Unit 1
Life Science:
Sustainability of Ecosystems

Unit Overview

Introduction

The focus on protecting the environment has grown substantially since the 1950s. Many would argue that not only is the focus too late, but it is not nearly enough to reverse the damage caused by the spend now/pay later attitude which has been so prevalent in our society. Owing to a change in environmental attitudes, today's students are much more aware of the fragile nature of the environment. Despite technological advances, which allow more efficient use of natural resources/systems, the drive to be economically competitive puts stress on the delicate environmental balance.

Much of the economy in Atlantic Canada is based on harvesting within fragile ecosystems. Examining how external factors affect the dynamic equilibrium which exists in an ecosystem provides valuable information. This process will be extended to encompass both equilibrium and sustainability of the environment within a province, region, country, and global biosphere. This unit allows students to understand the interrelationship of local ecosystems, our increasing awareness of ecosystems on a global scale, and the need to sustain the health of ecosystems at all levels.

Focus and Content

Many outcomes can be accomplished by using a **decision-making** focus, thereby moving students to think globally at a more sophisticated level, and to explore the concept of sustainability for the first time. Activities in the unit also provide an opportunity to focus on **observation/inquiry**. The local environment and economy may be conducive to an extensive ecosystem study. Time allocated for this unit will greatly affect the depth and scope of investigation. A spring or autumn time frame might be best for field work.

Curriculum Links

Sustainability of ecosystems connects with other clusters in the science curriculum to varying degrees. In elementary grades students learn about the "Needs and Characteristics of Living Things" and "Air and Water in the Environment," "Exploring Soils" and "Habitats and Communities." "Diversity of Life" in elementary is directly linked to this unit as it considers how the characteristics of living things permit systems of classification and how varying conditions relate to adaptations. More directly linked is the intermediate "Interactions within Ecosystems" unit. This unit concentrates on the flow of energy and matter through food webs in observable ecosystems. In high school the optional courses provide Life Science opportunities in the units "Evolution," "Change and Diversity," and "Interactions Among Living Things." *Consider developing the connection between this unit and "Chemical Reactions"* and *"Weather Dynamics,"* also in Level I.

Curriculum Outcomes

(From the K-12 Pan Canadian Science Framework Document)

Students will be expected to

STSE

Nature of Science and Technology

114-1 explain how a paradigm shift can change scientific world views

114-5 describe the importance of peer review in the development of scientific knowledge

Relationships between Science and Technology

116-1 identify examples where scientific understanding was enhanced or revised as a result of human invention of a technology

Social and Environmental Contexts of Science and Technology

117-3 describe how Canadian research projects in science and technology are funded

118-1 compare the risks and benefits to society and the environment of applying scientific knowledge or introducing a new technology

118-5 defend a decision or judgment and demonstrate that relevant arguments can arise from different perspectives

118-9 propose a course of action on social issues related to science and technology, taking into account human and environmental needs

SKILLS

Initiating and Planning

212-4 state a prediction and a hypothesis based on available evidence and background information

Performing and Recording

213-7 select and integrate information from various print and electronic sources or from several parts of the same source

213-8 select and use apparatus and material safely

Analysing and Interpretation

214-1 describe and apply classification systems and nomenclature used in the sciences

214-3 compile and display evidence and information, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots

Communication and Teamwork

215-1 communicate questions, ideas, and intentions, and receive, interpret, understand, support, and respond to the ideas of others

215-4 identify multiple perspectives that influence a science-related decision or issue

KNOWLEDGE

318-1 illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking carbon, nitrogen, and oxygen

331-7 describe how soil composition and fertility can be altered and how these changes could affect an ecosystem

318-2 describe the mechanisms of bioaccumulation, and explain its potential impact on the viability and diversity of consumers at all trophic levels

318-5 explain various ways in which natural populations are kept in equilibrium, and relate this equilibrium to the resource limits of an ecosystem

331-6 analyse the impact of external factors on an ecosystem

318-3 explain why ecosystems with similar characteristics can exist in different geographical locations

318-4 explain why different ecosystems respond differently to short-term stresses and long-term changes

318-6 explain how biodiversity of an ecosystem contributes to its sustainability

Life Science: Sustainability of Ecosystems

How does sustainability fit into your paradigm and society's paradigm?

