant would be examples of a point source pollution. Examples of pollutants that enter the water table from point sources would be metals, dyes and solvents, bacteria and viruses found in human sewage. Point sources are usually easier to control.

Non-point source pollution is that which originates from a diffuse source that is not easily traceable. Water run-off, contaminated groundwater, agricultural runoff, failing septic tanks, marinas, recreation and commercial boats.

Large concentrations of sewage can cause explosive algal growth that often leads to low oxygen levels in fresh water affecting the development of aquatic life. Sewage also brings bacteria and viruses into the water. Heavy metals can accumulate in the sediments and in the food web causing health problem to both animal and human lives. Floatable debris, such as litter, harms animals that ingest it or become entangled in it. These are just a few of the effects of coastal pollution.

Activity Introduction

1. What are some of the pollution issues facing the health of our local community?

2. What do you know about these issues? Are there solutions to the problems that exist? How can we prevent future problems?

3. Where would you go to get information on pollution problems? (Create a list on the board of possible sources of information)

Create a library of coastal issues information in the classroom. To create this library we are going to go on a scavenger hunt.

Idea List of Things to Collect

- Newspaper articles
- Magazine articles
- Summary of news items from the radio or television.
- Photographs of pollution.
- Summary of interviews
- Create a list of hazardous products found in the home.
- Investigate how sewage is treated in your community.
- Create a list of agencies or groups in your community that fight against pollution.
- Write a poem or a song about local pollution.
- Design a poster that identifies a coast pollution issue and its solution.
- Other

Scavenger Hunt Rules

1. Each member of the group must contribute equally to the group effort.
2. You can go anywhere that is appropriate to collect your materials.
3. Cameras and tape recorders may be used to record information.
4. Written summaries of interviews and radio or television shows are acceptable.
5. All sources of information must be recorded. Include any of the following that are appropriate:
    a. The name of the source, or the person you spoke to or the place you visited.
    b. The title of the book or article or the name of the person you interviewed
    c. The date of the interview
    d. The date of publication of the book
    e. Any other information you think is important.
6. To receive credit, all materials must be brought into the classroom.

Follow-up Discussion

1. What types of information were collected?

2. What were some of the sources of information?

3. Which information will be most useful to our library?

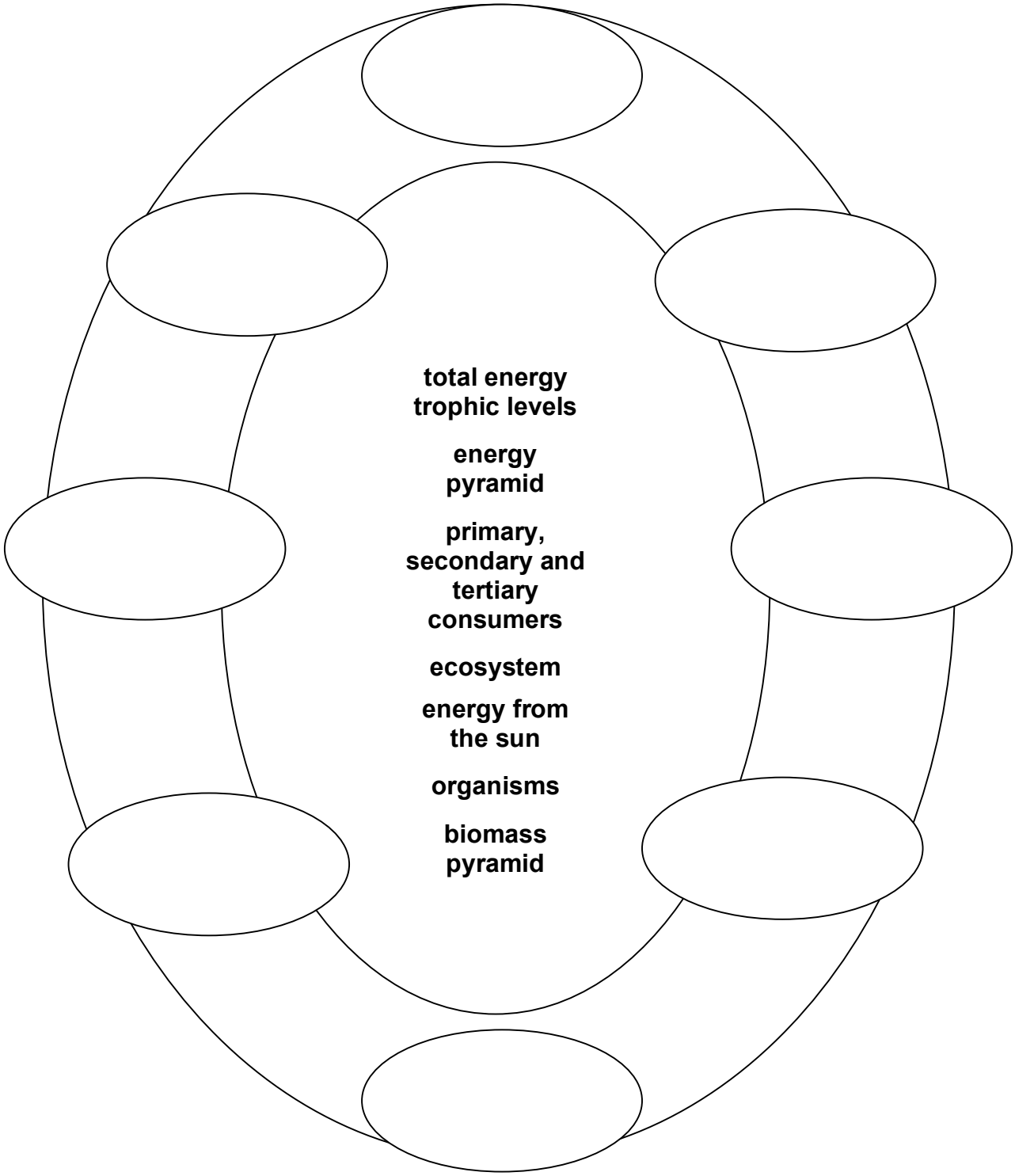
4. Can you think of any other sources of information that have not already been identified?

5. What is the most interesting thing you discovered?

6. Does some of the information present conflicting views? Why are they in conflict? How will you decide which information is most accurate? How can you be sure?

APPENDIX 4 - WORD CYCLE

Select two words from the list provided in the diagram and identify the connection between them. Place the words in two adjoining ovals, with the relationship between the words written in the band that connects the ovals. Continue this process, adding connections to additional words, until the cycle is complete.



APPENDIX 5 -FACT-BASED ARTICLE ANALYSIS

Key Concept (In sentence form):

Draw a Representation

Write a paragraph summary in your own words.

List at least 5 Scientific Facts:

List at least 2 Questions:

List at least 5 Key Terms

Relevance Today:
This is important because