



Introduction to Environmental Science 120 Curriculum

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Summary of Course

The objective of this course is for students to develop the knowledge base and skills for investigating and analyzing environmental issues and for communicating their knowledge and analysis to others.

Performance Objectives

By the end of this course, students will be able to:

1. outline the ecological processes inherent in natural ecosystems and how these can be impacted by human activity
2. characterize traditional Indigenous and historic European relationships with the environment in NB, and how those relationships have changed over time as reflected in current environmental policies and legislation
3. identify the impact of personal behaviours on the environment, and recognize that caring for and sustaining natural environments is an element of responsible global citizenship.
4. demonstrate an understanding of the importance of sustainable development, considering environmental, social, cultural, and economic aspects, to effectively resolve issues.
5. analyze and propose solutions to current environmental issues through research, experimentation and a presentation of their findings with respect to the issue

Key to this learning will be the development of competencies in *Critical Thinking and Creative Problem Solving, Collaboration, Communication, Personal Development and Self Awareness, and Global Citizenship* (see **Appendix C**).

Student Project

Completion of the student project is a requirement for all students in this course. The three components are 1) independent research and report on an environmental issue 2) collaborative work towards a group presentation on an environmental issue, and 3) completion of a choice of optional activities to demonstrate: personal appreciation of the environment, environmental stewardship through action, advocacy for the environment, and engagement of others in environmental inquiry. See **Appendix A** for outcomes and more details.

Unit 1 – An Overview of Environmental Science

After an initial exploration of students' beginning understanding and concerns, teachers will spend the first few weeks working with the class as a whole to **model investigative and presentation skills**, while exploring human population issues and providing an overview of current environmental and world issues.

As students practice and demonstrate competencies, formative assessment will help them to **hone these skills** as they gain an understanding of the history, context and methods for the study of environmental science and issues.

By the end of this unit each student will be required to provide a plan with a timeline to complete each aspect of their **student project** by the end of the course. They will use the research and presentation skills they have learned in this unit to complete the student project.

Unit 2 – Sustainable Development

As the course progresses through **Unit 2** students will gain an understanding of the connectedness of the natural world and of our place in it. Through the study of traditional Indigenous and historical European relationships with the environment in NB, and how these relationships did or did not change over time, students will begin to understand how humans interact with the environment at both a personal and societal level, and how this interaction is affected by economic, social, and cultural contexts.

Sustainable development, with parallels to Indigenous ways of knowing, is offered as a way to approach our responsibilities to the natural world, as we explore ways to minimize stress on the natural environment to ensure the maintenance of dynamic healthy ecosystems. This approach considers the environment in the context of peoples' social, economic and cultural perspectives and concerns. This holistic view of people's place in the world will help students to become aware of their responsibilities as global citizens.

Unit 3 – Investigating Environmental Issues

In this unit students are given the opportunity to develop their inquiry skills as they investigate and report on environmental issues of concern to them. The intention of this unit is to identify issues of concern and interest, understand the natural ecology of the environment and how it has been impacted by human economic, social, and cultural activity, and to explore ways to ensure sustainability.

Choices of topics and issues studied should address student and teacher interests and should include those topics that were chosen by students for their research projects. Choices should also reflect current issues and events, and connections should be made to local and regional concerns.

The teacher will act as facilitator to provide perspective and context for the issues researched and presented as part of the **student projects**. For example, if a group of students choose to do their research on agricultural issues such as the "100 mile diet", pesticide use, soil erosion, and alternative farming methods, the teacher would choose

to teach a section on agriculture, presenting an overview of agriculture to provide context, and the group would then present their findings to the class as a way of expanding on particular issues of concern to them.

The choice of which and how many issues to study is at the discretion of the teacher, with the caveat that each topic be studied to sufficient depth to ensure students achieve a thorough understanding of the ecology of the environment impacted and a thorough understanding of the issue from environmental, economic, social, and cultural perspectives.

There is no requirement in this unit to study any particular topic(s). However, for any topic chosen, the following specific learning outcomes should be addressed:

- develop an understanding of the ecosystem of the environment affected, both from a western scientific view and from an Indigenous worldview
- demonstrate the effective and critical use of a variety of investigation and research methods
- design and carry out a scientific experiment to test an impact on the environment related to the topic
- contact relevant local, regional and/or national organizations and groups, and identify their mandate and their perspective on the topic
- develop a working knowledge of environmental legislation, policies and treaties and their relevance to the topic

To illustrate how these five outcomes could be addressed in the context of a particular topic, seven possible topics are developed with learning outcomes, elaborations and teaching suggestions - Agriculture, Forests, Fresh Water, Ocean Fisheries, Energy Resources, Climate Change, and Air and Water Pollution.

Summative assessment for each student should be based on demonstration of competencies, and effective application of knowledge and skills.

Universal Design for Learning

The New Brunswick Department of Education and Early Childhood Development's definition of inclusion states that every child has the right to expect that his or her learning outcomes, instruction, assessment, interventions, accommodations, modifications, supports, adaptations, additional resources and learning environment will be designed to respect his or her learning style, needs and strengths.

Universal Design for Learning is a "...framework for guiding educational practice that provides flexibility in the ways information is presented, in the ways students respond or demonstrate knowledge and skills, and in the ways students are engaged." It also "...reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement expectations for all students, including students with disabilities and students who are limited English proficient" (CAST, 2011).

In an effort to build on the established practice of differentiation in education, the Department of Education and Early Childhood Development supports *Universal Design for Learning* for all students. New Brunswick curricula are created with universal design for learning principles in mind. Outcomes are written so that students may access and represent their learning in a variety of ways, through a variety of modes. Three tenets of universal design inform the design of this curriculum. Teachers are encouraged to follow these principles as they plan and evaluate learning experiences for their students:

- **Multiple means of representation:** provide diverse learners options for acquiring information and knowledge
- **Multiple means of action and expression:** provide learners options for demonstrating what they know
- **Multiple means of engagement:** tap into learners' interests, offer appropriate challenges, and increase motivation

For further information on *Universal Design for Learning*, view online information at <http://www.cast.org/>.

Inclusion of an Indigenous Worldview

In an inclusive *Environmental Science* curriculum, all students are encouraged to respect and understand the variety of science worldviews with which various cultures understand and explain their relationships with the natural world.

Students in New Brunswick have varied cultural backgrounds and come from geographic areas encompassing northern, rural, and urban environments. Teachers should use a variety of teaching methods that build upon the students' knowledge, perspectives, cultures, and learning styles. Teachers should also adapt instruction in order to be responsive to the interests and needs of their students and local communities.

Two-eyed Seeing

Both Indigenous and western scientific knowledges are based on observations of the natural world. Traditional Indigenous ways of knowing have contributed significantly to our knowledge and understanding of the natural world, not always accessible through western scientific methods.

Etuaptmumk is the Mi'kmaq word for Two-Eyed Seeing introduced by a Mi'kmaq Elder from Eskasoni First Nation, Albert Marshall. It refers to learning to see with one eye the strengths of Indigenous knowledge and ways of knowing, and with the other eye the strengths of western knowledges and ways of knowing, and to learn to use both eyes together to gain a clearer understanding of the world.

A Two-Eyed Seeing approach is one way to integrate, and develop a greater understanding of, and appreciation for Indigenous worldviews in our classrooms. It is also a way to offer First Nations students more opportunities to succeed in the dominant culture without compromising their own culture.

A respectful recognition of Indigenous contributions to science and an understanding of the environment from an indigenous worldview are of benefit to *all* students, regardless of background, as part of an inclusive society. Advantages include addressing and promoting understandings around misconceptions and negative biases; enhancing learning experiences for First Nations students by providing meaningful context; and making the subject more authentic, exciting, relevant, and interesting by including Indigenous examples of science and technologies. (Saskatchewan *Science 10*)

Traditional Indigenous worldview

Battiste and Henderson (2010) summarize the structure of Indigenous ways of knowing to include "(1) knowledge of unseen powers in the ecosystem, (2) knowledge of the interconnectedness of all things, (3) knowledge of the perception of reality based on linguistic structure or ways of communicating, (4) knowledge that personal relationships bond people, communities and ecosystems, (5) knowledge that traditions teach specialized knowledge related to "morals" and "ethics" and (6) knowledge that extended kinship passes on social traditions and practices from one generation to the next." (Referenced in Hatcher and Bartlett 2009)

Other curricula across Canada acknowledge the perspective and importance of Indigenous knowledge. For Saskatchewan, the *Science 10 curriculum* explains that, "Indigenous perspectives are holistic, and focus on understanding concepts at a macro

level, and then looking for specific examples that incorporate that knowledge. Inherent in these perspectives is an understanding of the relationships between the living and non-living, and a need to respect cultural values when exploring nature.”