Outcomes

Students will be expected to

- explain how a paradigm shift can change scientific world views in understanding sustainability. Explore and develop a concept of sustainability in relation to a natural resource industry (e.g., forestry, fishery, agriculture, aquaculture, mining, tourism or others) (114-1)
  - define sustainability
  - examine historical attitudes and practices in relation to those of sustainability
- communicate questions, ideas and intentions and receive, interpret, understand, support and respond to the ideas of others with respect to environmental attitudes (215-1)
  - define a paradigm and paradigm shift
  - discuss how attitudes towards pesticides have changed

Elaboration – Strategies for Learning and Teaching

It is the intention that the notions of paradigm shift and change in environmental attitudes and values related to sustainability be common themes throughout this unit.

Students should explore their own paradigms related to the environment. Through an introductory discussion, students can reflect on what they value about nature. What is the value of a boreal forest? What if it were to be clear-cut? What is sustainability? Are they willing to sacrifice something to ensure sustainability? Is the economy one of growth and expansion at any environmental cost? Does this lead to sustainable practices? What are sustainable practices in the home? How do we know when they are present?

For example, a historical examination of a sustainable industry could be comparing "traditional" methods and attitudes of fishing and those of the so called "modern fishery". The examination of the concept of sustainability will become clearer to students as they address other outcomes in this unit. Sustainability is itself a paradigm that the students will increasingly appreciate as they progress through the unit and will not be completed before moving on to address other outcomes.

Paradigm shifts are rare and represent significant changes in the way humans view the world. They are major changes which are controversial when first proposed but eventually come to be accepted as a major advancement in scientific knowledge and understanding. Examples of paradigm shifts in past scientific world views are such revolutionary ideas that the Earth is round not flat and that it rotates around the sun. Students can explore the concept of paradigm shifts through discussions, videos, role-playing, etc. Several questions could be posed - Who is affected by a paradigm shift? How is the general public affected in the short and long term? Students could explore the possibility of themselves presently being in the midst of a paradigm shift related to the environment and sustainability. Has the old world view that the Earth and all things on it exist for the sole benefit of humans changed? Has western civilization been created on the premise of the unlimited exploitation of the Earth? Overall, has the focus shifted to environmental issues and concerns? Are we (individuals, provinces, countries, continents, global community) now shifting toward the concept of sustainability? Is the shift real or perceived?

Life Science: Sustainability of Ecosystems

How does sustainability fit into your paradigm and society's paradigm?

Suggested Assessment Strategies

Portfolio

Portfolios can be used as a means of assessing the entire unit. Many of the assessment suggestions given throughout the unit can be used as part of an overall portfolio assessment. There are many ways in which portfolios can be assembled as an assessment tool, thus, the number of items and the specific content can be determined by the teacher. Suggestions for content are: experimental results (write-ups, graphs, data, observations, etc.), posters, illustrations, creative writing, videos, making web pages, photos, group projects, reports, responses, critical thinking exercises, self-assessment, etc. A culminating assignment may ask students to respond to the following questions: Describe a past paradigm that relates to the environment and sustainability. Describe past activities and/or practices that reflect that paradigm. Describe what has happened to cause the general public to shift their way of thinking. Evaluate the new ways people are thinking about sustainability. Do you think they are paradigms yet? Explain.

