ARCTIC MARINE SCIENCE CURRICULUM

MODULE 3

LIVING ORGANISMS

TEACHER'S GUIDE

2001

Prepared for:
Fisheries and Oceans Canada
Northwest Territories Dept. of Education, Culture and Employment
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Yukon Department of Education

Prepared by:
AIMM North Heritage Tourism Consulting
with
Prairie Sea Services, Bufo Incorporated and Adrian Schimnowski

MODULE 3

TEACHER'S GUIDE

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RECOMMENDED RESOURCES

Print:

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

Dando, Marc and Michael Burchett, contributors, Geoffrey Waller, editor. SeaLife, a complete guide to the marine environment. US: Smithsonian Institution Press, 1996.

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.

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

Graves, Jonquil and Ed Hall, Germaine Arnaktauyok. Arctic Animals. Yellowknife: Department of Renewable Resources, 1988.

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Kibaluk, Peter. Final Report on a Study of Inuit Knowledge of the Southeast Baffin Beluga. Iqaluit: Nunavut Wildlife Management Board. 1998.

Matthiessen, Peter. The Wind Birds, shorebirds of north america. Vermont: Chapters Publishing Ltd. 1994.

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

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

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

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

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

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

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

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

INTRODUCTION

This module presents an overview of the living organisms that appear throughout the Arctic Regions of Canada. An attempt has been made to provide the teacher with enough information to make choices in their classrooms. More specific details will be provided as living organisms are discussed again in the Module 4 – Habitats.

This module begins with an introduction to one example of an aboriginal perspective on living organisms through a look at Inuit worldview. The "Try This" questions will begin discussions on an important aspect that will be revisited throughout this module: human interaction with living organisms.

1.1 CLASSIFICATION SYSTEMS

SLO 3-01:	Demonstrate an understanding of western and traditional classification systems through application.
SLO 3-02:	Identify different orders of animals
Essential Question:	***How do people communicate about living organisms?***
Recommended Time:	1 class

Overview

Students will most likely be familiar with a number of classification systems like Dewey Decimal system which is used in their school or community library, but will need to talk about why these organizational systems are important. It is not intended that students memorize the taxonomic names of organisms in this module, but that they understand the western scientific and traditional way of describing organisms and gain an appreciation for the diversity and vast numbers of organisms in the North.

Activating

Activate students' prior knowledge by having them share what they know about classification systems, including providing examples of systems they may be familiar with. The teacher may begin by describing how common things; such as your mailing address are examples of different levels of classification. For example:

Nunavut Wildlife Management Board
P.O. Box 1379
Iqaluit, Nunavut, Canada
X0Z 0H0

If possible, encourage students to share their information about traditional ways of classifying organisms.

Students should be given a set of random objects and asked to classify. Once completed, they should record their "rules" for classifying and then reclassify the same objects in a different way. Students should share their methods of classifying and discuss the usefulness of the different methods and the fact that there is not ONE correct way to group the objects.

Talking With Elders

Bring an Elder or Elders to class to talk about how they "classify" or group animals. Be sure to use terms that they can relate to. Have students record information that is provided and record that information in the Community Profile book. This information will also be used in later activities.

E Check For Understanding

Have students read section 1.1 in the Student Guide up to Check your Understanding Part 1 and answer the questions provided. Discussion with another student will often provide the motivation to answer a question in class. The point of asking students to write in their notebook ensures that something will be written down. It is important to always ask several student groups to read out their answers. It maintains a link with students and provides another level of accountability. The answers that are given here should be used as a guide and should not be taken as the only answers possible.

1. What are two reasons why scientists needed a classification system? (*There are so many organisms to describe, organism that have similar characteristics can be linked together under a group or phylum name, better communication among scientists to ensure they are talking about the same species as different common names may be used in different regions.)*
2. Why are there so many levels to the system? (*As the number of sub-categories increases so does the level of specificity to physical characteristics.)*
3. Briefly describe a similar classification system. (*Dewey system has an infinite number of subcategories that are designated by increasing number of decimals E.g. 101.5.12.5.8.Ab)*
4. List the taxonomic levels. (*Kingdom, Phylum, Class, Order, Family, Genus, Species)*

Background Information

A new system of classification at the kingdom level has recently been gaining favor. It breaks up life into 3 kingdoms: Archea, Bacteria, and Eucarya (eukaryotes). Other systems create a higher category than kingdom called 'empire' or 'domain.' These new systems are more phylogenetically correct, meaning it is a more accurate representation of how life evolved. Archea, or ancient prokaryotes, is very different from bacteria and eukaryotes in terms of its DNA. Archea used to be classified together with bacteria, but more detailed DNA analysis has shown that it should be a separate kingdom. The bacteria kingdom includes the prokaryotes that evolved after Archea, going off on a separate branch. The third branch of life is eukaryotes, the more complex life that evolved much later than Archea and Bacteria split. Animals, Plants, and Fungi are at the very top of this branch, showing how recently they evolved. This system will probably replace the old five-kingdom classification, which does not recognize the diversity of microbial life.

On the other hand, students in the past (some of you may remember this from your schooling) were taught there were only two kingdoms. It is important for students to understand that taxonomy is a living science and what they learn today may come to be regarded as historical curiosity.

Ocean Profile

Have students read the remaining of Section 1.1 (Other Ways to Look at Living Things in the Ocean) and complete the following activity. The Check Your Understanding question can be completed following the Western and Scientific Classification Systems activity (see next section).

Have students create a diagram of the ocean profile using the following terms: benthic, pelagic, photic or epipelagic, littoral, sub-littoral. This diagram should be done in students' notebooks and will help to practice technical drawing skills. In addition, the development of a large classroom poster would be beneficial. A group of students may choose to take on this task and draw a large size ocean profile for the classroom wall. Alternatively, one student's drawing could be copied onto an overhead, projected on the wall, and traced to create a large poster. As the various levels are discussed, organisms can be placed onto the appropriate part of the wall charts.

Western and Traditional Classification Systems

Now that students have had a chance to look at traditional and western ways of grouping and describing living things, have them compare and contrast the approach. If information from Elders is not available, research can be done into other ways of classifying (e.g. from other cultures) to form the basis for comparison. Points for comparison could include purpose of the system, basis of system (structural characteristics, seasonal location, etc), and levels of organization.