Curricula in British Columbia refer to an Indigenous way of knowing as *Traditional Ecological Knowledge and Wisdom* (TEKW) which is defined as the study of systems of knowledge developed by a given culture. It brings the concept of wisdom to discussions of resource science. It tends to be holistic, viewing the world as an interconnected whole where humans are not regarded as more important than nature. It is a subset of traditional science and is considered a branch of biological and ecological science. (BC *Sustainable Resources 11 and 12* curriculum guide).

In a traditional Indigenous worldview, knowledge and the learners are intimately connected, in contrast to their separation in western thinking. A western contemporary scientific approach is generally characterized as reductionist, focusing first on the micro level of understanding, then progressing to the major macro concepts and connections.

A Note on Consultation with First Nation Elders

Students doing research may be interested in consulting directly with First Nation Elders. Especially for students crossing cultures, it will be important for them to understand appropriate protocols.

Student requests to interview First Nations Elders about traditional Indigenous ways of knowing, must be approved by one of the District Coordinators of First Nations programs and services who will provide protocols, and identify Elders willing to participate. It will then be the teacher’s responsibility to ensure these guidelines are followed.

References

Hatcher, A and C. Bartlett 2010 Two-Eyed Seeing: Building Cultural Bridges for Aboriginal Students From the “Canadian Teacher Magazine” May 2010
http://www.canadianteachermagazine.com/ctm_first_nations_education/may10_two_eye_d.shtml

British Columbia *Sustainable Resources 11 and 12* curriculum guide
<http://www.bced.gov.bc.ca/irp/pdfs/sciences/2008susres1112.pdf>

Saskatchewan *Science 10* curriculum guide
<http://www.education.gov.sk.ca/CURR/science-10Indian>

Essential Graduation Learnings

Graduates from the public schools of Atlantic Canada will be able to demonstrate knowledge, skills, and attitudes in the following essential graduation learnings. These learnings are supported through the outcomes described in this curriculum document.

Aesthetic Expression

Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through the arts.

Citizenship

Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.

Communication

Graduates will be able to use the listening, viewing, speaking, reading and writing modes of language(s) as well as mathematical and scientific concepts and symbols to think, learn, and communicate effectively.

Personal Development

Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

Problem Solving

Graduates will be able to use the strategies and processes needed to solve a wide variety of problems, including those requiring language, mathematical, and scientific concepts.

Technological Competence

Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems

Suggested Timeline

Unit 1 An Overview of Environmental Science (25 hours)

The Issues (5 hrs)

- ☞ current understanding of issues – environmental, economic and social justice perspectives

Population Growth and Resource Limitations (10 hrs)

- ☞ population dynamics in natural systems
- ☞ human population trends and influences
- ☞ resource limitations and carrying capacity

Researching Current Environmental Issues (10 hrs)

- ☞ class investigation of current issues, modeling research and investigative skills
- ☞ start of student project

Unit 2 Sustainable Development (30 hours)

Ecology (10hrs)

- ☞ interrelated systems that support living systems
- ☞ human impact on natural systems

Environmental Awareness (10 hrs)

- ☞ Indigenous ways of knowing nature
- ☞ historic and current attitudes to the environment
- ☞ early European settlers' attitude to the environment
- ☞ development of values for conservation and sustainability
- ☞ current land and water use
- ☞ history of the Western environmental movement

Sustainable Ecosystems and Communities (10 hrs)

- ☞ dynamics of healthy and sustainable ecosystems
- ☞ principles of sustainable communities
- ☞ relationships between local, regional, and global ecosystems and societies
- ☞ principles of sustainable development

Unit 3 Investigating Environmental Issues (35 hours)

- ☞ defining the issue
- ☞ investigating the natural ecosystem and human impact
- ☞ considering social, cultural, and economic aspects
- ☞ investigating human and environmental perspectives and solutions

Possible issues

Agriculture

Forests

Fresh Water

Ocean Fisheries

Energy Resources

Climate Change

Water and Air Pollution

Student Projects

- ☞ Independent research and report
- ☞ group presentation with research summary, exploration of solutions, and class activity
- ☞ demonstration of personal appreciation of the environment, environmental stewardship through action, advocacy for the environment, and engagement of others in environmental inquiry.

UNIT 1 *An Overview of Environmental Science*

The Issues

(5 hours)

NB Prescribed Outcomes

It is expected the student will:

- explore and communicate current understanding of local, regional and global environmental issues.
- identify links between personal behavior and local, regional and global environmental issues.
- identify ways to measure environmentally sustainable behaviours, and describe links to economic and social factors.
- identify individual impacts on the environment using the concept of ecological footprint.

Elaborations

This topic is meant as a brief overview to explore the understanding of environmental science and environmental issues that students bring to the classroom.

Students should be encouraged to culture a sense of personal and community responsibility for environmentally sustainable behaviours as part of responsible citizenship.

Students should produce their own list of resource and energy demands and estimate their own ecological footprint taking into account the land and water ecosystems affected and the resources required to produce resources, and to process wastes. This will introduce a quantitative estimate of human carrying capacity.

Ways of reducing human impact on the environment should be a recurring theme throughout this course.

The Issues con't

Suggested Activities for Learning and Assessment

Have the class brainstorm:

Local environmental issues e.g., waste management, sewage treatment, land development, mining, aquaculture, silvaculture

Global environmental issues e.g., climate change, resource depletion, loss of biodiversity, imbalance of resources

- a) Explore the *Who, What, Why, Where, When* and *How* of these issues.
- b) Prioritize brainstormed issues in terms of the urgency of the issue and provide rationale for the way they have been prioritized.

Have students research current articles from newspapers and magazines for environmental issues.

- a) Select an article, discuss it with a partner and then summarize your discussion and position on the issue
- b) Starting with one article, research the different perspectives and perception of the issues by different groups. Summarize.

Provide the following to guide student inquiry:

- Research the mandate and position of an advocacy, environmental, or naturalist group on a particular environmental issue.
- Select an issue that interests you and prepare a 5 minute presentation for the class, summarizing the issue.
- Using an on-line tool to measure your ecological footprint, explore as a group, ways in which each of you could reduce your footprint. At the end of this course measure your footprint again to see if it has changed.

Population Growth and Resource Limitations

(10 hours)

NB Prescribed Outcomes

It is expected that students will:

- explain various ways in which natural populations are kept in equilibrium and relate this equilibrium to resource limits of an ecosystem.
- explain the concepts of limiting factor and carrying capacity in the context of species population growth.
- understand and be able to use of the term “natural capital” and “natural income”.
- examine the growth and fluctuations of human population globally, regionally and locally.
- examine the ways in which population fluctuations are measured and tracked.
- evaluate Earth’s carrying capacity, human population growth and its demands on natural capital, and consumer culture.

Elaborations

To explain the concepts of resource requirements, limiting factors and carrying capacity, some examples of population growth and fluctuations of other species in the natural world should be discussed. These concepts can then be discussed with reference to human population trends.

The concept of carrying capacity can be difficult to apply to human populations, as the range of resources used by humans is usually much greater than for any other species. Furthermore, when resources become limiting, humans show great ingenuity in substituting one resource for another or importing resources from outside their immediate environment.

The term “natural capital” has been coined to refer to all the natural resources on which people depend and includes resources we use to produce manufactured goods, to support activities such as agriculture, forestry, tourism, and recreation, and to provide clean water and air, fertile soils, flood control and climatic stability.

If we use natural resources faster than the biosphere can renew them, and discharge waste faster than the ecosphere can assimilate it, we may be causing permanent or irreversible damage and we are said to be living off our “natural capital”. Alternatively if we can properly manage our resources to allow renewal and replenishment, we are said to be living sustainably.

Traditional Indigenous ways of living may provide clues on how to live sustainably, as it is based on generations of knowledge, close observation of natural order and a cultural and spiritual consciousness.