Performance

Students could take part in a debate between two opposing world views on environmental issues. *This would demonstrate students' understanding in the area of paradigm shift.* (114-1, 215-1)

Journal

Students could read, summarize, and respond to an article about environmental change that has taken place over time. Magazines, newspapers, and archived information may be possible sources. (114-1)

Resources

Science 10

pages 8-21; 42-44; 48-49; 70-73; 81-82

pages 86-87

pages 106-120

pages 52-57; 81-82

Life Science: Sustainability of Ecosystems

How does sustainability fit into your paradigm and society's paradigm? (Cont'd)

Outcomes	Elaboration – Strategies for Learning and Teaching
Students will be expected to	
• communicate questions, ideas and intentions and receive, interpret, understand, support and respond to the ideas of others with respect to environmental attitudes (215-1) (Cont'd)	Whenever possible these questions relating to sustainability should be addressed in relation to the major industries of this province. This will give students the opportunity to examine sustainability from a more realistic viewpoint given that that they and their guardians would have some contact with these "resource based" industries. In the text book it is useful to examine the "Work the Web" sections on pages 13, 15, 19, 149 and 154. Alternatively teachers may wish to do the "Take a Stand" sections on page 21 and 113 or the debate on page 82. The tent caterpillar could be replaced with another local animal such as a seal or pine martin to bring the issues local significance. Paradigm shifts and sustainability should be addressed throughout this unit to relate it to other outcomes.
– discuss how attitudes towards our forests have changed with respect to (1) commercial usage (2) residential usage (3) replanting programs	The recognition of the limitations of the harvestability of the resource should be stressed. Management practices have changed and this should be emphasised to the student.

Life Science: Sustainability of Ecosystems

How does sustainability fit into your paradigm and society's paradigm? (Cont'd)

Suggested Assessment Strategies

Presentation

Students could pick a method of presentation (poster, skit, poem) to illustrate opposing views on sustainability. (114-1, 215-1)

Journal

Students could reflect on a past paradigm (e.g., resources are limitless) by considering the following questions: How is it possible that people thought this way? What factors contributed to this mind-set? Are there still large numbers in the general population that think this way? Why are we shifting to a different paradigm? (114-1, 215-1)

Resources

Science 10

pages 152-153

"*Work the Web*": pages 13; 15; 19; 149; 154

"*Take a Stand":* pages 21; 113

"*Debate":* page 82

Biology 3201 Forestry Elective

OR

www.gov.nf.ca/edu/resources/science.htm

Life Science: Sustainability of Ecosystems

What are the factors affecting the sustainability of an ecosystem?

Outcomes

Students will be expected to

- explain biotic and abiotic factors that keep natural populations in equilibrium and relate this equilibrium to the resource limits of an ecosystem (318-5)
  - define ecology and ecosystem
  - explain how biotic and abiotic factors affect ecological interactions
  - define abiotic factors (include space, temperature, oxygen, light, water, inorganic and organic soil nutrients)
  - define biotic factors (include decomposing animals, disease, predator/prey, competition, symbiosis)
- select, compile and display evidence and information from various sources, in different formats, to support a given view in a presentation about ecosystem change (214-3, 213-7)
  - define succession
  - describe the factors that contribute to succession
  - describe what is meant by the term climax community

Elaboration – Strategies for Learning and Teaching

Ideally, an in-depth study of a local ecosystem (pond, lake, tidal pool, field, forest) could be undertaken to collect data. The selected ecosystem could be used for the topic of a public meeting discussed later in this unit. However, students may be able to observe an ecosystem, its components and interactions, by creating an ecosystem of their own.

Students will need an introduction to the basic concepts of ecology. They should understand that ecosystems are dynamic and abiotic and biotic factors both contribute to the characteristics of the system. Abiotic factors have a significant effect on the distribution of organisms in any system, schoolyard, rotting log, sea shore or forest. Ecotones are an excellent example of the influence of abiotic factors on the distribution of organisms.

Core Lab – Students are expected to conduct one of the two investigations: School Yard Ecosystem or A Natural Ecosystem. One core lab is required for this section. Each one is important in addressing a number of skill outcomes and should demonstrate the importance of abiotic and biotic factors in ecosystems

All lab work must focus on recording abiotic factors and how these influence the distribution of living things within the systems being studied.