Assessment Suggestion: Have students answer the question "Why are there so many different ways to group and describe living organisms?" *This question could be provided to students as a formative assessment to check their level of understanding of classification systems. Look for indications of the following in student responses:*

- Ability to identify the many possible purposes of classification systems

- Ability to describe several classification systems, including the scientific and traditional
- Recognition that one system is not BETTER than another, but that each serves its own purpose

Assessment Suggestion:

OCEAN PROFILE DIAGRAM RATING SCALE				
CRITERIA	RATING POOR 1	 FAIR 2	 GOOD 3	 EXCELLENT 4
Contains title				
Required terms clearly labeled (benthic, pelagic, photic, epipelagic)				
Accurate representation of profile				
Neat, clear, visually appealing				
OVERALL SCORE				

1.2 KINGDOM MONERA

SLO 3-03: Identify the key characteristics of bacteria.
SLO 3-04: Describe the role of bacteria in a marine ecosystem.
SLO 3-05: Examine bacteria slides and identify the three basic shapes of bacteria.

Essential Question**:** ***What are the characteristics of organisms found within the Kingdom Monera and why are they important?***

Recommended Time: 3 classes

Student Guide

Have students read section 1.2 Kingdom Monera in the student guide. The questions will be answered at a later point.

Research Project

One type of bacteria, which is important to the Arctic, is the Saprobic bacterium, which aids in the decomposition of organic matter. There is also some evidence that these bacteria can slowly degrade petroleum products so they can be safely absorbed into the environment. A research project in this area would be a good introduction for students to bacteria. As a class, parameters for the research project should be set, including identification of what types of information should be included (what are saprobic bacteria, what is their role in the food web, how do they interact with petroleum products) and how many sources should be accessed. This could be an on-line research project and a number of useful sites are provided below:

The following website offers lots of excellent photographs and video clips for the curious student. Of course if students try to download video clips and they have a slow connection they will get turned off quickly.

www.cellsalive.com/

This more advanced site provides a library of over 200 images.

www.microbeworld.org/

This site is excellent for general biology.

www.jdaross.mcmail.com/blgyhmpg.htm

This site from the University of Wisconsin has excellent teacher reference information.

www.bact.wisc.edu/Bact303/TheProcaryotes

Assessment Suggestion: Use the rubric for assessing a research project provided in *Appendix 1*.

The Compound Microscope (Refer to Module 2 Lab Manual)

If students did not conduct microscope activities in Module 2, they should carry out the introductory lab on the use of the compound microscope at this point. This can be found in Module 2, Lab 2 - Compound Microscope.

Nutrient Layers Activity or Demonstration

Because of various factors, such as currents, waves, and temperature, nutrients are not distributed evenly throughout the oceans. This means that organisms must live where the nutrients they need are be found. If these nutrients move to another level by an upwelling, it means that the organisms that need the nutrients must move to where the nutrients have gone. This activity shows students that different materials will float in different layers of liquids. The layers are different liquids for this activity, but in the ocean the layers may be caused by differences in salinity or temperature (causing changes in density) that restrict the movement of nutrients.

This activity can be done as a demonstration or with students working in pairs. With advanced trials, other materials could be used. This activity is an opportunity for students to design their own experiment to try out new materials.

The materials listed work well, but others can be substituted, depending upon availability.

1. A container that can be closed tightly yet has a large mouth opening works best.
2. Place approximately equal amounts of cooking oil and water in the container.
3. Add bran and washed rice to the container.
4. Observe which layer traps each solid. The bran should float on the top of the oil and the rice will sink to the bottom of the water. TRY IT FIRST.
5. If the mixture is shaken and allowed to settle, the same result should be seen as the two layers first mix then separate.
6. Have students draw diagrams to record their results and make linkages to what happens in oceans.

Alternative: Use layer dyed water of different water densities in a container (e.g. make solutions of different salinities). If undisturbed the layers will remain separate for a long period (days or longer). But when shook up (i.e. wind/wave circulation) the layers combine and do not separate.

Lab 1 - Bacteria Lab (Refer to Lab Manual)

Agar can be found in most science labs. Several recipes have been provided to help the teacher make the correct solution of agar for plating. Making the solutions according to the directions and then aseptically pouring the agar onto sterile petri dishes can make a relatively sterile agar plate. The nutrient agar plates can then be inoculated with a cotton swab from almost anything to produce bacterial colonies. Remember to turn the agar plates over once they have solidified and cooled. Otherwise the plates become wet with condensation.

Microscopes should have 400x high power magnification to clearly see if there are any cellular organelles. Lower powers can be used to see bacterial colonies. The greater the magnification, the smaller the colonies of cells that can be seen.

Data Table

	ANABAENA	BACTERIUM
Shape of cells	Round and oblong	Rod
Single cell or colony	Colony	Single cell
Colour	Green	May vary
Length of diagram	Will vary	Will vary
Actual length of cell	Will vary	Will vary

Answers to Questions

1. Which organism produces its own food? (*Any bacteria that is green which indicates it has the capacity for photosynthesis)*
2. To which kingdom do all these organisms belong? How do you know? (*Kingdom Monera, because no internal cellular organelles can be seen.)*
3. Observe other bacteria and make a comparison.

Agar Solutions

A. 15 g of agar
1L of boiling distilled water
1 g of glucose
1 g of phosphate

Dissolve the agar in the boiling water. Add the glucose and stir until dissolved. Pour into petri dishes and allow to cool before turning over to store.

B. 15 g agar
3 g beef extract
5 g peptone
1 L boiling distilled water

Mix the ingredients over heat until the agar dissolves. Pour into petri dishes or into sterile test tubes. Seal the test tubes with a cotton plug.

E Check For Understanding

Have students complete the questions provided in the student guide for section 1.2 Kingdom Monera. The answers that are given here should be used as a guide and should not be taken as the only answers possible.

1. Describe the difference between benthic and pelagic organisms. (*Benthic organisms are those that dwell on the bottom of the ocean while pelagic organisms are those that live in the water.)*
2. List the major kingdoms. (*Monera, Protista, Plantae, Fungi, Metazoa)*
3. What is the difference between a prokaryote and a eukaryote cell? (*Prokaryotic cells are the most primitive of all one-celled organisms. There are no well defined cell organelles like the nucleus. Eukaryotic cells are the more complex and are able to subdivide their cellular activity into cellular organelles like mitochondria).*
4. Describe an importance characteristic of saprobic bacteria. (*They are bacteria responsible for the decomposition of organic matter. They have been known to slowly degrade petroleum products. This answer will be more extensive if students have completed the research project).*

1.3 KINGDOM PROTISTA

SLO 3-06:	Describe the life cycles of red, brown, and green algae.
Essential Question:	***What are the characteristics of organisms found within the Kingdom Protista and why are they important?***
Recommended Time:	2 classes

Background Information

Protists are unicellular or colonial organisms with eukaryotic cells. Some are photosynthetic while others are heterotrophic. When protists occur as colonial forms (i.e. algae), there is little difference in the characteristics of each cell. There are approximately 50,000 species of protists divided into at least eight phyla. Only five of these are important in the marine environment, as discussed in the student guide: diatoms, dinoflagelletes, green algae, brown algae and red algae.