Students should examine the growth and fluctuations of Earth’s human population locally, regionally, nationally and internationally. It should include an examination of the distribution of population within and between countries, and distribution between urban and rural settings.

As students consider population with reference to limitations of natural resources, they should examine the difference between wants and needs and recognize that the lifestyle demands of rich countries such as Canada go well beyond a life-sustaining need for food, water, and space, and well beyond our share of the World's resources. This combined with the increasing wealth and demand for an increased standard of living in Asia and other parts of the World, present significant challenges for the future

Population Growth and Resource Limitations con't

Suggested Activities for Learning and Assessment

Provide the following to students to guide inquiry:

- Research various ways in which governments around the world such as India and China, have attempted to reduce population levels through legislation and policies. Explore the success and the issues around these attempts. Decide if they have been successful. Consider whether or not you would support these policies. Decide if you would support applying these policies in New Brunswick. Explain.
- Research population trends in Canada and New Brunswick and reasons why, as world population balloons, we would want to increase population levels in New Brunswick. Consider whether or not you would support increasing New Brunswick's population and if so, what methods would you recommend for this?
- Survey family members and generate a list of items that they feel are not required to live a healthy and fulfilling lifestyle. Think about whether or not having these items impact on demands for resources and energy.

Researching Current Environmental Issues

(10 hours)

NB Prescribed Outcomes

It is expected that students will:

- become aware of the range of issues arising from overpopulation and human activity.
- explore one or a few local or regional issues with respect to the impact on the environment, and on history, economics and social systems.
- practice research and presentation skills including experimenting to test environmental impact, identifying and accessing various organizations for information and expertise, and considering the legislation which impacts on environmental issues.
- explore how technology is used to gather and communicate information, and to address the issues.
- explore how past and current technologies have impacted our study and understanding of the environment, and have been developed to solve environmental issues.
- *choose an issue to explore in more depth, and develop a plan for a research project that will be presented during the last unit.*

Elaborations

This section is meant as an opportunity to both introduce students to a wide range of topics, and to model the methods of investigation and research that students will require for their independent research. It is suggested that the class first be introduced to a wide range of issues, and then to explore one or a few local or regional issues in more depth.

Issues could include:

- resource extraction (mining, forestry, fisheries, oil)
- food production and food security (agriculture, fisheries),
- waste and pollution (air, water, toxic, hazardous)
- social issues and the environment (urbanization, violent conflicts, protection of sacred sites)
- economic disparity (consumerism, rich/ poor countries)
- legislation on fishing and forestry (hunting and fishing regulations, Peace and Friendship Treaties)
- western scientific and Indigenous ways of knowing nature, alternate worldviews and what each has to offer

Technology is one of the ways that humans interact with the physical world. This includes communication tools (the internet, email, social networking), data collection and analysis (sensors, meters, software), and technical devices, machinery, materials and methodology (ultrasound, MRI's, heavy machinery, gene slicing, genetic modification). As they explore their current understanding of environmental issues, and throughout this course, students should consider the use and impacts of technology – both good and bad.

The study of a local or regional issue should include the development of social, ethical and environmentally responsible behaviour both in and beyond the classroom. It should encourage students' involvement in the life and concerns of their neighbourhood and communities. Skills of inquiry, communication, participation and responsible action should be developed as students become informed and involved citizens.

The methods that the class uses to investigate issues should be developed with an eye to developing skills that students will then be able to use when they explore in Unit 3, and when they do their own research projects.

By the end of this section students should have identified an issue for further research and should have developed a plan and timeline to complete their student project. Groups should commit to a presentation date at an appropriate point during *Unit 3*. (see **Appendices A-C**)

Researching Current Environmental Issues con't

Suggested Activities for Learning and Assessment

Assign students an ecosystem type (local and other). Coordinate efforts to collect information on formation of the ecosystem (geology, soil formation, weather), the abiotics that supports the biotic elements of the ecosystem, human interaction/ impact on the environment, sensitivity of the particular ecosystem, legislation to protect the environment, and solutions to environmental damage. Bring all this data together as a class, and develop a variety of presentation skills for sharing it with each other and with other classes. Review scoring rubrics.

Have students conduct literature reviews on a particular topic, gathering articles from newspapers, magazines, and scientific journals. Present their findings to one another.

Conduct experiments and investigations on the impact of humans on: soil, air and water quality (turbidity, pH levels, particulate air pollution); biotic and abiotic ecosystem components (soil structure, biodiversity, tree age, decaying biotic matter, rainfall)

Have students summarize and present an article or paper on a specific topic or issue.

Have students research and summarize local, provincial, national and international environmental legislation and present to the class.

Unit 2 *Sustainable Development*

Ecology

(10 hours)

NB Prescribed Outcomes

It is expected that students will:

- demonstrate an understanding of the organization of life from cell to organism, to species, to populations, to ecosystem, to biosphere
- explore Indigenous ways of knowing organisms beginning with the whole
- demonstrate an awareness and understanding of the concepts of energy flow, and chemical cycling (carbon, nitrogen, phosphorus, water, oxygen) that support ecological systems
- recognize and explore the role that technology has played in measuring factors such as weather and levels of chemical elements that cycle through natural systems.
- understand that the biosphere is a complex system of living things that interact with each other and extend into the geosphere, atmosphere, and hydrosphere
- demonstrate an understanding of evolution & natural selection. Briefly examine the history of life on earth. Consider that mass extinctions have occurred in the past.
- recognize that humans are just one part of a complex system of living things, with a inordinate impact on the biosphere, often accelerated by the use of technology

Elaborations

The emphasis here should be on establishing the complexity and connectedness of all of Earth's systems.

A western science approach builds understanding from the cell to the biosphere and explores relationships between organisms (symbiosis, predation, competition, parasitism, mutualism, and commensalism). An Indigenous approach begins with the whole to understand each part of the ecosystem.

The relationships of all Earth's systems create a dynamic balance of all the components of the Earth's natural systems. Students should recognize people as a part of the natural world, dependent upon a continuing balance.

Students should come to this course with a general scientific understanding of the chemical and structural basis of life, energy flow through food webs, the continuous cycling of nutrients necessary for all life, and ecosystem structure and dynamics. Some of these cycles and concepts will have been covered in previous grades but some, like the nitrogen and phosphorus cycles, they will not have seen before.

Connections should be made between environmental problems and the disruption of natural cycling by humans. Examples include radioactive contamination, pollution of the ocean, depletion of fish stocks, use of fossil fuels, use of fertilizers and pesticides, the draining of underground water aquifers, and the clearing of forests. This should be compared to a more respectful way of being in the natural world which recognizes the interconnectedness of every element of the whole.

Ecology con't

Suggested Activities for Learning and Assessment

Draw a food chain or web. Using the second law of energy, explain why there is such a sharp decrease in usable energy as energy flows through a food chain or web. Explain this decrease in usable energy with reference to the first law of energy. Using the second law of energy, explain why some may choose to become vegetarians.

Have students collect photos and examples from various media that show human impact on Earth. This could be included in their portfolio. This project could continue throughout the entire course and referred to at various times and units. Students could also present a sample from their portfolio to their course on a weekly or monthly basis. Teachers may also choose to develop a bulletin board in which selected articles/photos of human impact are displayed.

Using markers, draw a section on a balloon that is labelled humans. Draw other sections on the balloon that are labelled with living and nonliving elements of Earth. Squeezing the section on the balloon labelled humans causes the other sections to expand or contract. Have students look at their balloons and provide an example of how humans affect each of the other sections on the balloon.

Using technology such as probes, chemical testing kits, and pH meters, students could test and measure some of the environmental factors that impact on the health of various organisms in an ecosystem.

Teachers could consider accessing online records for climate and events such as earthquakes and volcanoes, and have students investigate the effect that these factors have had on various ecosystems and life forms.

Environmental Awareness

(10 hours)

NB Prescribed Outcomes

It is expected that students will:

- describe the variety of attitudes towards the environment in New Brunswick including traditional Indigenous and western scientific worldviews
- describe the development of attitudes towards the environment in NB by Europeans and later settlers to NB, from colonization times to today.
- describe how land and water use in New Brunswick has changed over the last 300 years.
- discuss the increasing awareness of environmental issues and understanding of ecology in New Brunswick.
- explore how the development of technologies has affected land and water use.
- explore the people and ideas involved in the development of the Western environmental movement
- research present day and historical Canadians and New Brunswickers who have contributed in a variety of ways to the environmental movement .