As an alternative to a field study, students could construct their own ecosystem using jars or pop bottles. The construction of a model ecosystem would focus the study on either terrestrial or aquatic. (An aquatic ecosystem would allow for microscope work, if this were a priority). In constructing these ecosystems there should be some student decision-making: What type of organisms need to be included and why? What makes a system sustainable? Why is biodiversity important? Computer simulations could also illustrate the basic components and interactions in an ecosystem.

Teachers will need to gather resources to supplement that which is provided in the text book. Sources include but are not limited to the High School Biology and Environmental Science resources. As well teachers could checkout www.gov.nf.ca/edu/resources/science.htm

Life Science: Sustainability of Ecosystems

What are the factors affecting the sustainability of an ecosystem?

Suggested Assessment Strategies

Much of the assessment conducted in relation to these outcomes can be related to the Core Lab – students are expected to conduct one of the two investigations: "School Yard Ecosystem" or "A Natural Ecosystem". This activity serves as an introduction to a complex system and will introduce students to the complexities of a simple ecosystem. There is a significant amount of knowledge to be obtained in relation to these outcomes – the knowledge is important as it will give the students a deeper appreciation of the systems they will be discussing and investigating later in the unit.

Presentation

Students could work in groups or alone to produce small web pages that would describe biotic factors, abiotic factors, human impact, biodiversity, local habitats, nutrient cycles. Small web pages can be posted together to make a larger site that would provide a student produced resource that would be accessible to all students within the class. (331-6, 318-5, 318-6, 214-1, 318-1, 318-2)

Students could present analysis of the data gathered by the group from the ecosystem Core Lab. This could be done either orally or videotaped on-site. Each member of the group would be responsible for a different aspect of the study for presentation (e.g., biotic factors, abiotic factors, human impact, biodiversity). Teachers should ensure students address the sustainability of the ecosystem. Is it sustainable? How do you know? (331-6, 318-5, 318-6)

Resources

Science 10

pages 22-23; 28-31; 40-44; 50-51; 60-68

pages 77-79; 126-131

Core Lab: *"Schoolyard Ecosystem"* - pages 24-26

OR

Core Lab: *"A Natural Ecosystem"* - pages 30-31

pages 48-49

Life Science: Sustainability of Ecosystems

What are the factors affecting the sustainability of an ecosystem? (Cont'd)

Outcomes	Elaboration – Strategies for Learning and Teaching
Students will be expected to	
• select, compile and display evidence and information from various sources, in different formats, to support a given view in a presentation about ecosystem change (214-3, 213-7) Cont'd	Regardless of the ecosystem chosen, many fundamental aspects of an ecosystem would have to be examined for further development throughout this unit. There would have to be an examination of: abiotic factors (space, temperature, oxygen, light, water) and biotic factors (disease, reproductive rates, predator/prey, competition, symbiosis). Additionally, classification of organisms into trophic levels, bioaccumulation, resource limits, impact of external factors, importance of biodiversity to an ecosystem, flow of energy, cycling of materials, etc. In some cases, this may involve a review of some of these topics previously dealt with in intermediate science. (D.D.T. and the Osprey would be an excellent example of bioaccumulation effects.)
- examine the flow of energy in ecosystems using the concept of the pyramid of energy - explain how energy availability affects the total mass of organisms in an ecosystem and summarize this relationship in a pyramid of biomass	The examination of energy flow is vital to the understanding of the complexities and relationships within any system. All biological systems that exist for extended periods of time have a stable nutrient pool and a supply of energy. For the most part the energy comes from the sun and is captured by photosynthetic organisms – the producers. As teachers conduct the classification of systems and provide students with the various names of trophic levels in a living system they should be mindful that the overall objective of the unit is an examination of sustainability. The energy relationships described within the nomenclature of trophic levels will be important vocabulary for the students as they move through the unit.
• describe and apply classification systems and nomenclature with respect to trophic levels in ecosystems (214-1) - define niche and relate it to habitat - classify organisms as producer, consumer, autotroph, heterotroph, decomposer, herbivore, carnivore, omnivore, saprobe - define competition and explain how competition arises among organisms	The discussion of niche and habitat are intended to demonstrate how individual organisms participate within and contribute to the uniqueness of a given biological system. The interactions of the organisms are important to demonstrate how biodiversity is important. The Core Lab will be useful to reflect upon in terms of the relationships demonstrated and the importance of the abiotic and biotic factors within the systems. Biotic interactions within food chains and food webs are important relationships that help students appreciate the need for diversity – a chain is easily broken but a web is not. It is a simple as this analogy – the more complex the system the greater the stability – the complex systems can endure more insults before they begin to show dramatic signs of damage. Simple systems will collapse easiliy when confronted with a disturbance that *breaks the chain*.

