

Manitoba

Education, Citizenship and Youth

Grade 12 BIOLOGY A Foundation for Implementation Part 2 - Biodiversity Unit 5 – Conservation of Biodiversity

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CONSERVATION OF BIODIVERSITY

S4B-5-01 Discuss a variety of reasons for maintaining biodiversity. Include: maintaining a diverse gene pool, economic value, sustainability of an ecosystem.

Entry-level Knowledge

In grade 6 Science, students are introduced to the concept of biodiversity and observe and describe the variety of living things in their local environment. In grade 7 Science, students identify environmental, social and economic factors that should be considered in the management and preservation of ecosystems. In Senior 2 Science, students examine the complex relationships present in ecosystems and explain how the biodiversity of an ecosystem contributes to its sustainability. They investigate how human activities affect an ecosystem and use the decision-making model to propose a course of action to enhance its sustainability.

Teacher Background

This outcome provides the opportunity to integrate cultural/local and community perspectives/values into the discussion. Students should understand that values may vary from one group to another. For example, sweetgrass (*Hierochloe odorata*) is of great sacred (inherent) value to First Nations peoples. The smoke of burning sweetgrass is used to purify and cleanse objects, places, and people. Sweetgrass is also of utilitarian value in that it can be used to keep clothing fresh when stored, was used for making baskets, and tea made from its leaves has been used to treat fever, coughs and sore throats.

Teacher Notes

Values clarification be an effective way to have student reflect on what their values are, why they value certain things, and how they can look beyond themselves into the worlds around them. You may wish to first discuss the definition of *value*. The teacher's role in the activities is that of a facilitator who does not impose his or her own values on the discussion.

When discussing an environmental issue, it is important to present more than just the conservationist side (i.e. "save the planet"). Students need to realize that there isn't just one "right" answer to a problem, and that decisions are often based on priorities. What is one person's priority may not be that of another. This can lead to conflict.

Suggestions for Instruction**Activate*****Think-Pair-Share***

Ask students to individually think of and record as many items that come from natural sources that they use in their everyday lives. Students then find a partner (pair) and share their lists. Lists may include items such as leather shoes, milk, vegetables, vitamins, gasoline...

Ask the pairs to think of and record a list of things they appreciate in nature. Lists may include items such as bird songs in the morning, flowers, sunsets, clean air, walk on a beach or in a forest...

Pose the question to the groups:

How would you describe the difference between the two lists?

Student responses should indicate the first list contains items we consider to be useful or practical (utilitarian), while the first list contains items of intrinsic or natural beauty (inherent).

Acquire/Apply***Direct Instruction***

Discuss with students the terms utilitarian and inherent (utilitarian: useful, practical; inherent: intrinsic, natural) and provide definitions. Based on the definition and the Think-Pair-Share activity, students list examples of items of personal utilitarian value (e.g. cow=leather & food) and personal inherent value (e.g. robin's song=sound cheerful).

Values Clarification

This activity will introduce students to values clarification and assist them with determining how they value biodiversity. See Appendix 1: Values Clarification (BLM) for the student handout.

Suggestions for Assessment***Values Clarification***

Use the discussion and written responses from the values clarification activity (Appendix 1: Values Clarification) to assess if students can:

- Identify potential conflicts that may arise when making decisions on environmental issues.
- Explain the logic and validity involved in forming personal opinions

Exit Slip

Pose the following to students:

Should we preserve only those things in nature that have utilitarian value? Why or why not?

Assess student responses logic and clarity. The response should include:

- The position the student took on the issue
- The rationale explaining the student's position

Resources

BioDiversity Perspectives (Manitoba Edition, 2005) is published by Keewatin Publications. This magazine contains articles on a variety of topics, ranging from global perspectives (Why conserving biodiversity is fundamental), to Canadian perspectives (Protecting species at risk), to Prairie regional perspectives (The boreal forest), to Manitoba perspectives (Mosquitoes, pesticides and protests). For a class set of copies, contact Keewatin@sasktel.net or call 306-586-9536.

Project WILD is an interdisciplinary environmental and conservation education program for elementary and secondary educators. The guide contains a variety of activities to integrate into the curriculum. Guides are supplied to all who participate in a Project Wild workshop.

Canadian Wildlife Federation. (1997) *Project WILD Activity Guide*. Canadian Wildlife Federation, Ottawa.

The Canon Envirothon (www.envirothon.org) is an annual competition in which winning state/provincial teams compete for recognition and scholarships by demonstrating their knowledge of environmental science and natural resource management. Envirothon offers both in-class curriculum and hands-on field experiences focused around ecology, natural resource management, and current environmental issues. For more information on the Manitoba Envirothon, visit www.mbforestryassoc.ca/Envirothon/envirothon_home_page.htm

Project WET is an interdisciplinary water-based environmental and conservation education program for elementary and secondary educators. The guide contains a variety of activities to integrate into the curriculum. Guides are supplied to all who attend a Project WET workshop.

S4B-5-02 Describe strategies used to conserve biodiversity.

Examples: habitat preservation, wildlife corridors, species preservation programs, public education...

Entry-level Knowledge

In grade 7 Science, students identify environmental, social and economic factors that should be considered in the management and preservation of ecosystems. Students propose a course of action to protect the habitat of a particular organism within an ecosystem.

In Senior 2 Science, students investigate how human activities affect an ecosystem and use the decision-making model to propose a course of action to enhance its sustainability.

Teacher Background

Students often confuse conservation with preservation. Clarify the concepts, indicating that conservation focuses on maintaining species biodiversity through

sustainable management of wild plants and animals and their habitats. Indicate that management does not necessarily mean a no kill policy. For example, the deer population of Manitoba is managed in part through hunting.

A species preservation program generally concentrates on protecting a particular endangered plant or animal from extinction (e.g. captive breeding programs in zoos).

The term stewardship refers to the wide range of voluntary actions that we can take to care for the environment. Activities range from monitoring and conserving wildlife species and their habitat, to protecting and improving the quality of soil, water, air, and other natural resources. (Canadian Wildlife Service, May 2005, www.cws-scf.ec.gc.ca/index_e.cfm).

Teacher Notes

There is a range of biodiversity conservation strategies in use in Manitoba. Some programs focus on the conservation of a particular species, while others focus on preserving or restoring a habitat in order to conserve the biodiversity of the ecosystem. A local or regional focus on the conservation of Manitoba's biodiversity is recommended.