Elaborations

Attitudes towards the environment will be influenced by a variety of factors such as where a person lives (rural or urban), their family or community's cultural attitude towards nature, their time spent in nature either for work (naturalist, ecologist, forester, farmer, fisher, in mining) or leisure (hunting, fishing, hiking, camping).

A scientific worldview is one way of understanding the natural world. It tends to be reductionist – studying the parts at one point in time and as separate parts of the whole. It also seeks to separate the physical world from human influence. An Indigenous perspective tends to be more holistic, both at a given point in time and over long periods, complementing an ecological and sustainable development worldview. This is an opportunity to explore these and other approaches and the ways in which they complement one another.

Students should also explore the early European settlers' views and use of their environment. When immigrants first began settling in New Brunswick they were escaping a Europe embroiled in political and religious upheaval, persecution and poverty. North America represented opportunities for a new start in a land rich in land and resources. The settlers came from a culture in which land was owned by individuals which ran contrary to the understanding of the people indigenous to New Brunswick who's culture did not include personal ownership of land. The Peace and Friendship Treaties were a promise to live in peace, but did not relinquish land or resources to the newcomers.

As early western naturalists and ecologists began to recognize the complexity of New Brunswick ecosystems, and conservationists began to see the increasing impact that people were having on the environment it gradually became apparent that people were depleting the natural capital. This has led to forestry and environmental protection legislation and to the establishment of protected and other conservation areas in NB.

Students should explore and discuss some of the numerous technological advances that have impacted both negatively and positively on the way we have interacted with the environment e.g., forestry and agricultural equipment, GIS,

pesticide use, chemical fertilizers, use of cars and urban sprawl, fisheries techniques, transportation of food.

After a study of land and water use in New Brunswick, students should put this in the context of the history of the Western environmental movement, including contributions in the past and in the present of Canadians and New Brunswickers. Pioneers of environmental conservation were visionaries at a time when most people thought Earth's resources and Earth's capacity to deal with waste and pollution was limitless.

Environmental Awareness con't

Suggested Activities for Learning and Assessment

Provide the following to students to guide inquiry:

- Have there been any land use changes in your community in your lifetime? How have those changes affected you
- Research the current status of treaty rights as related to access to natural resources for the aboriginal peoples of New Brunswick.
- At the time of first colonization by Europeans, how did the attitudes to land and water use differ between the Aboriginal peoples and European settlers? How did these attitudes impact on resource use in New Brunswick?
- Use historic aerial photos to track land use changes of a local area. What prompted these changes to occur? Were they due to social, economic and/or environmental influences? How might these three influences affect future land use in this area?
- Research the developing field of sustainable development in housing. What measures can be taken to integrate the building of new houses with the environment, and to minimize the ecological footprint for those moving in?

Sustainable Ecosystems and Communities

(10 hours)

NB Prescribed Outcomes

It is expected that students will:

- explain the principles of sustainable development.
- demonstrate an understanding of the dynamics of healthy and sustainable ecosystems.
- demonstrate an understanding of the requirements for sustainable human communities.
- demonstrate an understanding of the relationships between ecosystems and communities locally, regionally, and global.
- find examples of development that is sustainable and is not sustainable – ecologically, economically, socially, and culturally.
- understand stewardship in relation to sustainability.

Elaborations

Sustainable development is defined as development which meets the needs of today without compromising the needs of future generations.

For effective development to be sustainable, it must minimize stress on the natural environment to a level that the environment can recover from, and also address peoples' social, economic and cultural needs and concerns. Discussions of social factors should include consideration of culture, values, attitudes, and beliefs.

Teachers should have students consider resource industries such as agriculture, fisheries or forestry to explore what a sustainable, or non-sustainable ecosystem and community would look like. This will include the health of the ecosystem, the environmental impacts of the industry, and the support of the community's social and economic well-being.

Students should recognize that stewardship is a shared responsibility to ensure sustainability of the whole environment at a personal, local, regional and global level.

Sustainable Ecosystems and Communities con't

Suggested Activities for Learning and Assessment

Provide the following to students to guide inquiry:

- Explain the guiding principles of sustainability (economic, ecological, and social) and provide an example from your own community of how these principles are, or are not being met
- Reflect on the three levels of sustainability – self, local, and global - and how you might contribute at each. Record your thoughts in a brief 1-2 page essay.
- Identify how stewardship and eco-citizenship often conflicts with past or present human practices and economic realities. Pick the single guideline and the single strategy that they think is the most important.
- Greenhouse gas emissions from motor vehicles are a major contributor to global warming. The use of ethanol and other biofuels in motor vehicles reduces these emissions. However, diverting crops from food production can increase prices and decrease the supply of food. Analyse, on the basis of research, the environmental, social, and economic factors related to this issue
- Do you think that any of the three factors that affect sustainable development - environment, society, economy - is more important than the others? Why or why not?
- List several ecological, social, and economic factors that influence sustainability. Select one factor from each category and use a local or regional example to demonstrate an understanding of each factor.
- Research and provide a summary of social and economic issues related to a particular environmental challenge and the efforts that have been made to address the issues (e.g., overfishing, deforestation, Canada's tar sands projects, melting of the polar ice cap)

UNIT 3 *Investigating Environmental Issues*

(40 hours including time for student presentations)

In this unit the class will explore specific environmental issues in depth, interspersing student presentations as appropriate. The choice of which issues and how many different issues to study is at the discretion of the teacher, with the caveat that each topic be studied to sufficient depth to ensure students achieve a thorough understanding of the issue from economic, social, cultural and environmental perspectives. The topics and specific outcomes provided on the following pages may be used as a guide, or a teacher may choose a different topic.

Whatever topic or topics are chosen, the issues studied should address student and teacher interests and should include those topics that were chosen by students for their research projects. Choices should also reflect current issues and events, and connections should be made to local and regional concerns.

There is no requirement in this unit to study any particular topic(s). However, for any topic chosen, the following specific learning outcomes should be addressed:

- develop an understanding of the ecosystem of the environment affected, both from a western scientific view and from a Indigenous worldview
- demonstrate the effective and critical use of a variety of investigation and research methods.
- design and carry out a scientific experiment to test an impact on the environment related to the topic
- contact relevant local, regional and/or national organizations and groups, and identify their mandate and their perspective on the topic
- develop a working knowledge of environmental legislation, policies and treaties and their relevance to the topic

For those teachers for whom it would be helpful, optional topics for study are provided with specific outcomes and elaborations for the following topics:

1. Agriculture
2. Forests
3. Fresh Water
4. Ocean Fisheries
5. Energy Resources
6. Climate Change
7. Air and Water Pollution

Unit 3 – Optional topics for Study

1. Agriculture

NB Prescribed Outcomes

It is expected that students will:

- outline the present level of agriculture in New Brunswick. Include:
 - levels of employment
 - impact on the economy
 - number of active farms
 - primary products
- develop an understanding of the natural ecology of the environment and how it is affected by farming.
- design and carry out an experiment to test the impact of agriculture on the environment.
- explain different methods of farming including organic, non-pesticide, traditional, and industrial farming practices.
- explain practices for improving and maintaining soil structure and fertility.
- summarize the state of global food production and issues that affect it including natural disasters, war, and urbanization.
- contact local, regional and/or national organizations and government agencies, and identify their mandate and perspective on agriculture.
- develop a working knowledge of current environmental legislation and policy and how it applies to agriculture.

Elaborations

Agriculture should be placed in an historical context. It is a relatively new practice that allowed humans to settle in communities. It arose 10,000 years ago though Homo Sapiens have been around for approximately 200,000 years.

In the last hundred years there have been major changes with the rise of industrial agriculture, use of pesticides, and fertilizers. Students should evaluate the successes and failures associated with the green revolution.

Students should compare the energy sources, environmental impacts, yields, and sustainability of various methods of agriculture. They should also explain the purpose and effects of different methods used in farming such as interplanting, intercropping and polyvarietal cultivation.

Organic farming is a growing trend on NB and elsewhere in the world. Students should examine how the quality of food, quantity of food, and general farming practices differ from other farming methods They should be able to explain what is required in becoming “certified organic”.