Life Science: Sustainability of Ecosystems

What are the factors affecting the sustainability of an ecosystem? (Cont'd)

Suggested Assessment Strategies

Presentation

Students could participate in a simulated public meeting. Teachers should ensure that they have gathered the necessary evidence to support their point of view. *This would be reviewed by panels of peers and a report would be written by presenters and by each panel. A rating scale could be used to mark the presentation. A student's mark may be composed of two parts- the presentation and panel report.* (331-6, 318-4, 214-3, 213-7)

Journal

Students could record their experience with, and reaction to, the public meeting process. (214-3)

Resources

Science 10

pages 32-39

pages 10-11

page 40

pages 34-35

pages 17; 41

Life Science: Sustainability of Ecosystems

Investigate the Relationship Between Velocity, Time and Acceleration (Cont'd)

Outcomes	Elaboration – Strategies for Learning and Teaching
Students will be expected to	
• describe and apply classification systems and nomenclature with respect to trophic levels in ecosystems (214-1) Cont'd - differentiate between interspecific and intraspecific competition - describe the feeding relationships in terms of competition, food chains and food webs	It is important to note that population biology is an important section of study within the examination of biotic factors. The growth of populations is a result of biotic and abiotic factors and demonstrates how important these factors are in populations of organisms within a system. When is the proper time to introduce the study of how a population changes over time? Some prefer to instruct this before detailed examination of the biotic and abiotic factors. Others would chose to study population change after examining all the biotic and abiotic factors. The text examines population growth after examining the factors in ecosystems and then explores the issue of pesticides.
• explain how biodiversity of an ecosystem contributes to its sustainability (318-6) - demonstrate how the many interrelated food chains give a community stability and identify the conditions required for a stable self sustaining ecosystem	It is recommended that local habitats and organisms that students will likely encounter on a regular basis be used to provide examples of niche, habitat, competition (interspecific, between different organisms, and intraspecific, between the same organisms) and feeding relationships (food chains and food webs). Often these will be readily related to the discussion of sustainability in relation to an industry that uses a natural resource (examples include foresty, fishery, agriculture, aquaculture, mining, tourism or others). Both the Forestry and Fisheries Module from Biology are useful resources that provide examples of all the above relationships and describe them within the context of important industries within our province. (www.gov.nf.ca/edu/resources/science.htm)
• describe the mechanisms of bioaccumulation or bioamplification caused by pesticide use, and explain its potential impact on the viability and diversity of consumers at all trophic levels. (318-2) - examine the use of pesticides over the course of human history - describe the impact that DDT usage has had on bird populations - describe how continued DDT usage in third world countries is impacting bird populations	The text provides a useful description of the history of pesticides. The Forestry Module also examines the fight against forest pests in our province (Spruce Budworm, Hemlock Looper and Balsam Wooly Aphid). The description of the strategies of control and the damage caused by these pests is well outline in the elective module (pages 57-61).