The Riparian Zone Assessment (see Appendix 2a for Teacher Background and Appendix 2b for the Student Handout) is designed to integrate the conservation of biodiversity outcomes into one major assignment. It can be used in one class, or can be expanded to several, depending on the amount of fieldwork incorporated or the number of case studies examined. A general conservation dilemma (e.g. the clearing of riparian zones for beach property), or a local riparian issue (e.g. local stream/riverbank erosion or development) could be presented.

Suggestions for Instruction

Activate

Brainstorm

Students will have familiarity with a variety of conservation/preservation programs. Lead the class in a group brainstorming session and list the habitat

conservation/species preservation programs generated by the group. Examples of programs include:

- Seed banks
- Zoos
- Captive breeding programs
- Adopt an animal (i.e. World Wildlife Fund program)
- Species reintroduction (e.g. bison in Saskatchewan)
- Habitat protection (e.g. developing parks and preserves)

- Preventing illegal trade of wildlife (e.g. bear gall bladders, rare orchids...)
- Habitat restoration (e.g. restoring wetlands, removing toxic waste...)
- Public education (e.g. identifying species at risk)
- Wildlife corridors
- Improving forest management
- Bag/creel limits for hunters, fishers and trappers

Identify which programs focus on conservation and which focus on preservation.

Acquire/Apply

Guest Speaker

Invite a speaker to discuss conservation strategies with your class. Speakers could include:

- Conservation officer
- Elder
- National Parks Warden
- Manitoba Zoological Society volunteer
- Conservation District Manager
- Manitoba Wildlife Federation representative
- Member of the Canadian National Trappers Alliance

Take a Stand

This activity encourages open-mindedness and demonstrates the range of views on any controversial topic. It enables students to explore the grey areas that lie between the polar opposites of an issue, and helps them develop an appreciation for the spectrum of possible views. See Appendix 3a: Take a Stand Teacher Notes for background information on using the activity with your class. See Appendix 3b: Take A Stand Scenarios to present to your class.

Suggestions for Assessment

Reflection

Students reflect on their participation in Take a Stand activity and describe the value (utilitarian and/or inherent) they used in determining their decision. Assess student responses for accuracy and clarity. The reflection should include:

- The initial position the student took on the issue
- Identification of value used in determining his/her position

- Whether or not his/her position on the issue changed during the activity
- Why his/her position did or did not change

Resources

Manitoba Conservation (www.gov.mb.ca/conservation) website contains information on Manitoba species at risk, environmental issues, wildlife protection, the protected areas initiative, and other topics.

The Assiniboine Park Zoo's Education Centre (www.zoosociety.com/education), managed by the Zoological Society of Manitoba's Education Department, is a facility designed to promote the concepts of endangered species and wildlife conservation through public education and interactive learning.

The Manitoba Conservation Districts website (www.mcda.ca) provides a listing of the location of Manitoba Conservation Districts and contact information.

EnviroZine, Environment Canada's on-line newsletter

(www.ec.gc.ca/EnviroZine/english/issues_e.cfm) covers a wide range of current environmental issues of interest to Canadians and provide links to more detailed information on Environment Canada's Web site, the *Green Lane*, and to other valuable Internet sites.

The Canadian Wildlife Fund (www.cwf-fcf.org) advocates for the protection of Canada's wild species and spaces and is dedicated to fostering awareness and enjoyment of our natural world. The website contains information on programs, resources, current issues and actions, and has links to other websites.

The World Wildlife Fund (www.wwf.ca) is dedicated to conserving the world's biological diversity; ensuring that the use of renewable resources is conducted in a sustainable manner; and promoting the reduction of pollution and wasteful consumption. The website contains information on conservation programs and resources, and has links to other websites.

S4B-5-03 Describe methods used to determine and monitor biodiversity in an area.

Examples: field guides, dichotomous keys, quadrats, transects, mark and recapture...

Entry-level Knowledge

In grade 6 Science, students identify living things using an existing classification key, as well as observe and describe the diversity of living things in the local environment. In Senior 2 Science, students observe and document a range of

organisms that illustrate the biodiversity within a local or regional ecosystem. Statistical sampling procedures are introduced in Senior 2 Applied Mathematics.

Teacher Background

Field guides and dichotomous keys are tools used to identify organisms in the field. Plant populations can be sampled with transects or quadrats, which are plots within which the number or type of species are counted in randomly selected areas. The size of a mobile animal population can be estimated by mark and recapture, in which the organism of study is tagged or banded. These techniques are based on random sampling statistical procedures. Care must be taken in order to assure that randomness occurs when the sampling is performed, otherwise the erroneous population estimates will result. Biologists can determine then if a population is growing or declining by repeating sampling procedures over time.

Teacher Notes

This outcome provides an excellent opportunity to incorporate fieldwork into the course. However, if the weather or resources do not permit, various sampling methods can be simulated (see the investigation in Appendix 4: Estimating Population Size).

The Riparian Zone Assessment (see Appendix 2a and 2b) is designed to integrate the conservation of biodiversity outcomes into one major assignment. It can be used in one class, or can be expanded to several, depending on the amount of fieldwork incorporated or the number of case studies examined. A general conservation dilemma (e.g. the clearing of riparian zones for beach property), or a local riparian issue (e.g. local stream/riverbank erosion or development) could be presented.

Suggestions for Instruction

Activate

Opening Question

How do biologists working in the field identify the different species of organisms that they find? Possible student responses include:

- Field guides
- Reference books
- Dichotomous keys
- Collect and send to an expert
- Personal knowledge

Acquire/Apply

Dichotomous Key/Field Guide

Keys and field guides are relatively easy to obtain and use. Dichotomous keys are readily available in textbooks, lab manuals and on the Internet. See the

Resources below for suggestions of sources of field guides and keys for local flora and fauna.

Field Work/Field Trip

A variety of organizations across Manitoba offer programs that provide students with the opportunity to engage in ecological field studies. See the Resources below for some possible suggestions.

Suggestions for Assessment

Investigation

See Appendix 4: Estimating Population Size (BLM) for an activity in which students are introduced to quadrat and transect sampling, as well as the mark and recapture method in this activity. Assess student answers to questions posed in the investigation.

Note: Use 800-1000 grains of rice per jar when preparing the jars for the mark-recapture exercise in the investigation.

Resources

The Fort Whyte Centre in Winnipeg offers a variety of senior years hands-on field research programs. Call the Centre at 989-8364 or visit the website at www.fortwhyte.org for more information.

Manitoba Conservation offers free of charge school programs in some provincial parks across the province. For more information see the website at www.gov.mb.ca/conservation/parks/education/teachers.html

Oak Hammock Marsh is open year-round and offers a variety of curriculum-based programs for students and an interpretive centre. See the website at www.ducks.ca/ohmic or call 1-888-506-2774 for more information.