Students should become familiar with the terms malnutrition, undernutrition, and overnutrition and the occurrence in various communities around the world. Students should be aware of global organizations’ (e.g., UNICEF) efforts in dealing with malnutrition and undernutrition.

Students should consider these conditions and their prevalence in NB (prevalence of obesity and diabetes, demands on food banks, locally produced food vs. foods shipped from elsewhere).

Agriculture con't

Suggested Activities for Learning and Assessment

Have the class discuss the environmental, economic, political, and social consequences that might ensue from loss of fertile soils through erosion.

Have students design a landscaping project for the local area (i.e. a rooftop garden, a plot in a community garden, a riparian restoration) and, taking into account local climate conditions, have them propose a course of action to ensure sustainability of the project and its healthy interaction with the surrounding natural environment

Provide the following to students to guide inquiry:

- Research the “What? Where? Why? When? and How?” of the Green Revolution.
- Identify the three most important actions that you would take to reduce hunger (a) in New Brunswick. (b) in the World.
- What are genetically modified foods and how might they help, or hurt agriculture and the environment?
- In what ways can consuming locally grown foods help the local economy, society, and the environment? Do the advantages outweigh the disadvantages?
- Interview or invite a local farmer to your class to discuss local agricultural problems and opportunities. Have students develop a set of questions around, for example, changes in agriculture historically and in the future, what were/will be the consequences, what methods does this farmer use and why and how much is sold locally and how much is shipped.
- Compare monoculture farming with mixed farming. What are the economic, nutritional, energy (both human and fuel), environmental, soil health, and other costs and benefits of each method?
- Investigate issues around soil erosion.
 - What causes erosion? Why is it a problem?
 - How can soil erosion be reduced or prevented?
 - Using aerial photographs, identify areas that demonstrate soil management practices, or identify an area at risk
 - Develop your own soil management plan.
- Perform a soil analysis of a sample obtained from a certified organic farm and of a sample obtained from a farm that uses fertilizers, pesticides, fungicides, and/or herbicides. Share your results with the class.

Unit 3 – Optional topics for Study

2. Forests

NB Prescribed Outcomes

It is expected that students will:

- locate the major forest regions of Canada and examine their uniqueness.
- identify the forest types of New Brunswick and the characteristics of each type.
- identify the value of forests as natural capital, economically, socially and ecologically.
- develop an understanding of the natural forest ecology and how it is and has been affected by forestry practices.
- design and carry out an experiment to test the impact of forestry on the environment.
- explain how to manage forests for sustainably. Include:
 - role of forest certification
 - effect of harvesting methods
 - effect of deforestation
 - ways to prevent natural capital degradation
 - role of provincial and national parks, conservation areas, reserves and protected areas
- examine the history of old growth forests, second-growth forests, and tree farms in New Brunswick.
- contact relevant local, regional and/or national organizations, and identify their mandate and perspective on forest use.
- develop a working knowledge of current environmental legislation and policy and how it applies to forest use.

Elaborations

Maps can be used to identify where and what major forest types occur in Canada, and New Brunswick.

Students should recognize the importance of Forests, not just as an economic resource but for a variety of social, cultural and ecological values.

Maintaining a healthy forest ecosystem will ensure the sustainability of the supply of wood and other forest products, and of employment in forestry and eco-tourism. It will also be available for recreation and for physical and spiritual rejuvenation.

The ecological benefits to humans of a healthy forest ecosystem include maintaining water quality, controlling flooding, reducing air pollution, and cooling air and soil temperatures.

Just as important as the value of forests to humans, is the intrinsic value of the natural ecosystem as the home to a vast array of living organisms, all interacting and dependent on an intact forest ecosystem.

With approximately half of New Brunswick owned by the Province (Crown Land) there is an element of public control in New Brunswick that is not found in other areas. Students should become familiar with the current legislation that directs the use of the forests in New Brunswick.

Students should investigate forest management examples outside of Canada (e.g., tropical deforestation, Kenya's Green Belt Movement, Costa Rica's forest protection) to better understand global forest sustainability issues.

Forests con't

Suggested Activities for Learning and Assessment

Have students conduct a role play activity to represent a situation in which members of a community are at odds over how a public forest resource may or may not be utilized. Students could be divided into groups to represent the various ecological/social/economic interests (e.g., logger, conservationist, hiker, hunter, etc.). Each group develops a plan or proposal that will be presented to their town council. One member in the group will present the plan. The students who do not present will represent the Council and will identify the strengths and weaknesses in each proposal. At the end, the class will vote on which of the proposals (or modified proposals) should be awarded the use of the forest resource.

Have students brainstorm the social, economic, cultural and economic roles that forest ecosystems play in New Brunswick. Identify some of the issues that they know something about and have them research these further and report back to class the following day.

Provide the following to students to guide inquiry:

- Identify on a map of Canada the major forest regions and research the characteristics of each type of forest.
- Research the history of the establishment of the Protected Areas Strategy in New Brunswick. What factors encouraged the development of this strategy, what legislation is now in place, and what characteristic ecosystems are represented by each of the various protected areas?
- Research how much of NB is covered in forests. How much is crown land and how much is privately owned? What is the legislation that directs how crown land is used?
- Create a visual product (e.g., collage, poster, multimedia presentation) or a written product (e.g., an article for a newsletter, poem, song, short story) that describes the way we use forests in New Brunswick.
- Use a dichotomous key to identify local tree species

Unit 3 – Optional topics for Study

3. Fresh Water Use

NB Prescribed Outcomes

It is expected that students will:

- describe Earth's water supply.
- describe water use, locally, nationally, and globally.
- develop an understanding of the natural fresh water ecology and the impact of people.
- design and carry out an experiment to test the impact of people on fresh water ecology.
- investigate the causes of water scarcity and assess the significance of water resources for international relations.
- describe ways in which we can use water more sustainably.
- contact relevant local, regional and/or national organizations and government agencies, and identify their mandate and perspective on water issues.
- demonstrate the effective and critical use of a variety of investigation and research methods.
- develop a working knowledge of current environmental legislation and policy and how it applies to water issues.

Elaborations

Water is a finite resource and all the water that currently exists on Earth is all the water that has ever been here. Although our planet is covered by approximately 70% water, less than 1% is readily accessible fresh water.

A study of the water cycle demonstrates how fresh water moves, and where it is accessible for human use as groundwater or as part of a watershed. The importance of groundwater as a water source should be established. Topographical maps can be used to study local watersheds, and often there are local watershed groups which provide information and expertise.

Primary uses of water around the world (mainly agriculture and energy) differ from the primary uses in Canadian households (mainly flushing toilets and taking showers). Canada has an abundance of water resources but our per capita consumption is very high.

An important issue around water use is the depletion of underground aquifers at a greater rate than it can be replenished.

Water resources can affect international relations and can lead to conflicts between nations. Students should be challenged to discuss how the natural capital that exists in Canada's water resources will be affected as the world's demand for fresh water continues to increase.

Students should create a plan for more sustainable water use. The plan should consist of a water budget for domestic water use and a plan for more global/holistic strategies for improved water sustainability.

Fresh Water Use con't

Suggested Activities for Learning and Assessment

Conduct a class debate on the topic “Should Canada sell water to the United States?”

Conduct an experiment to test for nitrates in groundwater.

Collect and display local articles relating to development or farming activities and how they impact watershed areas or groundwater.

Have students interview a resources person from a local environmental or watershed group to discuss how various activities and developments can affect the local watershed.

Provide the following to students to guide inquiry:

- Which in your opinion will be a more valuable resource in Canada in the year 2100, oil or fresh water? Explain.
- Identify areas of your daily consumption in which you are wasting water and suggest ways to conserve water.
- Congratulations! You are in charge of managing the world's water resources. What are the three most important things that you would do?
- What are some of the social and economic challenges associated with cleaning up and conserving fresh water supplies?
- What are some strategies that the world could follow to use water more sustainably? What are the advantages and disadvantages associated with these strategies?
- Is it better to drink bottled water instead or tap water? What regulations are there that monitor what goes into bottled water?

Unit 3 – Optional Topics for Study

4. Ocean Fisheries

NB Prescribed Outcomes

It is expected that students will:

- identify the importance of ocean resources to New Brunswick.
- describe a range of fishery practices.
- develop an understanding of natural ocean ecology and how it is and has been affected by fisheries practices.
- design and carry out an experiment to test the impact of fisheries on the environment.
- outline the major issues facing the world's ocean resources.
- contact relevant local, regional and/or national organizations and government agencies, and identify their mandate and perspective on fisheries.
- demonstrate the effective and critical use of a variety of investigation and research methods.
- develop a working knowledge of current environmental legislation and policy and how it applies to fisheries.