Students should understand that these organisms make form the base of all food chains. Arctic food chains are highly evolved but extremely fragile. Each link of the chain depends on the other links. If one of the species in a chain is adversely affected it impacts on the entire chain.

Student Guide

Have students read section 1.3 Kingdom Protista in the student guide.

Lab 2 - Algal Plants Lab (Refer to Lab Manual)

This lab can be done with samples taken from the community or with purchased samples from a science supply house such as those provided below:

Carolina Biological: www.carolina.com/

Boreal: www.boreal.com/

Wards: www.wardsci.com/

Sargent Welch: www.sargentwelch.com/

1.4 KINGDOM PLANTAE

SLO 3-07:	Describe adaptive features of intertidal flora.
SLO 3-08:	Investigate and explain the importance or grasses that grow in marine environments.
SLO 3-09:	Discuss the importance of plants in the supra littoral zone and classify them.
Essential Question:	***What are the characteristics of marine organisms found within the Kingdom Plantae and how are they different than terrestrial flora?***
Recommended Time:	1 class

Flora Collection

Have student collect samples of intertidal flora and representative terrestrial flora. A class plant collection should be established and maintained, for comparison and/or for examination when new plants are not available. Students could also take digital pictures of these to maintain a digital plant collection.

Have elders and/or local experts visit the class to describe the adaptive features of intertidal flora as well as any medicinal uses. Students should summarize the information from the presentation and other information they have gathered in a report that contrasts the adaptive features of intertidal flora with an example of terrestrial flora.

E Check For Understanding (sections 1.3-1.5)

Have students read the Kingdom Plantae and answer the following questions taken from sections 1.3 to 1.5

1. What organisms are included as phytoplankton? (*Diatoms, and dinoflagellates)*
2. Diatoms and dinoflagellates are micro-organisms. Sketch a food chain to show their importance. (*See the sample Arctic food chain in the Student Guide).*
3. Sketch a diagram of green algae to show its three basic structures. (*See the diagram in the Student Study Guide).*
4. What is the primary function of marine fungi? *(To break down organic matter.)*
5. What is the principal difference between land plants and marine plants? *(Plants rely on the evaporation of water from the leaf surface to provide the force that draws water from the roots and through the stems to the leaves. For plants that are only partially submerged in seawater, such as saltwater marshes, this evapotranspiration system can still work, although these plants must use up a lot of energy to desalinate the salty water coming into their root system)*

1.5 KINGDOM ANIMALIA

SLO's are provided in the subsections that follow.

Essential Question: ***What different kinds of organisms are found within the Kingdom Animalia and why are they important?***

The purpose of this discussion of organisms is to develop a sense of dependency among the various animal links in the Arctic food chain, including human.

ZOOPLANKTON

SLO 3-10: Describe and explain the key characteristics of zooplankton.
SLO 3-11: Identify typical zooplankton.
SLO 3-12: Describe the role of zooplankton in Arctic marine ecosystems.

Recommended Time: 2 classes

Student Guide

Have students read the section describing Zooplankton. 'The Polar Connection' has been included to emphasize the incredible growth of whales that use plankton for food. A math connection would be to take the weigh of a copepod or crustacean and divide that number into the weight of a whale calf to determine the number of crustaceans digested during the calves increase in size. Remind them that a metric tonne is 1,000,000 g and that the weight of a krill might be 0.01g.

Lab 3 - Plankton Lab (Refer to Lab Manual)

This lab includes both prepared slides as well as the collection of water samples. If there is a current in a stream or river then a net is excellent for collecting larger amounts of plankton. Nets for the collection of plankton can be either purchased from any of the science supply companies that have been listed previously or they can be made from nylon stockings. The problem with the stockings is that the material is not as durable and is most likely to tear. Commercially purchased nets can be ordered with specific mesh requirements for the selection of different organisms.

INVERTEBRATES

SLO 3-12:	Describe and explain key characteristics of major benthic invertebrate groups.
SLO 3-13:	Identify benthic invertebrates
SLO 3-14:	Describe the role of benthic invertebrates in Arctic marine systems.
SLO 3-15:	Explain representative life cycles of typical benthic invertebrates.

Recommended Time: 2 classes

Student Guide

Have students read the section describing Invertebrates.

Lab 4 - The Brine Shrimp Experiment (Refer to Lab Manual)

This student-designed lab will help students develop their scientific inquiry skills while investigating an area related to their study of oceans. A Lab Report Template has been provided in the *Appendix 1.*

The Brine shrimp cysts are readily available at science supply sources (and kids science stores, sold as Sea Monkeys) for less than $20.00. Read the instructions carefully. Cysts can come packaged separately from the food and salt, in which case students can make their own saline solutions. Alternatively, if cysts come packaged with salt and food, remove the salt, replacing enough to make a 0.5% saline solution (5 g salt/1L water). Keeping the cysts mixed with the water, the mixture can then be poured into 10 000-mL graduated cylinders. Students can then increase salinity by adding additional salt to the cylinders. Shaking the mixture to once again keep the cysts well distributed, students can then pour these mixtures into their test tubes.

Ensure that students use procedures that allow them to assume that the numbers of cysts in each test tube are roughly equal. You should discuss the role that such assumptions play in investigations, particularly biological ones where it may be unlawful or unethical to manipulate all variables. When counting hatched brine shrimp, discuss the need for taking repeated samples from the water being tested, then averaging the count. This gives a quantitative basis for comparison. Alternatively, students could place a piece of paper with a small hole cut for a "window" against the test tube. The number of shrimp seen in the window in a certain period of time could give a quantitative reading (a magnifying glass may help).

Hatched brine shrimp are extremely small, so students may want to let them grow for a day or two before counting. If so, mix the test tubes several times each day. Cover and invert the test tubes to keep the shrimp and the food from settling at the bottom. Clean a small aquarium or a 4L jar with salt, not soap, and fill it with an appropriate salt concentration. Students can put their brine shrimp in the aquarium at the end of the experiment.