Manitoba Conservation has a dichotomous key to Manitoba's sport fish available on its website (www.gov.mb.ca/conservation/fish/images/fishkey1.pdf).

Contact Manitoba Conservation Pamphlets and Publications (945-6799) for the *Field Guide to the Native Trees of Manitoba*, Manitoba Natural Resources Forestry Branch, MG-10041, reprinted Feb. 1998.

Lone Pine Publishing (www.lonepinepublishing.com) of Edmonton produces books focusing local wildlife, history and the outdoors. Field guides include *Animal Tracks of Manitoba* (Ian Sheldon and Tamara Eder, 2001), *Manitoba Birds* (Andy Bezener and Ken De Smet, 2000), and *Manitoba Wayside Wildflowers* (Linda Kershaw, 2003).

**S4B-4-04 Investigate an issue related to the conservation of biodiversity.
Examples: heritage seeds, water quality in Lake Winnipeg, land use designations, hydroelectric development...**

Entry-level Knowledge

In grade 7 Science, students identify and describe positive and negative examples of human interventions that have an impact on ecosystems. They identify environmental, social and economic factors that should be considered in the management and preservation of ecosystems.

In Senior 2 Science, students explain how the biodiversity of an ecosystem contributes to its sustainability. They investigate how human activities affect an ecosystem and use the decision-making model to propose a course of action to enhance its sustainability.

Teacher Background

There is a range of issues related to the conservation of biodiversity in Manitoba. A local or regional focus is recommended. The issue of water quality, particularly in Lake Winnipeg, is an on-going concern. Newspaper articles are readily available on the topic. Topics related to agriculture, such as the grazing of livestock in riparian zones, draining of potholes, and maintenance and planting of shelterbelts that could be examined. The impact of logging in the boreal forest is another possible area of discussion.

Teacher Notes

Students should be given the opportunity to investigate a current issue related to the conservation of biodiversity in Manitoba. This investigation should include some type of decision-making process. The type of decision can vary greatly.

For example, it could include:

- A personal/individual decision (e.g. Should I fill in a pothole on my land for additional farmland, or should I preserve it as a nesting site for birds?)
- A community decision (e.g. Should our community raise its tax rate to pay for an improved water treatment plant that would improve the water quality in Lake Winnipeg?)
- A societal decision (e.g. Should we continue to build hydroelectric dams in Manitoba, or should we explore other alternatives?)

There are a number of approaches that can be used to simulate a real-life context or promote interactions among students. Refer to Appendix 5: Decision-Making for more details.

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general conservation dilemma (e.g. the clearing of riparian zones for beach property), or a local riparian issue (e.g. local stream/riverbank erosion or development) could be presented.

Suggestions for Instruction

Activate

Opening Question

In Manitoba today, there are a number of issues related to the conservation of biodiversity that are being discussed. Which ones are you aware of? Possible responses include:

- saving the polar bears in Churchill (climate change)
- logging in the boreal forest/provincial parks
- invasive species such as purple loosestrife or zebra mussels
- decline of Lake Winnipeg
- at risk species such as the sturgeon, piping plover, peregrine falcon, burrowing owl
- possible introduction of foreign species through diversion of water from Devil's Lake ND into the Red River
- shelterbelts in agricultural areas

Acquire/Apply

Sim Fishery

This is a series of activities that addresses a large context problem about sustainable development. Students are given a lake stocked with fish and money in a bank account. The goal is to create a sustainable fishery. See Appendix 5 for the activity.

Case Study

Shadows of the Forest: Managing Woodland Caribou (2004) tells the story of Manitoba's threatened caribou and the work being done to protect them. The 25 minute video introduces the woodland caribou and some of the factors that make it a species at risk. The second half of the video documents research activities including state-of the art collaring and computer mapping the Eastern Region Woodland Caribou Advisory committee has undertaken to protect caribou habitat. Copies are available in CD or VHS format through the Manitoba Model Forest by calling 204-367-5232 or via email at www.manitobamodelforest.net

Case Study

A number of case studies are available from The National Center for Case Study Teaching in Science at the University of Buffalo website

<http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm>

- "First in Flight, Last in Wetlands Preservation?" on land development and wetland loss when a metropolitan airport proposes expansion

- “The Fish Kills Mystery” on the cause of a major fish kill in an estuary
- “Endangered? The Scenic St. Croix River: A Case Study in Water Stewardship” on a controversy over the river’s management

Suggestions for Assessment

Written Report

Students prepare a scientific report incorporating technical writing to address a conservation dilemma or local riparian issue they have investigated. The report should focus on:

- Identifying the issue and its parameters
- Describing possible courses of action and resulting consequences
- Making a recommendation that is the most ecologically sustainable

See Appendix 2a: Riparian Zone Assessment – Teacher Background and Appendix 2b: Riparian Zone Assessment – Student Handout (BLM).

Resources

BioDiversity Perspectives (Manitoba Edition, 2005) is published by Keewatin Publications. This magazine contains articles on a variety of topics, ranging from global perspectives (Why conserving biodiversity is fundamental), to Canadian perspectives (Protecting species at risk), to Prairie regional perspectives (The boreal forest), to Manitoba perspectives (Mosquitoes, pesticides and protests). For a class set of copies, contact Keewatin@sasktel.net or call 306-586-9536.

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APPENDIX

Appendix 1: Values Clarification – Student Handout (BLM)Introduction

What do you value? What is important to you? Scientists, economists, and policy makers are attempting to determine how important biodiversity is to humans and how it is of value. In this activity will decide how you value biodiversity.

Procedure

Step 1: With a partner, discuss the following questions on how your life is affected by biological diversity:

- a) Which would have a greater impact on your life – if all the bears in the world became extinct or if all the snails in the world became extinct?
- b) Bacteria, fungi and other microorganisms are decomposers in ecosystems. What would happen if these organisms no longer existed on Earth?

Step 2: Answer the following individually; then discuss you answers with your partner.

- a) In order to build a shopping mall and parking lot, a developer wants to build on a field that contains one of the few remaining stands of tall grass prairie in Manitoba. Would you be for or against this development? Explain your answer.
- b) What if the land was to be developed as housing for low-income families and senior citizens? Would your answer be different? Why or why not?
- c) If you won a lottery prize of \$1 million, how much of it would you give to save one hectare of endangered forest?
- d) Was it hard for you to put a dollar value on the endangered forest? Why or why not?

Step 3: Rank the five species in order of their value to you by arranging them on the continuum.