Life Science: Sustainability of Ecosystems

Investigate the Relationship Between Velocity, Time and Acceleration (Cont'd)

Suggested Assessment Strategies

Presentation

Students could illustrate a food web or nutrient cycle that exists in an ecosystem, in poster or other form. (214-1, 318-1, 318-2)

Journal

Students could write a biography or diary of an organism that exists in the studied ecosystem. (318-6)

Resources

Science 10

pages 40-45

pages 22-23; 28-29; 35-39

pages 52-57

Life Science: Sustainability of Ecosystems

Sustainability Issues in an Ecosystem

Outcomes	Elaboration – Strategies for Learning and Teaching
Students will be expected to	
• illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking carbon, nitrogen and oxygen (318-1) - diagram the carbon cycle and describe the processes required to cycle from carbon reservoirs to the atmosphere - describe the importance of oxygen to ecosystems - describe the signifigance of globel warming and eutrophication	The cycling of matter is a vital topic that will demonstrate human impacts on small systems up through to the effects on the biosphere. All nutrients a cycled through systems, they never leave the planet, moving around in different forms. The basic cycle is from the atmosphere to the ecosystem and then returning to the atmosphere. How the nutrients move can be quite complex. Diagrams of each cycle are important and will become more useful if the impact created by humans is related to them. Discussions of global warming and eutrophication to aquatic systems will completely sum up any discussion of these three nutrients (carbon for global warming on page 64, and oxygen and nitrogen for aquatic eutrophication on pages 70-71 and 132-133) The teacher will need to supplement the material from the text book to cover this outcome. It is important that the impact of climate change to all lifeforms be stressed. Possible resources include but are not limited to the Biology and Environmental Science resources.
• plan changes to predict the effects of, and analyse the impact of external factors on an ecosystem (331-6, 213-8, 212-4) - describe how humans have altered the carbon, oxygen and nitrogen cycles in ecosystems - describe what is being done to negate human impact on these cycles	After researching the pathways along which energy and matter flow through ecosystems, students should diagram the cycling of carbon, nitrogen and oxygen in their ecosystem. Students could identify the resource limits of the constructed ecosystem. If an open system is also considered, the resource limits of the open system could be compared to those of a closed system. This activity is very similar to the development of an Environmental Impact Assessment (EIA). Many models of this can be found on the web or at the Nelson Web Site. Teachers could pose questions that require students to predict the effects of external factors on the ecosystem. For example, predict the effect of sulfur being burned inside the closed ecosystem. Students could simulate acid rain, and the effects of sulfur, by burning sulfur in a deflagrating spoon within their own ecosystem. *Note: link to chemistry and weather units.*

Life Science: Sustainability of Ecosystems

Sustainability Issues in an Ecosystem

Suggested Assessment Strategies

Journal

Students could answer: How is the balance of nature affected by the influence of human activity on bio-geochemical cycles? (331-6, 318-1)