It is likely that students will encounter difficulties, resulting in the need to modify their plan. They should also recognize the need for keeping all variables constant except the one being tested and for developing good recording techniques.

Suggestion for Assessment: An assessment tool for a student-designed experiment has been provided in the *Appendix 2*.

Background Information

A model for understanding benthic creatures:

Look out your window at night. If the ground below you were the seafloor you would see very little; the ocean bottom has little life compared to terrestrial environments. But at eye level you would see a constant rain of particles, many very small, falling towards the bottom. And swimming past you in the dark, eating the particles or eating the 'particle-eaters' would be a parade of creatures some of which are no larger than the particles while others may be the size of whales. And far above, as you glance up, is the faint, dim light from the surface.

The particles that make it to the bottom, many of which are whole or bits of dead organisms, are food for the benthic creatures that are mostly invertebrates. These include many relatives of those that live in the water column: copepods, amphipods, etc. There are also larger mobile creatures such as shrimp and crabs. There are bottom grazers like the urchins, predators such as sea stars, gastropods such as snails and clams, burrowers such as flatworms and polychaete worms, and even a few fish. The range of benthic organisms differs with the water depth. Shallower waters can have an impressive range of benthic organisms.

FISH

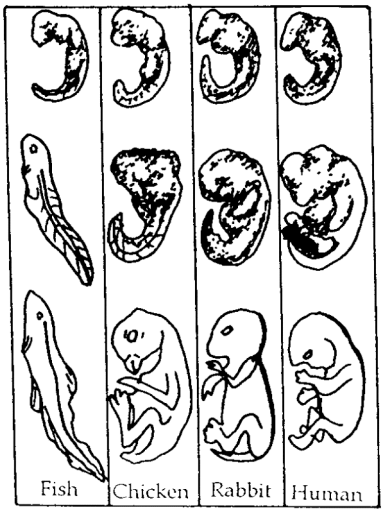
SLO 3-16:	Describe and explain the key characteristics of fish.
SLO 3-17:	Describe, illustrate and identify the body plan of a typical Arctic marine fish.
SLO 3-18:	Examine the form and function of the different parts of a fish.
SLO 3-19:	Interpret a dichotomous key.
SLO 3-20:	Construct a dichotomous key.
SLO 3-21:	Define anadromous and marine fish.
SLO 3-22:	Explain and illustrate migration patterns of anadromous and marine fish.
SLO 3-23:	Illustrate and describe the life cycles of anadromous and marine fish.
SLO 3-24:	Discuss the importance of fish in a food web including up to humans.
SLO 3-25:	Investigate the importance of fish in Arctic society from a commercial, traditional, and ecological perspective.

Recommended Time: 3 classes

Student Guide

Have students read the first section on fish, up to and including the section from Village Science. Discuss with students why the local people did not explain the reason for not feeding fresh fish to the dogs. Ask students the practice in the community. What types of fish are fed to the dogs. Bring in a fresh fish and look for worms in it.

Most students will have some experience with the catching of fish and then and preparation of dried or smoked fish. They will not likely know the anatomy of fishes in scientific terms or the functions of the various physical properties of fishes. The following diagram represents the embryo stage of a number of organisms.



During certain embryological stages, vastly different organisms show similarities. All embryos have all the characteristics of Animalia that are described in the Student Guide.

During later stages of development, profound changes occur. Thus the adults have little resemblance to each other.

Lab 5 - Dichotomous Fish Key (Refer to Lab Manual)

Traditional Perspective: Have students discuss how they (or people in the community) identify local fish. Compile the information and create a guide to the identification of these fish. Some of the points used may not relate to structural characteristics as dichotomous keys use, but to where they fish are found, how they behave, etc. Students could then create a display for the school and younger grades.

Western perspective: Have students complete the fish identification activity using the key provided.

Comparison: Have students discuss the strengths and weaknesses of various ways of identifying fish.

Lab 6 - Fish Anatomy Lab (Refer to Lab Manual)

In order to collect fishes for use in a program such as this course, a letter of permission (educational permit) should be obtained from the Department of Fisheries and Oceans. Contact the nearest Fisheries Officer. This letter, which may vary between jurisdictions, enables the holder to net fish for educational purposes. In many cases students have nets at home and can bring them in. There is usually a limit placed on both the size and the number of fish that can be caught. The permit usually lasts for a fixed period of time and must be renewed each year.

Another option is for the fish to be supplied by one of the local fishermen. It will be necessary for each school to check with the local authorities for special regulations. If in doubt, always ask. A further option is to use frozen fish, but thawing changes the consistency of the fish and makes it less useful for dissection.

The lab is the dissection of a bony fish, the Arctic Cod (*Boreogagus saida*). However, the lab can be adapted for any type of fish that is available to the class. If there are a number of different species of fish that are available, then a comparison could be done for form and function (i.e. flat bottom feeders like a skate or a sculpin).

NOTE: The location and extraction of these otoliths requires careful dissection. Ask local elders or an expert in the community to demonstrate the dissection first.

E Check For Understanding

Have students read the sections on Anadromous Fish and answer the questions provided.

1. It is possible for fish to asphyxiate (suffocate). Speculate on the conditions that would make this happen. *(If a cold water Arctic fish were suddenly exposed to warmer water, it would not be able to extract enough oxygen from the warmer water. Remember from module 1, that according to Henry's Law, warmer water cannot hold as much gas as cold water.)*
2. What enables fishes to adapt to their sub zero temperature environment? *(They have antifreeze built into their system).*
3. How do scientists determine the age of fishes? *(By either using scales or an otolith from the fish)*
4. Explain why it is necessary that anadromous fishes return to freshwater for the winter. *(They return to breed)*
5. Using a map identify areas that the class members have caught anadromous fish. *(Use a local, large scale map to mark the location of any fish that are caught)*

Background Information

This is one of the most interesting examples of animal adaptation to its environment. The information here is additional material for the teacher who may require more detail to the student notes.