Snail**Fox****Moss****Tuna****Rattlesnake**

High Value**Low Value**

Now place the species with the highest value at the top of the list in the chart below. Then provide your rationale for your ranking.

Species	Reason for Ranking

Suppose the organisms above were endangered and you have to save from extinction. Which would you save and why?

(adapted from Blair, Robert. B. et al. (1999) *Ecology: Teacher's Guide*. Everyday Learning: Chicago.)

Appendix 2a: Riparian Zone Assessment – Teacher Background

Introduction

Riparian areas, especially those in prairie environments, support high levels of natural biodiversity. The combination of water, lush vegetation and connections to other landscapes provides opportunities for many species... Riparian areas create important corridors that link a variety of ecosystems together. Species and genetic material travel easily through these small but unique, pieces of the landscape.

(Cows and Fish, 2002)

The Riparian Zone Assessment is designed to integrate the conservation of biodiversity outcomes into one major assignment. It can be used in one class, or can be expanded to several, depending on the amount of fieldwork incorporated or the number of case studies examined. A general conservation dilemma (e.g. the clearing of riparian zones for beach property), or a local riparian issue (e.g. local stream/riverbank erosion or development) could be presented.

The activity is based on the work done by Alberta's Cows and Fish organization to promote riparian awareness. Their focus is on agricultural issues related to riparian zones, which may appeal to students in agricultural communities. Many additional resources are available on the Cows and Fish website (www.cowsandfish.org). Other riparian issues can have a recreational or industrial focus. Development along the banks of the Red River in Winnipeg is one such example.

Part 1: Importance of Riparian Zones

Students are to:

- Identify what a riparian zone is
- Describe what healthy riparian areas do
- Give examples of how riparian zones conserve biodiversity

Teaching Tips

- Provide students with *Biodiversity and Riparian Areas* for general discussion and background information
- Show pictures/slides of various landscapes and ask students to identify riparian zones based on the three criteria in *Riparian Zones: A User's Guide to Health* (page 4).
 - "Lots of water is present, seasonally or regularly and that water is either on the surface or it's close to the surface
 - Vegetation is present that responds to, requires and survives in abundant water

- Soils have been modified by abundant water (as in high water tables), stream or lake processes (like sediment deposition) and lush, productive vegetation
- Key ideas for discussion: Healthy riparian zones trap and store sediment, build and maintain banks and shorelines, store water and energy, recharge aquifers, filter and buffer water, reduce and dissipate energy, maintain biodiversity and create primary productivity

Part 2: Riparian Zone Assessment

Students are to:

- Examine a local riparian zone (streambank or lakeshore)
- Determine if the riparian zone is healthy

Teaching Tips:

- Provide students with “Looking at my Streambank” or “Looking at my Lakeshore” or “Looking at my Riparian Area”, found in *Caring for the GreenZone: Riparian Areas and Grazing Management 2nd ed*, p. 35. The booklets contain a lot of information on assessing the health of riparian zones
- Demonstrate how to use the checklist by showing pictures/slides of riparian zones and discuss with students what the scores from the checklists mean
- The checklists focus on how much of the riparian zone is covered by vegetation, how much of that is disturbance-caused vegetation, if woody vegetation is maintaining itself and being used, if there is dead wood, if there is deep-rooted vegetation to hold together the bank, if there is bare ground, how much of the shoreline has been altered by human activity, if the soils are compacted, access of the stream to the floodplain, if the water levels are being manipulated
- This is an excellent opportunity to integrate a fieldwork component into the course. Students can use their checklists to assess the area, survey plant populations with transects or quadrats, and identify species with field guides and dichotomous keys.
- If you choose not to go on a field trip, present a new area to students with pictures/slides and plant samples. The students can complete the checklist and determine what the riparian health score means for ecosystem biodiversity

Part 3: Issue Analysis

Students are to investigate an issue related to a riparian zone, focusing on:

- Identifying the issue and its parameters
- Describing possible courses of action and resulting consequences
- Making a recommendation that is the most ecologically sustainable

Teaching Tips

- “Today, riparian areas attract a variety of urban, recreational, industrial and agricultural activities.” (Cows and Fish, 2002). Some of these uses contribute to the health of the riparian zone while others do not. Work through a case study of one particular situation in a riparian zone.
- Key management ideas;
 - Prevent potential problems by maintaining healthy riparian zones
 - Reduce pressures or stresses on the area
 - Encourage and protect native vegetation
 - Fix problem areas (e.g. improved paths, fencing)
 - Monitor progress in maintaining riparian health (long-term)
 - Work as a community of stakeholders to improve the area
- If you wish to examine an agricultural issue, consider the grazing of livestock in riparian zones. The Cows and Fish website has numerous Consumer and Producer Stories that could be used. The video “Along the Water’s Edge” interviews ranchers using riparian zones in their operations.
- The issue of water quality, particularly in Lake Winnipeg, is an on-going concern. Newspaper articles are readily available on the topic. Issues include the alteration of the lakeshore, erosion and agricultural run-off
- The impact of recreation on a riparian zone (e.g. motor boat & jet ski wave action on shorelines, cottage and resort development) could be analyzed. The management plan for a lake in a provincial park could be examined as the plans set out the type of recreation allowed on the lake (e.g. motorized boats allowed, no cottage development). Create a scenario in which a developer makes a proposal to develop a resort hotel on a lake. What impact would such a development have? How could it be done to maintain a sufficient riparian zone?

Resources

Fitch, L. and N. Ambrose. (2003). *Riparian areas: A user’s guide to health*.

Lethbridge, AB: Cows and Fishes Program.

- ISBN: 0-7785-2305-5
- This publication is promoted by Manitoba Habitat Heritage Program, Manitoba Agriculture and Food, Riparian Health Council and local conservation districts to promote sustainable land management practices involving cattle grazing and riparian areas.
- There are several editions available and can be downloaded from the Cows and Fish website (www.cowsandfish.org). The organizations listed above can be contacted for copies
- Single-page handouts are available on the website in the Publications section including
 - Facing the Issue
 - Riparian Health Assessment and inventory

- Water Quality and Riparian Areas
- Crops, Creeks and Sloughs
- Lakes and Wetlands
- Value of Wetlands
- Biodiversity and Riparian Areas
- Looking at my Streambank
- Looking at my Lakeshore
- The focus is on the practical aspects of assessing the health of a riparian zone. The simplest forms are the Streambank Riparian Health Checklist and the Lakeshore Riparian Health Checklist.
- Students can be trained in using the checklists by members of the organizations listed above.