Elaborations

Students should gain an understanding of the importance of ocean food resources in New Brunswick today and throughout history. Since much of the history of settlement has been directed by proximity to ocean resources, our social and cultural identity is strongly linked to it as well.

Pressures facing the global fishing industry include increased demand from the rising global population, climate change, pollution, and habitat loss.

The United Nations Food and Agriculture Organization (FAO) provides recent data on the global fishery. This data provides information on the levels of exploitation and dependence on fishing.

Overfishing is a serious threat to biodiversity in coastal waters and to some marine species in open ocean waters. The contribution of technology to overfishing should be examined. Fishing techniques such as bottom trawling, and side effects such as by catch or ghost fishing can also have a significant effect on biodiversity.

Students should gain an understanding of the regulations and legislation around the fisheries. Students should also be exposed to NB's aquaculture industry and the advantages and disadvantages of this type of food production.

Sustainable management strategies for NB's fishery resources may be a topic of interest for student research projects.

Fisheries con't

Suggested Activities for Learning and Assessment

Provide the following to students to guide inquiry:

- Do you feel that the economic importance of NB's fisheries should outweigh the ecological impacts that it may be having on ocean resources? Explain.
- What are some of the major issues facing the world's ocean resources?
- How are managing ocean resources important to NB's environment, economy, and society?
- What are some of the main environmental impacts of commercial fishing techniques? Suggest some strategies to minimize these effects.
- Do the advantages of aquaculture outweigh its disadvantages? Explain your answer.
- Research a fish population that has been threatened by overharvesting (e.g., Atlantic cod, orange roughy, blue fin tuna, red snapper). Present to the class the conditions that led to its threatened state and what actions were taken to protect its remaining population.
- Interview a local fisher and discuss how fishing practices have changed throughout his or her career. Do they feel that current practices are sustainable? If not, what needs to change?
- Examine the complexities of international environmental cooperation e.g., bass vs. gaspereau in the St. Croix River.

Unit 3 – Optional Topics for Study

5. Energy Resources

NB Prescribed Outcomes

It is expected that students will:

- outline the range of energy resources, renewable and non-renewable, available in New Brunswick.
- evaluate the advantages and disadvantages of renewable and non-renewable energy sources from a variety of perspectives.
- describe energy use in NB, its impact on the environment and the factors that might affect its future.
- design and carry out an experiment to test energy use and effect of efficiency measures.
- describe how to improve energy efficiency nationally, globally, regionally and at the community and home level.
- contact relevant local, regional and/or national organizations and government agencies, and identify their mandate and perspective on energy resources.
- demonstrate the effective and critical use of a variety of investigation and research methods.
- develop a working knowledge of current legislation and policy on energy use and resources.

Elaborations

Concerns over energy resources currently focus on renewable versus non-renewable resources.

Simply stated, renewable resources such as wind, solar, hydro, geothermal, wave, tidal, ocean thermal gradient and wood do not increase the Carbon levels in the atmosphere and so do not contribute to global warming.

This contrasts with non-renewable resources such as oil, natural gas and coal which, when burned, release CO₂ from plant and animal remains that have been building up over millions of years.

Nuclear power is neither renewable nor non-renewable but is a new source of energy produced for human use. It does not increase CO₂ levels (except in mining and building reactors), but does increase the amount of radioactive materials in our environment.

Students should examine sources of energy in New Brunswick, and amounts that come from each source. All energy sources have costs and benefits, which should be examined from all perspectives - environmental and also from an economic, cultural, community, and technological perspective.

As Canadians we are not used to limiting the amount of energy that we use. However, with greater awareness we have begun to explore ways to reduce our footprint by using less fossil fuel, and by increasing our energy efficiency. This is often accompanied by significant cost savings.

Students may be interested in researching energy efficiency at their school or in their homes and using their findings to develop an energy efficiency improvement plan, including cost savings and necessary lifestyle changes.

Energy Resources con't

Suggested Activities for Learning and Assessment

Provide the following to students to guide inquiry:

- Discuss Canada's energy plan and its prospects for the future.
- Research the prospects for oil production in the future. What do you envision the future will look like when oil runs out?
- What role will economics play in New Brunswick's energy development?
- Research new technologies that produce energy with minimal impact on the environment. What limits the development and production of these technologies? How would they affect the communities where the energy would be produced?
- Calculate the amount of energy that is used by the major appliances in your home. How much do these appliances cost to operate every month? Can their use be reduced, and if so how much money could be saved?

Unit 3 – Optional Topics for Study

6. Climate Change

NB Prescribed Outcomes

It is expected that students will:

- distinguish between the greenhouse effect, global warming, and climate change.
- describe how Earth's climate has changed in the short and long term, and how scientists have studied these changes.
- identify possible effects of climate change on NB. Include ecosystem changes, community effects, economic impact, cultural and social impacts.
- contact relevant local, regional and/or national organizations and government agencies, and identify their mandate and perspective on climate change.
- demonstrate the effective and critical use of a variety of investigation and research methods.
- design and carry out an experiment to test an impact that climate change could have on the environment.
- develop a working knowledge of current environmental legislation and policy and how it applies to the topic.

Elaborations

There is often confusion between what is meant by greenhouse effect, global warming and climate change. Discussion of these alternate concepts would serve as a good introduction to the various concerns around the atmosphere.

To understand the discussion around climate change it would be helpful to investigate how scientists study changes in climate over time and how they study current atmospheric changes.

The climate data over time indicates that the Earth has undergone long periods of global warming and global cooling. Climate naturally cycles, and is impacted by natural events such as volcanic activity, ocean currents, solar variability, Earth's orbit and tilt, Milankovitch cycles, and plate tectonics.

However, the scientific community agrees that the world is warming more quickly than ever before and there will be significant temperature increases this century. It is likely due in large part to burning fossil fuels, deforestation, and increases in number of livestock which all contribute large amounts of greenhouse gases.

The resulting climate change could impact New Brunswickers in many ways. Students should consider possible effects on biodiversity, forests, agriculture, water resources, weather extremes, and human health.

Students should investigate the challenges and successes that have been prompted by international agreements on new environmental climate change policy (e.g., the Rio Declaration on Environment and Development, the Kyoto Protocol, the Copenhagen Summit, carbon tax and carbon trading).

Climate Change con't

Suggested Activities for Learning and Assessment

Provide the following to students to guide inquiry:

- Research which human activities are most likely responsible for global warming.
- Consider how dependent you are on the burning of fossil fuels. Are there ways that you could reduce your dependence and is this something you would be willing to do? Why or why not?
- What is the difference between the greenhouse effect and global warming?
- Research the link between the destruction of the lodgepole pine forest in British Columbia by the mountain pine beetle, and the warmer temperatures in recent years (2011). Is there any chance that this beetle could affect the Maritimes?
- Research geographical and temperature ranges of local flora and fauna. Are there any particular species that would migrate or not survive if the average temperature in New Brunswick increased by 10°C? Decreased by 10°C ?
- How has global warming affected the Arctic flora and fauna?
- Conduct an experiment that models the warming effect of greenhouse gases.
- What are some individual actions that you could take to lower your impact on climate change? What are some actions your school could take? Your municipality?
- What are the main challenges that nations face in coming to an agreement on international policies for climate change?
- Identify an NB coastal community that would be significantly impacted by rising water levels. Explore a possible response to this threat.
- Identify the various types of greenhouse gases - CO₂, Methane, CFC's & Hydrochlorofluorocarbons, Halons, Water Vapour, Nitrous Oxide, Ozone - and their sources. What can we do to decrease their use?