How do we tell if a particular fish (or a population of fish) is anadromous or not? *(Virtually all anadromous fish in the Arctic (and in Canada) belong to the Salmonid family that has a bewildering diversity of life styles including species that are anadromous in one part of their range and non-anadromous in others.)*

1. Size: Why are anadromous fish from the same population are usually many times larger than non-anadromous fish (called residuals) from that population?
2. Colour: why do anadromous fish usually lose their parr marks, become silvery overall when in the sea and not spawning, and become bright on their sides at spawning time. Non-anadromous fish usually keep parr marks throughout life, and are colourful at all times (orange or dark).
3. Otolith Analysis: Otoliths are small 'rocks' of calcium carbonate laid down in the fish's inner ear that are used for balance. Otoliths can be used to determine the age and the growth rate of a fish. Many communities have people in the Hunters and Trappers Organizations (HTO) that have experience in this aging process.

E Check For Understanding

Have students read the second piece from Village Science: A Fish Story and complete the questions provided. This story will allow a continuation of the discussion from the previous story and allow students to share their own experiences with learning something new. Students should begin to recognize the power of discovering something for yourself rather than being told the same thing.

Food Chain

Have students read about the Biological Importance of Arctic Cod in the student guide. At this point in the course students should have a good idea about the importance of food chains and the links that connect the loops of the chain together. This account of Arctic Cod further develops this point. Have students in groups make a wall-sized food chain with cut out photographs of the various species involved and the connections. If they then remove cod from the chain, it will become very clear how cod affects the rest of the food chain.

ARCTIC MARINE MAMMALS

WHALES

SLO 3-26:	Identify and describe species of Arctic whales.
SLO 3-27:	Explain the form and function of a whale's body plan.
Recommended Time:	4 classes

Students will likely have much prior knowledge about this topic and should be encouraged to share what they know. This can be accomplished through a KWL strategy where students list what they know about a topic, what they want to know, and at a later point, what they have learned.

Research Activity

The topic of whales is an excellent area to have students conduct investigations into areas of interest to them personally, or to the community. These investigations should include an issues-based or problem-solving approach related to areas of concern. A research project could be on-going throughout the rest of this module. An emphasis should be placed on the concept of conservation and identifying the differing views of stakeholders.

There is an overwhelming volume of resources available for marine mammals. The electronic sites that have been provided in the document are those that relate to organizations that have been around for a while and so the sites should be more reliable. However, sites should still be visited before students use them to see if the links work and if the material is appropriate.

These links contain many varied points of view about marine mammals. However, because many of them are commercial, they focus on the hype of whales and dolphins to promote themselves and their point of view. This is not necessarily all bad as students quickly see a different viewpoint from their own and recognize that everyone does not think in the same way. Some of the material contained in these sites will certainly generate discussion among students. One of the difficult functions of teachers is to expose students to various points of view without displaying an obvious biased towards the topic.

As students read articles about marine mammals they will be able to identify most of the stakeholders: subsistence users, scientists, commercial hunters, commercial fisherman, politicians, bureaucrats, eco-tourism groups, and other commercial ventures that depend on the local environment for their success.

Many of these sites contain student activities in addition to good information. Every site listed contains scores if not hundreds of links to other sites related to this huge topic. Many of them were taken from an excellent web based resource called Classroom Connect at:

www.classroom.com

Government of Canada, Fisheries and Oceans, Arctic Region
This very large site contains information about Canada's role in marine research, wildlife and habitat management. This excellent site provides current Arctic research on most of the marine mammals that have been discussed in this course. The site also provides other links to world conservation and wildlife management agencies.
www.dfo-mpo.gc.ca/

Marine Mammal Centre
This is a must see site. It presents an excellent introduction to marine mammals. In addition to information about most marine mammals and good photographs, the site also contains information about careers.
www.tmmc.org/edumain.htm

Gander's Academy
An absolute must see site. Great information on all species of marine mammals especially whales. There are very good activities, worksheets and projects for students to use directly off the web. Excellent teachers resource. The workbook requires Acrobat 4.0.
www.stemnet.nf.ca/CITE/whales.htm

Cetacea
A slick United States site that provides complete background information about every species of whale, dolphin and porpoise. Individual pages are devoted to specific cetacea and cover topics such as: classification, local names, recognition, habitat, and threats from humans. However, the site does use the term 'Eskimo' and has a very strong view of conservationalism using phrases like "slaughtering of Free Willy" and "action must be taken."
www.cetacea.org/

World Wildlife Fund
The web page is for ALL endangered species but a well designed side bar takes you to whales. There is an extensive discussion of the dangers to whales like: habitat degradation, noise pollution, climate changes, and accidents. It is a neat site. You can even buy a membership as part of its mandate to support endangered wildlife.
www.worldwildlife.org/

Cetacean Society
The focus for this site is saving the whales. It has an excellent photo gallery and contains information issues that relate to whales. The site also provides excellent links to other sites.
http://elfnet1a.elfi.com/csihome.html

Zoom Whales
This site is directed at a generally younger audience but the graphics and information might be suitable for modified students. Even though the presentation style may be for a younger group, the biology material is well explained and accurate. There are lots of activities that can be adapted.
www.zoomwhales.com/subjects/whales/

Two other sites that may be of use from the University of Guelph are:

www.aquatic.uoguelph.ca
www.arctic.uoguelph.ca

These sites are planned to have some information on TEK included. They are still in progress to an extent.

Here are some objectives that could be used to direct student learning as they move through the various web sites on whales. These objectives could be modified for any marine mammal. This information will become important for Module 5 – Governance.

- Understand how whale anatomy and physiology are adapted to life in the sea.
- Identify common behaviours of whales. What is the purpose of these behaviours?
- What are some of the threats to whales in the north? How could they impact on whale populations?
- Determine the impact of subsistence whaling on whale populations
- Is commercial whaling currently banned by all nations?
- What efforts are being made to conserve whales?

How Big is Big?

Most students have little concept of the size of a whale such as the bowhead whale. A quick way to emphasize the enormous size is to have students lay down on the floor head to feet until they have mapped out the size of an average bowhead whale. The following diagram of other animals would help as well. An interesting activity is to make a whale out of black garbage bags that are cut to fit together to make the body of a whale. Duct tape works well. Even the tail and fins can be manufactured out of the black bags. Once the whale has been made, a large commercial fan can be taped to the mouth of the whale. If the fan is large enough (about 60 cm square) the air going into the bag will slowly inflate it. This makes a great gimmick for parent day or a good kick off to the section on whales.

Use a comparison / similarity chart to emphasize the characteristics of the various whales in the Arctic.

Estimation Activity

Marine mammals seem to draw the most attention from the news and society as a whole. There is always conflicting information about the number of animals that are in a particular region. How close are some of them to extinction? How do scientists count marine mammals or any animal for that matter? The following simple demonstration or activity should provide an answer to this question. NOTE: This activity presents a scientific approach to estimating population numbers. Ensure that traditional knowledge is also discussed as an important tool.