Appendix 2b: Riparian Zone Assessment – Student Handout (BLM)

Introduction

Riparian areas, especially those in prairie environments, support high levels of natural biodiversity. The combination of water, lush vegetation and connections to other landscapes provides opportunities for many species... Riparian areas create important corridors that link a variety of ecosystems together. Species and genetic material travel easily through these small but unique, pieces of the landscape.

(Cows and Fish, 2002)

Tasks

1: Importance of Riparian Zones

- Identify what a riparian zone is
- Describe what healthy riparian areas do
- Give examples of how riparian zones conserve biodiversity

2: Riparian Zone Assessment

- Examine a local riparian zone (streambank or lakeshore)
- Determine if the riparian zone is healthy

3: Issue Analysis

Investigate an issue related to a riparian zone, focusing on:

- Identifying the issue and its parameters
- Describing possible courses of action and resulting consequences
- Making a recommendation that is the most ecologically sustainable

Appendix 3a: Take a Stand - Teacher Notes

Use a space large enough to accommodate the class. Designate one end of the space as “Totally Agree” and the other end “Totally Disagree”. A line connecting the two opposite poles can be marked with masking tape to represent the continuum of positions that lie between.

Read a scenario out loud, providing students with a paper copy or use the overhead if needed. Then ask students to find a position on the line that reflects their opinion on the issue. Once the students are in place, ask for explanations of why they chose their particular stand. Encourage students to respond to the opinions stated by others, but do not permit them to attack another’s position. Explain to students they are free to adjust their positions on the line as they hear ideas that they have not previously considered, as a reflection of their changing views on the issue.

This activity can be used at the beginning of the topic to stimulate interest, discussion and research and doesn’t depend on students having any special expertise on the issue. Repeated at the end of the topic it can assess what the student have learned over a period of time, and how their views have changed as a result of their learning.

Appendix 3b: Take a Stand Scenarios

1. Fish Now or Later?

Mike has made a living for himself and his family for the last twenty years as a commercial fisherman on Lake Winnipeg. He recently purchased a new, larger fishing boat. The payments on his boat are high, but Mike and his crew can work more safely and efficiently.

Mike's neighbour Ramone is a freshwater biologist who works for the government. He has been studying fish populations in the lake over the past ten years and is supporting a large reduction in the amount of commercial species (pickerel and whitefish) that can be caught in a year. Ramone says "My research shows that the numbers of fish in the lake is declining. We need to cut back on the quotas assigned to fishers."

"I can't have my quota cut back," replies Mike. "I have to make my payments on my boat, and have a family to support. My crew needs their jobs as well. Why don't you do something about the pollution in the lake that is causing the fish stocks to decline?"

Ramone replies to Mike's concerns by saying "If we don't act now, there won't be any fish left in a few years. The fish are at great risk. Look what happened to the East Coast cod fishery."

"There still are lots of fish in the lake," answers Mike, "and I expect to catch my fair share, which is why I bought my new boat. How else can I pay for it? How else can I earn a living?"

**Where do you stand on the question of cutting back on fishing quotas?
(Mike's position)**

2. Wolves and Cattle

Wolves are natural inhabitants of Yellowstone National Park in Montana and Wyoming, but humans killed off all the wolves in the region in the early 1900's. After many years of work, environmental groups convinced the US government to release a pack of wolves in the park in order to re-establish a wolf population in the area.

Sarah works for Wolves in the Wild. She says that wolves must return to these wild areas because they are an important part of the ecosystem, and will help restore the natural population balance of many wildlife species. "We destroyed

these animals in what was their natural habitat. It's only right that we return it to them. It isn't the same country without the wolves."

Pete is a rancher. He points out that wolves don't know about park boundaries, and says there's no way to protect his cattle from them. "They're as happy to bring down a heifer as they are to kill a deer," claims Pete, "and I shouldn't have to have my cattle's lives threatened. This is now, not 75 years ago. The wolves are gone. Let them stay away. I have to make a living."

Where do you stand on the question of introducing wolves back into the park? (Sarah's position)

Note: In 1995 and 1996 wolves were captured from Canada and released in Yellowstone Park. An additional ten were moved from northern Montana into the park in 1997. Tracking and scat analysis has shown that concerns over cattle predation by wolves have not materialized. For more information on the Yellowstone Wolf Restoration Project, visit www.nps.gov/yell/nature/animals/wolf/wolfrest.html

(adapted from Greene, Alanda. (Winter 1997-98). Where Do You Stand? *Green Teacher*, 54, 19-21.)

Appendix 4: Investigating Population Size (BLM)

Problem: What methods are used to estimate the size of plant and animal populations?

Introduction: It can be difficult to determine the size of plant and animal populations. This is why biologists use a variety of sampling strategies to estimate the size of populations in an area. Plant populations can be sampled with transects or quadrats, which are plots within which the number or type of species are counted in randomly selected areas. The size of a mobile animal population can be estimated by mark and recapture, in which the organism of study is tagged or banded.

These techniques are based on random sampling statistical procedures. Care must be taken in order to assure that randomness occurs when the sampling is performed, otherwise the erroneous population estimates will result. Biologists can determine then if a population is growing or declining by repeating sampling procedures over time.

Materials (per student group):

- biology textbook
- ruler
- microscope coverslip
- opaque jar or coffee can with a lid containing a number of rice grains
- felt-tip marker
- calculator

Procedure:

Part 1: Transect Sampling

1. Select one page at random from your biology textbook.
2. Hold the ruler flat over the page at a height of 10 cm. Close your eyes and drop the ruler.
3. Slide the ruler so that it extends the length or width of the page. One side of the length of the ruler is the transect line.
4. Count the number of letter e's (small and capital) along the transect line. Record this in your data table.
5. Select another page at random in your textbook. Repeat steps 2 – 4 an additional four times, recording your data after each trial.

Part 2: Quadrat Sampling

1. Obtain a microscope slide coverslip. The opening in the index/file card is the quadrat.
2. Select one page at random from your biology textbook.

3. Hold the coverslip 10 cm away from the textbook. Gently toss the coverslip onto the page.
4. Count the number of letter e's (small and capital) in the quadrat. Record this in your data table.
5. Select another page at random in your textbook. Repeat steps 2 – 4 an additional four times, recording your data after each trial.