Unit 3 – Optional Topics for Study

7. Air and Water Pollution

NB Prescribed Outcomes

It is expected that students will:

- describe examples of the effect of air and water pollution on human health and society, and on the natural environment.
- summarize the main types and sources of water pollution
 - distinguish between point sources and nonpoint sources
 - distinguish between primary and secondary pollutants
- explore the concept of cultural eutrophication amid its causes
- design and conduct an experiment to determine the presence and concentration of air or water pollutants.
- research and report on prevention and cleanup strategies to reduce air and water pollution.
- contact local, regional and/or national organizations and government agencies, and identify their mandate and perspective on pollution
- demonstrate the effective and critical use of a variety of investigation and research methods
- develop a working knowledge of current environmental legislation and policy and how it applies to the topic

Elaborations

Human activities that burn fossil fuels can often cause harmful levels of air pollution especially in urban areas. Each year air pollution prematurely kills about 3 million people, depletes soil nutrients, kills fish, and damages property and infrastructure.

Nonpoint sources of water pollution include municipal and agricultural runoff, leading to cultural eutrophication.

A lake's natural food web could be compromised, by a reduction in the amount of dissolved oxygen in the water, causing animal and plant death.

Pollutants that enter groundwater are often unseen and take a very long time to decompose. This makes removal of the contaminate difficult and costly.

Teachers should explain how coliform bacteria counts, dissolved oxygen levels, turbidity and colorimetric can be used to detect water pollutants.

Students should conduct an experiment to test the water quality of various samples from local sources (e.g., ocean, stream, well, municipal water) and present their results.

Students should discuss or present strategies to mitigate or prevent these water pollution sources.

Air and Water Pollution con't

Suggested Activities for Learning and Assessment

Have students collect water from a variety of water sources and have them conduct an experiment to determine the presence and concentration of water pollutants. Each group can present the water quality test results. As a class compare results and determine if there are any geographic areas, or water sources, that had higher readings than others, and explore the possible causes of any elevated readings.

Provide the following to students to guide inquiry:

- Do you think that clean drinking water should be a human right? If so, what responsibilities do developed countries have to make this happen?
- How can your personal actions influence the air or water quality in your local area?
- Identify several ways to prevent pollutants from entering groundwater resources.
- Describe some of the effects of air pollution on our environment.
- Why is groundwater so hard to clean once polluted?
- Explain some of the main culprits of cultural eutrophication in NB. Why are they so hard to detect or prevent?
- Evaluate, on the basis of research, the effectiveness of government initiatives or regulations, and the actions of individuals, intended to improve air and water quality, and propose a personal action plan to support these efforts.

Appendix A Student Project

Completion of a three part student project is a requirement for this course. Students should be introduced to this project at the beginning of the course and made aware that by the end of the first few weeks, each student will be expected to commit to a topic for their independent research and paper (Part 1), to join a group with others with similar interests to develop a presentation (Part 2), and to commit to a number of actions to fulfill their requirements for the *Eco-challenge* (Part 3). The student project can follow the model of *Project Based Learning* as outlined in Appendix B.

Once class size is known, topics are chosen, and *Eco-challenge* activities determined, the teacher can determine topics to be covered in Unit 3, and the schedule for research days and presentation dates.

Throughout **Unit 1** and **Unit 2**, in-class time will be required for research on the internet and with reference texts and materials. Time may also be required for student-led and student arranged activities related to the *Eco-challenge*. Some flexibility may be required if speakers or events are planned that are dependent on schedules or weather.

For **Unit 3**, teacher led lessons on a given issue should clearly link with student presentations that can be interspersed throughout the unit as topics arise. Student presentations could be poster presentations or demonstrations, presented concurrently in a science fair style format, or could be full class presentations. Outsiders with particular interest or expertise could be invited to help judge student presentations.

Student Project

Part 1) Independent Research and Paper

It is expected that students will:

Demonstrate the ability to work independently to research and present, the results of their research on an environmental issue of interest.

- independently research an environmental issue (modeled in **Unit 1**)
- summarize and analyze the results of their research and communicate the results in writing, which can be supported with visuals.

The complexity and depth of the topic and the writing expectations should be adjusted according to the ability of the student.

Part 2) Collaborative Presentation

It is expected that students will:

Demonstrate the ability to work collaboratively to develop an effective group presentation on an environmental issue.

- team up with others researching related environmental issues to develop a cohesive and engaging presentation for the class, including visuals such as graphs, pictures, or videos.
- actively participate in other student presentations

Part 3) Eco-challenge

It is expected that students will demonstrate:

- **Personal Appreciation of the Environment**
- **Stewardship of the Environment**
- **Advocacy for the Environment**
- **Engagement of Others in Environmental inquiry**

All four of these aspects should be demonstrated by every student working individually or as a group, through activities to which students agree at the beginning of the term. A list of **suggested activities** is shown below to illustrate each component. The number and type of activities that students undertake are at the discretion of the teacher.

Personal Appreciation of the Environment

- * Read a teacher approved book and present a review to the class.
- * Write a poem or song about the environment.
- * Create a piece of artwork - drawing, sculpture, painting etc – relating to the environment
- * Participate in a Sunrise Ceremony, and share your experience with the class
- * Attend a lecture or seminar related to the environment out of class & report to class.
- * Create a scrapbook of articles about current environmental issues.
- * Take a series of photographs and create a display around a nature theme
- * Create a field guide to the flora and fauna in an area with which you are familiar
- * Organize a nature walk to share your knowledge of the plants and animals with your classmates
- * Build a model using recycled materials.
- * Review how different publications and different media handle a particular environmental issue.
- * Research traditional Indigenous plant use
- Other (student suggestions)

Stewardship of the Environment

- * Organize a community workshop on composting and/or recycling.
- * Share your work experiences on a farm with the class, and describe ways in which sustainability for future generations is ensured.
- * Research hunting and fishing regulations in NB, and how quotas are adjusted year to year to ensure populations are maintained.
- * Organize a school art show for recycled art
- * Create and market an earth-friendly product (bags, soaps, stationary etc)
- * Participate in a community garden or create a garden at a local senior citizen home
- * Design and maintain for the duration of the term, a web-based environmental newsletter
- Other (student suggestions)

Advocacy for the Environment

- * Write a letter to a local paper in support of local sustainability practices.
- * Interview a local ecologist or naturalist who you consider a role model.
- * Complete a career profile for which studies in environmental science is a requirement.
- * Organize a special awareness and promotion day at school around an environmental issue.
- Other (student suggestions)

Engagement of Others in Environmental Inquiry

- * Organize a lab activity for the class
- * Design a game for the class to review or introduce a topic (Board game, computer activity)
- * Design a Web Quest or scavenger hunt for your classmates which you will collect and correct.
- * Invite a guest speaker to class. Prep class before and debrief class after.
- * Research and present a First Nations perspective of ways of knowing the natural world
- * Other (student suggestions)

Appendix B Project Based Learning

One of the project-based learning (PBL) models used in New Brunswick is based upon a model developed by the Buck Institute for Education (www.bie.org) which is used internationally to provide rigorous and relevant learning opportunities for students. PBL is described as “heads-on and hands-on” learning where learning occurs throughout the project just in time to solve the problem(s) presented. Unlike the traditional model where a project is the fun reward for completing the “real” business of learning (the poster at the end of a chapter, for example), in PBL, learning occurs throughout the block of time (usually three to six weeks) set aside for the PBL activity. Students take an active role in developing content knowledge and competency proficiency as they work in teams to solve contemporary, real-world problems.

Through an extensive five-step development process, teachers can design a PBL plan to meet curriculum outcomes by starting with an assessment plan (beginning with the end in mind or backwards planning) which includes a balance between formative and summative, individual and team, knowledge content and application, and product and process assessments. With a focus on the desired performance outcomes, facilitated learning activities are then planned so that students can answer the driving question, presented during the final presentation. PBL in this model always includes a literacy outcome, self-reflection, and scaffolded instruction and assessment in collaboration skills.

NB’s adaptation of the Buck Institute’s model is referred to as the **7 Cs for PBL for NB**:

1. Curriculum The starting point for PBL development is always learning outcomes from official provincial curriculum.
2. Competencies Along with meeting knowledge content outcomes, one or more elements of the five proposed NB 21st Century competencies are instructed and assessed.
3. Collaboration The final product, presentation, and/or exhibition is deliberately designed to be a task, or group of tasks, that cannot be completed by one individual but which requires meaningful participation from all members of a high-performing team. Thus a genuine need for collaboration is presented to students.
4. Current The driving question frames the learning by presenting a current, real-world problem to be solved; one that is taken seriously by adults engaged in similar work.
5. Community Where possible, to provide utmost relevance for students, expert assistance for teachers, and authentic assessment opportunity, the issue or problem should be based in the local community.
6. Connected Students should be able to connect to the question to be answered; they should see the value in their work beyond just getting a final mark.
7. Cool! A great PBL engages students right from the beginning with a launch activity (the “grabber”) designed to capture their interest followed by the introduction of a PBL “briefcase” which includes rubrics for assessment, a list of resources, project milestones, final presentation schedules, etc. so that there is clarity of expectations, and thus a sense of “do-ability” for students.