Give student groups an organism to count. If possible, it should be organism in the school yard. It might be a certain type of bird, rodent, fly, butterfly, bug, etc. A class discussion should give students some ideas, but generally let them design and count by what even means they think are the most accurate. Make sure that several groups have the same organism so a comparison can be done. If one organism is very common, then the very group could count the name one and then

estimate how many there are in a certain area. The area should be set before the activity starts so comparisons are possible.

Students groups should write out a procedure plan before they begin. Depending on the class, more or less instructions can be given. After the time period have students put their results either on a wall chart and / or a spreadsheet. The spreadsheet can be used to calculate and project populations.

The following questions could be considered after the activity is complete:

1. What method did your group use?
2. What is your group's estimate to the size of the population? Show the math.
3. How does your group's estimate compare with other groups?
4. Why are the estimates not the same?
5. How can you account for the difference?

Ask students how they think technology has improved the accuracy of population studies? Possible answers could be: satellite tags, radio transmitters, radar, sonar, Doppler radar, aircraft sightings, cliff-top counts (as done for beluga in SE Baffin) catching and then tagging, satellite photographs, etc. Have a natural resources person visit the class to discuss methods they use to track and count animal populations. Highlight the trade-offs that are always a part of population studies - accuracy vs. time and cost. The more accurate the counts, the more time consuming and the more costly they become.

Relate the following story to students, and have them discuss its implications.

A Story

Northerners were invited to a meeting to discuss whale stocks in the north. A map was made showing the distribution of whales based on biologists' information. One of the northerners told the researchers of two more areas where the whales could be found. The researcher said that there were no whales there. The northerner asked if they had checked and they said no but could not include the area as the biologists had not observed whales there. The northerner noted that the map showed the distribution of biologists and not that of whales.

Story related by:
John MacDonald
Nunavut Research Institute, Igloolik.

Estimating whale numbers is more difficult that estimating land animals for the obvious reason that they can go under water and under the ice cover. Most whales migrate thousands of kilometers to feed. Another complicating factor is that they move continuously both during the day and night and they are only seen when they surface.
It is no wonder that there is conflicting data on whale populations and other marine mammals.

Have students read the sections on contaminants and impacts of technology in the Student Guide. It provides a physical account of these whales that includes the concern expressed by biologists that these whales are highly contaminated by toxic substances. There is also an article from a workshop on traditional and contemporary knowledge of Nunavik Belugas. This article strongly reinforces the concern for the accumulation of these poisons in these marine mammals.

Prior to having students answer the questions provided, the class should talk about the meaning of technology. Technologies are simply tools that were developed to meet human needs.

In summarizing the impacts of technologies on Beluga, students should note that it appears that noise has the greatest impact on the Beluga behaviour. These animals are very sensitive to sound and hunters have known this for generations. Traditionally, various methods were used to limit noise made during hunts.

Technologies used during hunting today include not just firearms, but other things such as transportation, food and camping equipment, navigation and communication devices. The implications should include reference to hunters having the ability to travel greater distances to reach their prey and kill more efficiently. This can result in greater stress on animal populations and the need to travel farther afield to find prey. There is also no longer the necessity to utilize all parts of the animal, as many needs are now supplied from modern materials. From a cultural perspective, it also means loss of traditional methods of hunting, including the full utilization of the kill that was so important to communities.

Have students read the final section on whales, and answer the questions provided.

E Check For Understanding

1. Why do you think whale stories attract the interest of the media? *(Student answers will vary with their experience with the media)*
2. Describe the process by which a baleen whale collects food. *(It opens its mouth and allows water that contains food to enter. It then closes its mouth and squeezes the water out through its baleen combs. The food is left behind in its mouth.)*
3. Research more about echolocation.
4. How do scientists arrive at the conclusion that whales are very social animals? *(By observation and data gathering)*

SEALS, SEA LIONS AND WALRUSES

SLO 3-28: Identify and describe species of seals and walrus.
SLO 3-29: Describe and explain the life cycle of typical Arctic seals and walrus.
SLO 3-30: Explain the form and function of seal and walrus body plans.

Recommended Time: 2 classes

This group of marine mammals has been singled out as the cause of the declining in fish stocks around the world. They have become the scapegoat for what is wrong in the fishing industry. Students should be aware of as many of the different arguments as possible so they can make informed decisions.

Marine Mammal Survey (*Appendix 3)*

This survey will give students some of the arguments and solutions that have been considered by the Fisheries and Oceans Canada, community representatives, fisheries advocates, and animal activists. An answer sheet has been provided.

E Check For Understanding

Students will have a variety of answers depending on the location of their community.

1. What kind of seals do you have in your community? Estimate how many there are. How has this number changed over the last 10 years?
2. What are the traditional names for the seals in your community?
3. How important to your community are seals today?
4. Speculate why nature delays the implantation of the embryo in the uterus of ringed and bearded seal. *(To coincide with warmer weather)*

POLAR BEAR *URSUS MARITIMUS*

SLO 3-31:	Identify morphological features of polar bears.
SLO 3-32:	Describe the life cycle of polar bears.
SLO 3-33:	Compare and contrast the form and function of polar bear body plans with terrestrial bear forms.
Recommended Time:	1/2 class

Bear Safety Activity

The polar bear is usually shown lumbering slowly across the ice floes. It is rarely seen as the most powerful predator in the Arctic. Student research focusing on this top of the food chain mammal will provide information as to its true character and its ecological and cultural importance. Have students talk to local elders about safety related to bears when out on the land.

Life Cycle of a Polar Bear Activity (*Appendix 4*)

Have students use a "reading for information" strategy to summarize information on the life cycle of a polar bear reading provided in the appendix. They can strategies such as a concept map or web diagram to record their notes, or headings and subheadings using point form information.

Have students add to their notes with information provided by local experts and/or elders.

ARCTIC BIRDS

SLO 3-34: Identify and describe species of Arctic marine birds.
SLO 3-35: Explain the form and function of sea bird body plans.
SLO 3-36: Describe the role of sea birds in Arctic marine systems.
SLO 3-37: Describe migration patterns of marine birds.
SLO 3-38: Examine the food web relationships of local marine birds.
SLO 3-39: Identify and describe marine bird habitats.