Part 3: Mark and Recapture

1. Obtain a can containing grains of rice. The rice represents an animal population. Your teacher will assign your group a specific number of rice grains to be picked out and marked. The number will either be 50, 100 or 150, and will represent the number of animals captured for the first time and marked (M). Record this number in your data table
2. Take turns and remove your assigned number of rice grains from the can. Use the marker to colour the grains of rice you removed.
3. After allowing the ink to dry, place the coloured rice grains back into the container. Shake the container well.
4. Your teacher will assign you a specific number of rice grains to be picked out a second time. The number will either be 60 or 120, and will represent the number of animals captured a second time (C). Record this in your data table.
5. Remove the cover of the can and without looking into the can, draw out the number of assigned rice grains out of the can. Count how many grains of rice are the marked ones (recaptured). Record this as R Trial 1 in your data table.
6. Return all of the rice grains back into the container. Shake well and repeat step 5, removing the same number of rice grains. Record the number of marked rice grains as R Trial 2.
7. Repeat step 6. Record the number of marked rice grains as R Trial 3.
8. Determine the average of your three recapture trials and record this in your data table as the average R value.
9. With your partners, count the total number of rice grains in the can. Record this in your data table as the actual number of rice grains.

Data Table:

Part 1: Transect Sampling

Trial	Number of letter e's
1	
2	
3	
4	
5	

Part 2: Quadrat Sampling

Trial	Number of letter e's
1	
2	
3	
4	
5	

Part 3: Mark and Recapture

Step	Number
M (number of rice grains picked the first time and marked)	
C (total number of rice grains picked the second time)	
R Trial 1 (number of rice grains recaptured)	
R Trial 2 (number of rice grains recaptured)	
R Trial 3 (number of rice grains recaptured)	
Average R value	
Actual number of rice grains in the can	

Analysis:

Part 1: Transect Sampling

1. Calculate the average number of letter e's on a page of your textbook.

2. Calculate the number of e's in your textbook. Multiply the average number of e's per page by the number of pages in the book.

Part 2: Quadrat Sampling

1. Calculate the average number of letter e's on a page of your textbook.

2. Calculate the number of e's in your textbook. Multiply the average number of e's per page by the number of pages in the book.

3. Share your results with the class by placing your calculation of the number of e's in the textbook on the board and record them in the table below:

Group	Number of e's

Part 3: Mark and Recapture.

1. Calculate the estimated size of your population using the formula:

$$N = \frac{MC}{R}$$

N = total number of individuals in a population

M = number of animals marked and released (50, 100 or 150)
C = total number of animals caught in the second sample (60 or 120)

R = average number of marked animals caught in the second sample (recaptured)

3. How does your population estimate compare the actual number of rice grains?

4. Calculate the percent error in your estimation using the formula:

$$\text{percent error} = \frac{\text{estimate} - \text{actual}}{\text{actual}} \times 100$$

5. Share your results with the class by placing your percent error values on the board and record them in the table below:

Size of Marked Sample	Recapture Sample Size	
	60	120
50		
100		
150		

6. What is the effect of a large marked sample size on the percent error?

7. What is the effect of a large recapture sample size on the percent error?

Conclusions

1. Compare your quadrat estimate with your transect estimate of the number of e's in the textbook. Why might your results differ?

2. Compare your quadrat estimate with that of your classmates. Why might the estimates vary?

3. If you were conducting a mark-recapture population estimate in the field, what sampling sizes would you choose to optimize your results? Explain.

4. Why is random sampling important in the techniques used to estimate the sizes of populations?

5. Manitoba Hydro is building a dam on a river that has a lake sturgeon

population. This rare species has been declining in numbers across the province. You are the wildlife biologist in charge of determining how sturgeon populations would be affected when the river is dammed.

- a) How would you go about making an estimate of the existing sturgeon population?

- b) How would you determine whether or not the dam had an impact on the sturgeon population in the river?

Appendix 5: Decision-Making

Introduction

The decision-making process is an approach for analyzing issues and making a choice among different courses of action. Issues are often complex with no one right solution to a problem. They can be controversial, as they deal with individual and group values. In order to make an informed decision, student must understand scientific concepts involved in an issue and also be aware of the values that guide a decision. The process involves a series of steps that may include:

- identifying and clarifying the issue
- being aware of the different viewpoints and/or stakeholders involved in the issue
- critically evaluating the available research
- determining possible alternatives or positions related to an issue
- evaluating the implications of possible alternatives or positions related to an issue
- being aware of the values that my guide a decision
- making a thoughtful decision and providing justification
- acting on a decision
- reflecting on the process

Suggestions for Instruction

Students have been introduced to the decision-making process in Senior 1 Science. Some of the issues in Biology 40S can involve personal decisions, while others have a community or societal/global focus. If students have little experience with the decision-making process, teachers can begin by offering more guidance in a structured environment. The class could examine a specific scenario or issue as a group. Students should eventually become active participants this process, by choosing their own issues, conducting their own research, making their own decisions and acting on those decisions.

The decision-making process can be approached in a variety of ways. For instance, students can play the role of different stakeholders involved in an issue, work in small groups to discuss issues or make a decision based on their own research and personal values. Students can be asked to take a stand and debate issues, or be placed in situations where they have to reach a group consensus. Students should not always defend a point of view that they agree with. They should be given the opportunity to put themselves in the mindset of others and speak from that point of view. Regardless of the approach used, the following questions can guide students in the decision-making process:

- What is the issue?
- What is the important scientific information needed to understand this issue? Where do I find this information?

- Who has a stake in this issue and why?
- What are the possible options?
- What are the pros and cons for each of the possible options?
- What is my decision? What criteria were used to make this decision?

Suggestions for Assessment

Because there are so many different ways of approaching an issue, a variety of products or culminating events can result from a decision-making process. Examples can include a town hall meeting, a round table, a conference, a debate, a case study, a position paper, a management plan, a class presentation... Regardless of the product or event, the assessment should focus on the skills outlined in cluster 0.

For role-playing activities such as a town hall meeting, round tables or conferences, the assessment criteria should be related to how the students are able to put themselves in the position of their stakeholders. For example:

- The stakeholder's position is clearly stated
- Evidence is presented to support arguments
- Answers to questions are clear and aligned with the position of the stakeholder
- Presentation is clear and organized
- Position of stakeholder is accurately represented
- Personal biases are absent

Appendix 6: SIM FISHERY

“A large context problem about sustainable development.”

By: Lisa Tack, Manitoba Water Stewardship, Fisheries Branch

Premise:

Students create a hypothetical fishery on Lake Winnipeg.

Story Line:

“All of you have been gathered here because you have been selected to compete for the opportunity to access the interest from a \$1 billion account. This account is in Lake Winnipeg – the *fish* in Lake Winnipeg to be exact. And, at 10%, the annual interest would be \$100 million! Would you like a “piece of the pie”? The Province of Manitoba invites you to develop a proposal and compete for a share in the interest from this natural capital (i.e. to create a sustainable fishery that profits from this natural capital). ‘What’s the catch?’, you ask? Well, there are certain guidelines and rules you must follow and they are outlined below.”