Resources

Science 10

pages 50-51; 60-69; 132-133

pages 60-68; 70-74; 81-82; 106-107; 132-135; 138-142

Life Science: Sustainability of Ecosystems

Extension to the Biosphere

Outcomes	Elaboration – Strategies for Learning and Teaching
Students will be expected to	
• analyze the impact of external factors on the ecosystem biomes (331-6) – weather change – introduced species – pollution – industry/agriculture	*It is suggested that an ecosystem, which is significant to students' community, be selected to form the context of this unit. The choice may be determined by geographical location, the economic base, and demographics of the area. A simulated public meeting, to discuss a proposed project, might serve as the vehicle to reach the outcomes.* *The* "Case Study" and the "Explore an Issue" sections of the text are useful for examining the impact of external factors on ecosystems. One "Case Study" or "Explore and Issue" is not enough to complete the outcome and there are several that relate directly to this outcome, including: Comparing Ecosystems (pg 28), Pesticides (pg 52), Effects of Deforestation on Cycling (pg 72), The Great Lakes (pg 140), Managing Fish Populations (pg 150).
• explain why the ecosystem may respond differently to short-term stress and long-term change (318-4) – describe the potential impact that a large scale logging project could have on a native species such as the pine martin – explain the impact that an abnormally dry summer could have on a bog ecosystem	Students could choose a project that will affect the ecosystem, such as the construction of a new highway, electrical transmission line, gas pipeline, shopping mall, residential subdivision, alternative agricultural use or industrial facility. Teachers should challenge students to develop a way of assessing human impact. What baseline data must be gathered? How will the impact be determined? Over what time periods should the impact of these effects be monitored? Students should discuss plans of action to ameliorate this impact; determine what defines short-term stress, e.g., seasonal peaks in temperature, water supply, sudden but limited human impact; determine long-term change, e.g., climate change, permanent human influence, infestation by foreign flora and fauna.
– describe how ecosystems are able to respond to changes and return to its previous state	The intent is to have students examine the means by which an ecosystem can respond to change.
• communicate questions, ideas and intentions, and receive, interpret, understand, support and respond to the ideas of others in preparing a report about ecosystem change (215-1)	Teachers should challenge students to define the critical questions and issues, conduct research into the present conditions and potential impact, and to marshal evidence in order to support a given interest group. By role playing in a public meeting students will practice skills of research, presentation and communication. A field trip to a pristine area, and then to an area that has been severely impacted, may enable students to assess the impact on the sustainability of an ecosystem. Students could examine actual reports from public meetings or Environmental Impact Assessments (EIA) on local issues. Resource people from various interest groups could be interviewed. Students could also apply to make a presentation at a local public meeting about an environmental issue.

Life Science: Sustainability of Ecosystems
Extension to the Biosphere

Suggested Assessment Strategies

Journal

Teachers could ask students to think about the ecosystem they are going to study. What things do they value about it? What would they hate to see disappear or destroyed?

Students could record their experience with, and reaction to, the public meeting process. (215-1)

Resources

Science 10

pages 10-13; 16-21; 28
52-58; 72-73; 116-118;
132-134; 140-142;
150-153

pages 34-39; 48-49;
70-73; 106-107;
126-127

The Fisheries Module and Forestry Module (Biology 3201) are resources that will assist in collecting information about human impacts and ecosystem change. This can be found at www.gov.nf.ca/edu/resources/science.htm. Many school web sites have direct information pertaining to these outcomes. Checkout www.stemnet.nf.ca

Life Science: Sustainability of Ecosystems
Extension to the Biosphere (Cont'd)

Outcomes	Elaboration – Strategies for Learning and Teaching
Students will be expected to	*The context for this cluster of outcomes may be an issue which has social/ economic importance and is global in nature .The focus is intended to emphasize the shift in environmental attitudes and thinking towards sustainability. Resource based sectors or industries such as forestry or food production may be used here. Given our region's environmental diversity, there are several contexts in which resource management encourages sustainability, including: farming, land use, forestry, tourism, fishing, acquaculture, and so on.*
• describe how soil composition and fertility can be altered and how these changes could affect an ecosystem. (331-7) – explain the role that fertilizers and irrigation practices have had on soil quality – describe the potential impact that overuse of fertilizers can have on ecosystems	As the world's population grows, there is an increasing demand for food on our agricultural systems. Students should be able to describe how soil composition and fertility can be altered to increase crop yield. This could be a springboard to begin discussions on the risks and benefits that scientific and technological advancements have on the food production industry and the world. Students should predict the improper use of natural and synthetic fertilizers that may cause detrimental effects on an ecosystem. Conducting the Core Lab activity on pages 102-103 or 104-105 will provide a better understanding of the impact of using fertilizer or soaps and detergents.
• explain why ecosystems with similar characteristic can exist in different geographical locations (318-3) - relate the distribution of biomes within Canada to the impact of external factors – discuss how abiotic factors affect the distribution of organisms – discuss the reasons for ecosystems that share similar abiotic features also sharing similar animal life	The studies should include an investigation of the aquaculture industry in other countries (Norway, Scotland, Chile, etc.). Students should examine the environmental factors that exist in the different countries to see why the same type of fish is farmed in geographical locations other than Atlantic Canada. Each study should consider why the environments are similar (e.g., climate, water conditions, geographical features). Biomes are large systems and their distribution is largely based upon abiotic factors such as radiant energy, precipitation, nutrient levels and elevation. A brief examination of the distribution of biomes in Canada can demonstrate clearly the importance of these abiotic factors and how external factors impact upon them (some authors have suggested the Taiga is vanishing as a result of global warming and disrupted nutrient cycles). The study of biogeography seen on pages 94-96, of the student text demonstrate the importance of climate variation as an important abiotic factor in biome distribution.