Recommended Time: 2 classes

To Think About

Have students read the first section on Arctic birds and complete the questions provided. This is a good opportunity to showcase community crafts and workmanship and hold a community celebration.

Viewing Birds

Ask a local expert to introduce students to the field study of birds. This includes use of binoculars and field markings to identify birds. Have students travel on the land with elders and have them share their knowledge of birds.

Sea Birds Project

Provide students with a number of topics for research. Have students work in groups to carry out the research required and prepare a presentation to the class of their findings. Encourage students to present their information in interesting ways. For example: create models illustrating body plans, prepare multimedia presentation on local birds and their identification.

Topics of study:

- Species of Arctic birds
- Form and function of seabird body plans
- Migration patterns of marine birds
- Marine bird habitats
- Food web relationships
- Management of birds (preserves, hunting regulations)
- Legends related to birds
- Tracking and/or counting birds

These areas of study will allow students to integrate information they have already learned, and/or carry out some initial research for topics that will be studied in more depth in later modules.

Sources of information include:

- When the World Was New, Stories of the Sahtu Dene, 1990, By George Blondin. Outcrop, Yellowknife.
- Inuit Legends. 1997. Ed. by Leoni Kappi. GNWT Department of Education.
- Tales From the Igloo. 1972 Ed. by Maurice Metayer. Hurtig Pub, Edmonton.
- Hinterland Who's Who. Environment Canada. (some Inuktitut versions available). (819) 997-1095.
- Birds of the NWT Checklist and bird song tapes are available from the Canadian Wildlife Service in Yellowknife.
- Birds of Nunavut. Baffin Divisional Board of Education.

APPENDICES

APPENDIX 1: RUBRIC FOR ASSESSING A RESEARCH REPORT

CRITERIA	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Source of Information	Only one information source used and/or information not properly referenced	Two information sources used and proper references included	A variety of information sources used and proper references included	A variety of information sources used, including different media, and proper references included
Information Collected	Information not relevant, and/or not from reliable sources	Information generally relevant	Information relevant and generally from reliable sources	Information relevant and from clearly reliable sources
Organization of Material	Lack of organization, cohesiveness, clarity	Information somewhat organized, clear and cohesive	Information organized into clear sections,	Information organized into clear sections that included introduction, main body with supporting details, and a conclusion or summary
Presentation of Material	Difficult to read (poorly handwritten or typed) Contains major grammatical errors that detract from content No bibliography	Neatly handwritten or typed Contains minor grammatical or spelling errors Includes a title page and bibliography	Neat and organized presentation Minor grammatical or spelling errors Includes title page and bibliography Some supporting graphics provided	Neat and organized presentation No grammatical or spelling errors Includes title page and bibliography Extensive supporting graphics provided

APPENDIX 2: LAB REPORT

Name: _____ **Date:** _____

Experiment: _____

Question: _____

_____

Prediction/Hypothesis:

_____

_____

_____

Planning For a Fair Test

Apparatus/Materials: _____

_____

_____

_____

Variables to Hold Constant: _____

_____

_____

Method: *(Include steps, safety considerations)*

_____

_____

_____

_____

_____

_____

Observations: _____

Analysis of Data (identify patterns and discrepancies):
NOTE: Attach graph on a separate page (if required)

Strengths and Weaknesses of Approach/What I Would Do Differently Next Time:

Conclusion: *(support or reject prediction/hypothesis; new question/s)*

Applications/Implications for Daily Life or Link to Area of Study:

APPENDIX 3: RATING SCALE FOR THE ASSESSMENT OF LABS

Experiment Title: _____

Team Members: _____

CRITERIA	POSSIBLE POINTS*	SELF-ASSESSMENT	TEACHER ASSESSMENT
Making a Hypothesis: • Clearly stated and reasonable • Includes some justification drawing on prior learning or experiences			
Planning the Lab: • Required apparatus/material identified • Major variables to be controlled identified • Steps to be followed included and clearly described • Safety consideration addressed • A plan for disposing of wastes included			
Observing and Recording: • Evidence of repeated trials is provided • Detailed data recorded, appropriate units used • Relevant observations clearly described • Data are recorded in a clear, well-structured, appropriate format			
Analyzing and Interpreting: • Graphs are included, where appropriate • Patterns/trends/discrepancies are identified • Strengths and weaknesses of approach and potential sources of error are identified • Changes to the original plan are identified and justified			
Drawing a Conclusion: • Results are summarized and explained • Hypothesis is supported or rejected • Alternative explanations are identified • Potential applications to or implications for daily life are identified			
TOTAL POINTS:			

**NOTE:* The teacher and/or the class assign possible points to reflect the particular emphasis/es of the lab. Students should complete the self-assessment portion of this form and submit it with their written lab report.

APPENDIX 4: MARINE MAMMAL/FISHERY INTERACTIONS SURVEY

Name: _____ **Date:** _____

NOTE: Please write your answers on the sheet provided separately.

Part 1

1. Overall, how much do you care about the interactions between marine mammals like seals and whales, and commercial fisheries in the Arctic?

2. How much have you heard or read about the interactions between marine mammals and commercial fisheries in the Arctic?

Part 2

1. I am interested in marine mammals.
2. I believe people have the right to control the wildlife of the Arctic.
3. One has to admire the skill and daring of Arctic sealers who came from Europe and hunted seals in wooden boats in the dead of winter.
4. I believe the proposal to reduce seal numbers because they supposedly compete with commercial fishing is just an excuse for resuming the commercial hunting of seals.
5. Commercial fishers are justified in killing seals that damage fishing equipment or steal fish from their nets.
6. I think seal watching could be an important contribution to the tourist industry of the Arctic.
7. If the government decides that seal numbers in the Arctic must limit because they are perceived to be too abundant, then I would prefer to see a commercial harvest of seals where their meat or furs are sold, rather than a government controlled hunt.
8. Canada should not allow foreign fishing fleets in its waters if their fishing activities might harm seals.
9. Seals are gluttons.
10. I believe seals are being unfairly blamed for declines in the commercial fishing industry.
11. I believe commercial fish quotas should be based on economic considerations and
12. Not based on ecological issues such as possible impacts to marine mammals.
13. Because we know so little about the biology of mammals, I think the government should be very conservative in setting commercial fishing quotas if this activity

might harm marine mammals.

14. Fishers who deliberately harm seals caught in their nets should be severely punished.
15. I support passing a law to protect areas of the ocean important to marine mammals, even if it results in less commercial fishing in these areas.