Information: Natural Capital and Sustainable Development

Manitoba’s fisheries are a source of natural capital where fish habitat is the bank and fish stocks are the principle in the bank account that generates surplus fish production or “interest” for Manitoba’s benefit as follows:

- 1) a food source for many,
- 2) a source of leisure time/recreation activity,
- 3) a means of generating income for many families and
- 4) millions of dollars of revenue/wealth for Manitoba.

Sustainable development resolves the perceived conflict between economic development and sustaining the natural world. In reality, the environment, the economy, and the health and well-being of society are interdependent and interrelated (Manitoba Education, (1997), p. 5.4).

Resource:

Manitoba Education, Training and Youth (1997).

Senior Years Science Teachers’ Handbook.

See Chapter 4: STSE Connections

See Chapter 5: Science and Sustainable Development

Guidelines:

- 1) Form a “corporation” between 2-3 other students to develop a *sustainable* fishery on Lake Winnipeg with consideration to science, technology, society, environment and economy.
- 2) Create a multi-media presentation (power point, website, video, etc.) that will persuade “judges” to award your corporation the winning bid to develop this multimillion dollar fishery.
- 3) To enhance your multi-media presentation, your group will also create a portfolio about your fishery.
- 4) Each corporation must complete and participate in all of the activities outlined below.
- 5) Meeting all deadlines is crucial.

Rules:

- 1) All money must be in Canadian dollars – you must convert other currencies to Canadian dollars before making transactions.
- 2) All facts and figures must be current and referenced (i.e. you have to provide proof for realistic costs, expenses and revenue).
- 3) You must complete a variety of assignments (i.e. when given a choice for assignments, you should not complete two assignments the same way). This means that you are not allowed to complete two power point presentations or two brochures or two web-pages, etc.

Activities: summary of goals and class activities

#	TITLE	GOAL	CLASS ACTIVITIES
1	Fishery history.	To learn about the historic background of the fishery industry in Manitoba.	Research and investigations.
2	Money, money, money.	To understand fishery economics and create a budget for the corporation.	Budgeting.
3	Here fishy, fishy, fishy...	To learn about fish biology and aquatic environments.	Setting a quota and analyzing case studies.
4	Who's line is it anyway?	To understand the impacts of a fishery on society, technology, science, the economy and the environment.	Role play debate.
5	You're hired!	To learn about fishery-related careers.	Job searching.
6	What a disaster!	To learn about the effects of natural disasters and human activities on the fishing industry.	Research and investigations.

Activities: summary of requirements

#	TITLE	PRESENTATION	PORTFOLIO
1	Fishery history.	Information package (booklet, brochure, video, article, etc.).	Journal entry.
2	Money, money, money.	Highlight areas of budget that promote sustainability.	Budget.
3	Here fishy, fishy, fishy...	Description/highlight actions for sustainability.	Information package (booklet, brochure, etc.)
4	Who's line is it anyway?	Description of stakeholders and concerns.	Brochure, website, ad, commercial, news article, etc.
5	You're hired!	Advertisement (poster, commercial, etc.).	Resume, cover letter (individual).
6	What a disaster!	Poster, ad, campaign, etc.	Booklet, brochure, website, video, etc.

ACTIVITY #1: Fishery history (Have you ever been to sea, Billy?).

Goal: To learn the historic background of the fishery industry in Manitoba.

Research the origins and history of the fishing industry, using sources such as the Internet, interviews, publications, etc.

- ◆ Who are the people involved?
- ◆ How the industry evolved/changed?
- ◆ What were the driving forces of change?
- ◆ What are some scientific/technological developments?
- ◆ What have been their impacts?
- ◆ What is the current status of the Manitoba fishing industry?
- ◆ How has culture shaped the industry?
- ◆ What are some laws/regulations governing the industry?
- ◆ How have human needs influenced the industry?
- ◆ What are the rights of Aboriginal and Non-Aboriginal fishers?

Include in presentation: an information piece (research paper, video, information booklet, etc.) to display the group's findings and understandings of fishery history.

Include in portfolio: a group journal entry about what the corporation wants their fishery to "look" and "feel" like with regards to sustainability (goals, aims, how they will make it environmentally

Resources:

Manitoba Water Stewardship, Fisheries Branch Website:

<http://www.gov.mb.ca/conservation/fish/index.html>

"A Profile of Manitoba's Commercial Fishery":

<http://www.gov.mb.ca/conservation/fish/images/history.pdf>

Domestic Fishing:

<http://www.gov.mb.ca/conservation/sustain/domestic.html>

First Nations Rights and Responsibilities:

<http://www.gov.mb.ca/conservation/firstnations/index.html>

ACTIVITY #2: ...Money, money, money (to theme music of “The Apprentice”).

Goal: To create a budget for your corporation by gaining an understanding of the economics of the fishing industry in Manitoba.

Determine what is needed to establish your corporation in this industry by considering the following:

- ◆ Start up costs (license fees, etc.)
- ◆ Building
- ◆ Equipment (boats, motors, nets, anchors, tubs, knives, sideline, etc.)
- ◆ Maintenance (building, boats, etc.)
- ◆ Storage (boats, equipment, etc.)
- ◆ Technology (GPS unit, 2-way radios, cell phones, etc.)
- ◆ Labour (wages, salaries, etc.)
- ◆ Training (safety training for staff, up-grade training, etc.)
- ◆ Licensing requirements
- ◆ Quota system
- ◆ Regulations regarding fishing seasons
- ◆ Annual income
- ◆ Lines of credit and banking (costs of interest, etc.)
- ◆ Insurance requirements and costs
- ◆ Energy requirements and costs (fuel, hydro, etc.)
- ◆ Processing industry requirements
- ◆ Catch to table cost estimates (cost estimate to get fish from lake side to a final consumer)
- ◆ Marketing and costs of marketing

Include in presentation: highlight how your budget promotes sustainable development.

Include in portfolio: the budget.

Resources:

Attachment A: Budget Sheet (a skeleton budget for a fishery)

Freshwater Fish Marketing Corporation:

<http://www.freshwaterfish.com/english.htm>

ACTIVITY #3: Here fishy, fishy, fishy...

Goal: To learn about fish biology and aquatic environments.