Life Science: Sustainability of Ecosystems
Extension to the Biosphere (Cont'd)

Suggested Assessment Strategies

Journal

Students could record perceptions and observations of a case study in resource management. (118-1, 116-1)

Students could conduct a print or electronic search on the topic of sustainability. Was there evidence of peer review? They could comment on the importance of peer review of scientific work. *Students may conclude that information on the Internet may not have been reviewed by experts.* (114-5, 213-7)

Interview

Students could record an interview of a local scientist to discuss the importance of peer review in their studies of environmental issues. (114-5)

Presentation

Students could research a case study and present findings in the form of a radio or television documentary about a significant environmental issue. (117-3, 118-5, 118-9)

Presentation

Students could be assessed on their participation in a debate or group project. Checklists, observation records, self-evaluation, and peer evaluation could assist in the evaluation. (118-9, 118-5, 215-4)

Resources

Science 10

Core Lab: *"Soil Nutrients and Plant Growth"* - pages 102-103

OR

Core Lab: *"The Animal community in Soils"* - pages 104-105

pages 88-95

pages 12-13

pages 28-29

Life Science: Sustainability of Ecosystems

Outcomes	Elaboration – Strategies for Learning and Teaching
Students will be expected to	
• describe how Canadian research projects in environmental science and technology are funded (117-3)	Students examine the development of aquaculture projects from which the salmon farming industry grew. Questions to consider might include which agency sponsored the project, how it was funded, how the project was managed, when the research changed from pure to applied, at what stage business adopted responsibility for the project.
• compare the risks and benefits to the biosphere of applying new scientific knowledge and technology to industrial processes (118-1)	Students could examine case studies which present the technological, environmental, and economic advantages and disadvantages of food production industries (e.g., fish farming), and resource based industries such as forestry, mining, and so on.
• propose and defend a course of action on a multi-perspective social issue (118-9, 215-4, 118-5) • describe the role peer review has in the development of scientific knowledge (114-5) • identify examples where scientific understanding about an ecosystem was enhanced or revised as a result of human invention or related technologies (116-1) – discuss the improvements that have occured with respect to pest control	Students participate in a debate, or a simulated hearing, about the introduction of a new, or expansion of existing, salmon farm. Students could represent or role play: fish farmers, local fishers, the town council, the chamber of commerce, environmental groups, and the Departments of Fisheries/Environment. Farming some varieties of shellfish are not new. Threatened stocks of other fish species have made farming these species viable. Students might research and present information about discussion in the scientific community regarding the viability and support for farming certain types of fish. Consider the changes that take place in attitudes. Part of the debate about the efficacy of fish farming on a large scale is its impact on the surrounding environment with regard to artificial food supply, waste products settling from the cages, use of antibiotics and the potential escape of transgenic stocks. Through study of fish farm sites before and during operation it becomes possible to assess the potential for bioaccumulation in local and global systems and to estimate the carrying capacity of a system before harmful levels of bioaccumulation develop. The economic drive to increase production through these facilities has led to improved technologies and the need to better understand development of various fish species. Students could research examples of improved science and technology that have developed from this context.

Life Science: Sustainability of Ecosystems

Suggested Assessment Strategies

Journal

Students could comment on a controversy surrounding the aquaculture industry. (116-1, 118-9)

Resources

The National Sciences and Engineering Research Council of Canada or NSERC web site: www.nserc.ca

Industry Canada web site: www.ic.gc.ca

Social Sciences and Humanities Research Council of Canada web site: www.sshrc.ca/

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