Part 3

1. Indicate if you approve of harvesting abundant adult seal populations in the Arctic for any of the following reasons:
    a) For their meat.
    b) For their furs.
    c) When they damage the nets of commercial fishers.
    d) When they are important to the local economy.

2. If seals in a particular area are considered too large and harmful to commercial fishing, indicate if you would approve of the following methods proposed for reducing the number of seals.
    a) Use only guns to reduce the seal populations.
    b) Allow the use of clubs to reduce the seal population.
    c) Allow the use of poisons to reduce the seal population.
    c) Use only non-lethal methods, like loud noises to scare away seals or possibly contraceptive injections, to limit seal populations.
    d) Remove live seals and relocate them elsewhere.
    e) Do not limit seal populations but financially compensate fishers for their losses.

3. Figures suggest the number of cod available for commercial fishing has declined significantly. Indicate if you approve of the following methods proposed for increasing cod populations.
    a) Reduce the number of boats allowed to fish for cod in areas more than 12 miles from the Canadian coast.
    b) Reduce the number of boats allowed to fish for cod within 12 miles of the Canadian coast.
    c) Reduce the number of foreign fishing vessels in Canadian waters, even though these boats may not be officially fishing for cod.
    d) Reduce the number of seals that may compete with fishers for cod.
    e) Reduce fishing methods (e.g., large size nets, bottom trawling) that may accidentally catch many fish at cod feed on, or damage areas where cod feed or reproduce.

4. Marine mammals occasionally become entangled in fisher's nets causing damage and sometimes drowning. Indicate if you approve of the following methods proposed for reducing entanglement.
    a) Pay fishers for nets damaged by seal entanglement.
    b) Provide information and materials to fishers on how to reduce the likelihood of seal entanglement.
    c) Require fishers to use nets that reduce the likelihood of entanglement, even though these nets may be more expensive.
    d) Limit or ban the use of nets that increase the likelihood of entanglement, even though these nets may catch more fish at lower cost.
    e) Eliminate seals that become entangled in fisher's nets.

Part 4

How many of the following activities threaten the future of commercial fishing in the Arctic do you believe?

a. Oil and gas development.
b. Competition from marine mammals.
c. Fishing by foreign countries.
d. Pollution of the marine environment.
e. Damage to commercial fishing equipment by marine mammals.
f. Over-fishing by commercial fishers.
g. Inadequate knowledge of the marine environment.

SEAL SURVEY ANSWER SHEET

Name: _____ **Date:** _____

Part 1:
Use the following scale to answer the questions in part 1.

A great deal / A fair amount / Some / Very Little / Nothing at All

1. _____
2. _____

Part 2 :
Use the following scale to indicate your position on the statements made in part 2.

Strongly Agree ……..1
Moderately Agree ……..2
Moderately Disagree ……..3
Strongly Disagree ……..4
No Opinion ……..5

1. _____	6. _____	11. _____
2. _____	7. _____	12. _____
3. _____	8. _____	13. _____
4. _____	9. _____	14. _____
5. _____	10. _____	

Part 3:

Use the following scale to indicate your position on the statements made in part 3.

Strongly Approve ……...1
Moderately Approve ……...2
Moderately Disapprove ……...3
Strongly Disapprove ……...4
No Opinion ……...5

1. a) _____
   b) _____
   c) _____
   d) _____
   e) _____

2. a) _____
   b) _____
   c) _____
   d) _____
   e) _____
   f) _____

3. a) _____
   b) _____
   c) _____
   d) _____
   e) _____
   f) _____
   g) _____
   h) _____

4. a) _____
   b) _____
   c) _____
   d) _____
   e) _____

Part 4

Answer using a scale of 1 to 5 where 1 indicates a great threat and 5 little threat.

a) _____

b) _____

c) _____

d) _____

e) _____

f) _____

g) _____

APPENDIX 5: LIFE CYCLE OF THE POLAR BEAR

The polar bear, *Ursus maritimus*, evolved from the brown bear and is the largest member of the bear family. Adaptations by polar bears to life on sea ice include: translucent fur with water repellent guard hairs and dense under fur, short furred snout, small ears, teeth specialized for a carnivorous rather than omnivorous diet, and hair on the bottom of their feet. Polar bears also have better eyesight than most bears and excellent sense of smell. Many hollow hairs trap warm insulating hairs and act as solar collectors. The long legs and neck permit the wide-reaching blows and bites necessary to capture seals quickly. The long legs also help in swimming, in moving in deep snow, and – when standing on hind legs for a better view – in scanning the horizon.

Polar bears are the most nomadic of all bears, some of which travel an average of 8,000 kilometres a year or about 23 km a day. Males measure from 2.4 – 3.4 m from nose to tail and generally weigh from 272 to 543 kg, but may weigh up to 680 kilograms. Females measure from 1.8 - 2.4 m and weigh from 181 - 317 kg.

Polar bears generally live alone except when mating or rearing cubs. Exceptions occur when polar bears gather at food sites such as a whale carcass or when they are concentrated on land during the open water season in parts of Canada. At these times, males will often play fight to establish dominance and to practice for the real fights over females.

Female polar bears will reach breeding maturity between the ages of 4 and 6. Pregnant female bears seek out denning areas in late fall on land or sea ice. Dens are made in snow along bluffs and rough ice where snowdrifts accumulate. The female digs out a small chamber in the snowdrift to serve as a maternity den. A litter of 1 to 3 cubs is born in December or January. The cubs will not leave the den until March or early April and will stay with the mother for about two and a quarter years. Female polar bears will have a litter every 3 or 4 years. Polar bears can live up to 32 years but most probably do not live past 25 years in the wild.

Polar bears can be found in Greenland, Norway, Russia, Canada, and in north and northwest Alaska. Polar bears travel on sea ice which expands and shrinks during annual cycles. In the winter, they will travel as far south as St. Lawrence Island or even St. Matthew Island. During summer months, they are more commonly found near the edge of the ice in the Beaufort Sea and the Chukchi Sea. It is estimated that there are 22,000 - 28,000 polar bears worldwide and approximately 3,000 - 5,000 in Alaska.

Ringed seals are a favorite food of polar bears. They capture the seals by waiting by breathing holes and at the edges of leads and cracks in the ice. Bears may also stalk seals resting on the top of the ice and catch young seals by breaking into pupping chambers in the spring. Polar bears also hunt bearded seals, walrus and beluga whales. They will feed on carrion also, including whale, walrus and seal carcasses found along the coast.