Identify the commercial fish species and their habitat requirements in Lake Winnipeg by learning about the following concepts/topics:

- ◆ Population dynamics
- ◆ Carrying capacity
- ◆ Biodiversity
- ◆ Impact of introduced, extinct species
- ◆ Fish health (parasitology/diseases)
- ◆ Determining fish quotas
- ◆ Environmental laws, regulations, quotas, fees, and reasons for them
- ◆ Restocking
- ◆ Tips and hints on how to make the fish population sustainable
- ◆ Give consideration to how natural selection, divergent and convergent speciation apply to fish species in Lake Winnipeg
- ◆ Reproductive and geographic isolation

Class Activity: example of setting a quota

Class Activity: analyzing case studies

Analyze case studies that demonstrate interdependence among science, technology, society and the environment (i.e. pollution-water quality issues)

Include in presentation: highlight all actions taken to create a sustainable fishery (laws, regulations, quotas, fees, etc.) and reasons for these actions (i.e. to control the amount of fish taken from the lake we introduced a quota for each fisher and/or decided to restock the lake each year, etc.).

Include in portfolio: an information package that explains (to another beginning fishery) what fish need to survive and tips/hints on how to make a fish population sustainable.

Resources:

Sustainable Fisheries Teacher's Resource Tools for Senior 2,
Cluster 1: Dynamics of Ecosystems Background and Lessons:
<http://www.gov.mb.ca/conservation/sustain/10.html>

Manitoba Fisheries:
<http://www.gov.mb.ca/conservation/sustain/index.html>

Legislative Framework for Manitoba Fisheries:
<http://www.gov.mb.ca/conservation/fish/images/flow.pdf>

Fisheries Act:
<http://laws.justice.gc.ca/en/F-14/index.html>

Manitoba Fishery Regulations:
<http://laws.justice.gc.ca/en/F-14/SOR-87-509/122202.html>

Fisheries Branch – Links listed under “Legislation/Regulations” on left hand side:

Harvest Schedule
[The Fisheries Act \(F90\)](#)
[Commercial Fishermen's Records Regulations](#)
[Fishermen's Loans Regulations](#)
[Fishing Licence Fee Regulations](#)
[Fishing Licensing Regulations](#)
[Fish Transportation Loadslip Regulations](#)
Fisheries Inspection [Act \(F12\)](#) and [Regulation](#)
[Freshwater Fish Marketing Act \(F13\)](#)
<http://www.gov.mb.ca/conservation/fish/index.html>

Stewart, K. & Watkinson, D. (2004). The Freshwater Fishes of Manitoba.
Winnipeg, Manitoba: University of Manitoba Press.

ACTIVITY #4: Who's line is it anyway?

Goal: To understand the impacts of your fishery on society, technology, science, economy and the environment.

Research the impacts of a fishery on the environment, society, science, technology, etc., in order to develop a course of action to minimize the negative impacts and maximize the positive impacts of your fishery.

- ◆ Who are the stakeholders?
 - ◆ Commercial fishers
 - ◆ Domestic fishers
 - ◆ Recreation
 - ◆ Tourism
 - ◆ Hydroelectricity
 - ◆ Environmental, habitat, pollution groups
 - ◆ Other groups that use the lake
- ◆ What are their concerns?
- ◆ How can the negative impacts of your fishery be minimized?
- ◆ How can the positive impacts of your fishery be maximized?

Class Activity: role play debate

Each corporation will represent different stakeholders, research their positions/ concerns and will role-play this point of view in a debate.

Include in presentation: a description of all stakeholders and a brief synopsis of their concerns. Also, demonstrate which concerns your group has addressed/taken care of and how.

Include in portfolio: a brochure, commercial, news article, website, etc. that outlines and discusses one stakeholder's position/concerns and the

Resources:

Manitoba Education, Training and Youth (1997).

Senior Years Science Teachers' Handbook.

See Chapter 4: STSE Connections

- debates, role-playing scenarios and case studies of STSE issues.

See Chapter 5: Science and Sustainable Development

Manitoba Fisheries:

<http://www.gov.mb.ca/conservation/sustain/index.html>

International Institute for Sustainable Development:

<http://www.iisd.org/>

Manitoba Education – Sustainable Development:

http://www.edu.gov.mb.ca/ks4/learnres/mbcontsub/sust_dev.pdf

Environmental Stewardship Division Sustainable Resource Management Branch:

<http://www.gov.mb.ca/conservation/susresmb/index.html>

ACTIVITY #5: You're hired!

Goal: To learn about various careers related to the fishery industry.

Research various careers related to fisheries in order to determine who you need to hire and how you will hire them. Learn about:

- ◆ Description of jobs needed (duties, requirements, salary, benefits, employer expenses, etc.)
 - ◆ Biologists
 - ◆ Technicians
 - ◆ Managers
 - ◆ Scientists
 - ◆ Specialists
 - ◆ Captains
 - ◆ Commercial fishers
 - ◆ Administration
 - ◆ Maintenance workers
 - ◆ Etc.
- ◆ Hiring and contracting out for corporation employees (costs and benefits)
- ◆ Related hobbies and careers

Include in presentation: a brief description of each job needed and your hiring decision (i.e. did you contract out or hire people yourselves?). Also include one advertisement for a fishery-related job.

Include in portfolio: a resume and cover letter for the fishery job you would like to do and an explanation of why you want that job. (To be done by each group member *individually*.)

ACTIVITY #6: What a disaster!

Goal: To learn about the effects of weather, climate change, natural disasters, and human activities on the fishing industry, and what can and cannot be done about them.

Research the following topics and their corresponding effects on the fishing industry.

- ◆ Over-fishing
- ◆ Global warming (Kyoto)
- ◆ Acid rain
- ◆ Nutrient loading
- ◆ Irrigation
- ◆ Hydroelectricity
- ◆ Pollution
- ◆ Flooding
- ◆ Water quality
- ◆ Environmentally friendly programs such as recycling, education, emissions reductions, work incentives, carpooling, transit, etc.
- ◆ Possible conflicts between fishing industry, aesthetics and recreational activities
- ◆ Possible conflicts with other industries such as tourism, agriculture, etc.

Include in presentation: highlight one of your incentives, programs, ads or campaigns that your group has initiated to help reduce the effects of natural disasters and human activities on your fishery

Include in portfolio: an information package (booklet, brochure, video, website, etc.) that provides a brief description of all incentives, programs, ads, campaigns, etc., your group has initiated to help reduce the effects of natural disasters and human activities on your fishery (note: costs must be included in your budget!).

Resources:

Water Stewardship, Water Branch – Water Quality:
http://www.gov.mb.ca/conservation/watres/water_quality.html