A self-directed module on using the five design steps to develop a PBL plan is available in the NB Virtual PD Centre along with resources for assessment and classroom management. Please contact your district PD Coordinator to register.

Appendix C NB Competencies (proposed)

1. Critical thinking and creative problem solving

Students will know and be able to use strategies and processes to solve problems, to think creatively, to understand deeply and conduct meaningful reflection. Through innovative ideas, entrepreneurship, and/or artistic expression, students will demonstrate that they:

- have learned the elements and processes associated with critical thinking and problem solving.
- have a deep understanding of complex concepts and the ability to work creatively in order to generate new ideas, theories, products and knowledge.
- have learned to think logically and to solve ill-defined problems by identifying and describing the problem, framing and testing hypothesis and by formulating creative solutions.
- have explored and reached an understanding of their own creative talents and how best to make use of them.
- are able to acquire, process and interpret information critically to make informed decisions.

2. Collaboration

Students will be able to interact with others in generating ideas and developing products. They will use appropriate interpersonal skills within a variety of media and social contexts. Students will demonstrate that they:

- understand how to relate to other people in varying contexts, including those in which they manage or are managed by others.
- are able to collaborate across networks, using various technologies.
- are able to effectively participate as a team member and know their own capacities for filling different team roles.
- have developed proficiency in managing personal relationships.
- are able to use various means to manage conflict.
- understand the creative process through collaboration, exchange of ideas and building upon the achievement of others.
- have been sensitized to the issues and processes associated with collaborating across cultures.

3. Communication

Students will be able to communicate effectively using the listening, viewing, speaking, reading and writing modes of language(s), the arts, and mathematical and scientific concepts and symbols. They will communicate using a variety of media and technologies. Students will demonstrate that they:

- explore, reflect on and express their own ideas, learning, perceptions and feelings.
- understand ideas and relationships presented through words, actions, numbers, symbols, graphs, images and charts.
- have a level of proficiency in the second official language.
- manage, access, process, evaluate and present information clearly, logically, concisely and accurately for a variety of audiences.
- critically interpret and evaluate ideas presented through a variety of media.
- think divergently and creatively through use of analogies, metaphors and visual thinking.

4. Personal development and self awareness

Students will be resourceful, reliable and resilient. They will see themselves as capable learners, aware of their own potential. They will make well-informed, healthy choices that contribute to the well-being of themselves and others. Students will demonstrate that they:

- make decisions and take responsibility for those decisions.
- pursue an active, healthy lifestyle.
- have developed techniques for managing change, risk and uncertainty in a wide range of contexts.
- have persistence and determination.
- are self-motivated and have a “can-do” attitude.
- acknowledge and consider different points of view.
- are able to take control of learning.
- are well positioned and prepared for post-secondary studies and the workplace.

5. Global citizenship

Students will be able to assess social, cultural, economic and environmental interdependence in a local, national and global context. Students will demonstrate that they:

- understand the dynamic interactions of Earth’s systems, and the dependence of our social and economic systems on these natural systems
- recognize our fundamental connection to all living things, and the impact of humans on the environment.
- comprehend Canada’s political, social and economic systems in a global context.
- are able to critically analyze the social, political and economic forces that have shaped the past and present and apply those understandings in planning for the future
- understand key ideas and concepts related to democracy (for example: human rights).
- comprehend the contributions of multiculturalism to society, and comprehend cultural and societal diversity in local, national and global contexts.
- possess the dispositions and skills necessary for effective civic engagement.
- use creative and critical thinking to develop innovative solutions to complex societal and environmental problems.

Appendix D Online Resources

*The links to organizations listed below direct you to just a sampling of available online resources. Some of these organizations present information objectively, and some with significant biases. These website references are provided solely as a convenience and do not constitute an endorsement by the Department of Education of the content, policies, or products of the referenced site. The Department does not control the referenced websites and subsequent links, and is not responsible for the accuracy, legality, or content of those websites. Referenced website content may change without notice. **Teachers should preview all links before recommending them to students.***

United Nations

UN Educational, Scientific and Cultural Organization (UNESCO)

<http://www.unesco.org/new/en/unesco/>

UN World Health Organization

<http://www.who.int/en/>

UN Environment Programme

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

Canada

Environmental Non-Government Organisations

Green Peace Canada – search for NB issues

<http://www.greenpeace.org/canada/en/>

COSEWIC Endangered Wildlife in Canada

http://www.cosewic.gc.ca/eng/sct5/index_e.cfm

Sierra Club Canada

<http://www.sierraclub.ca/>

Lights out Canada

<http://www.lightsoutcanada.tpweb.ca/>

Federal Government

Department of Fisheries and Oceans (DFO)

<http://www.dfo-mpo.gc.ca/>

Natural Resources Canada (NRCan)

<http://cfs.nrcan.gc.ca/>

Agriculture and Agri-Food Canada (AGR)

<http://www.agr.gc.ca/>

Parks Canada

<http://www.pc.gc.ca/>

Canadian International Development Agency (CIDA)

<http://www.acdi-cida.gc.ca/index.htm>

New Brunswick

NB Department of Education and Early Childhood Development Portal

High School Science Page

<https://portal.nbed.nb.ca/tr/lr/HSS/Pages/default.aspx>

Greening our Schools

<https://portal.nbed.nb.ca/tr/lp/current/gs/Pages/default.aspx>

Provincial licenses for NB teachers and students– National Film Board, Alliant Learning Centre, Image Bank

<https://portal.nbed.nb.ca/students/multimedia/Pages/default.aspx>

<https://portal.nbed.nb.ca/tr/m/Pages/default.aspx>

Provincial licensed research tools for NB students and teachers

<https://portal.nbed.nb.ca/students/rt/Pages/default.aspx>

<https://portal.nbed.nb.ca/tr/rt/Pages/default.aspx>

Non-Government Organizations

Conservation Council

<http://conservationcouncil.ca/>

Envirothon

http://www.cfanb.ca/envirothon_nb

Falls Brook Centre

<http://www.fallsbrookcentre.ca/>

Nature NB

<http://www.naturenb.ca/>

New Brunswick Environmental Law Society

<http://www.sade-els.org/>

New Brunswick Environmental Network

<http://www.nben.ca/>

Petitcodiac Watershed Alliance (with links to other NB watershed groups)

http://www.petitcodiacwatershed.org/related_links

Tantramar Wetlands Centre

<http://www.weted.com/>

NB Government

Government of New Brunswick – Department of Environment

<http://www.gnb.ca/0009/>

NB Regional Solid Waste Commissions

<http://www.gnb.ca/0009/0372/0011/index-e.asp>

Government of New Brunswick – Department of Natural Resources

<http://www.gnb.ca/0078/>

Government of New Brunswick – Department of Agriculture, Aquaculture and Fisheries

<http://www.gnb.ca/0027/>

Other Sites

CBC Documentaries

<http://archives.cbc.ca/environment/>

Guardian Weekly International Environment News

<http://www.guardian.co.uk/environment>

Environmental jobs

<http://www.eco.ca/>

World Bank Development Education Program

<http://www.worldbank.org/depweb/index.html>

Environmental Literacy Council

<http://www.enviroliteracy.org/subcategory.php/243.html>

Facing the Future

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

The Biology Corner

<http://www.biologycorner.com/>

Young adult organization for global change

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

Green Teacher magazine

<http://www.greenteacher.com/>

Big Pictures Small World

<http://www.bigpicturesmallworld.com/index.shtml>

Environmental Decision Making, Science, and Technology

<http://telstar.ote.cmu.edu/environ/m1/s1/index.shtml>

World Clock

<http://www.peterrussell.com/Odds/WorldClock.php>

Sample lessons and activities

CBC archives - search clearcutting and logging

http://archives.cbc.ca/environment/environmental_protection/topics/679/

Speciation Simulation

http://wps.prenhall.com/esm_freeman_biosci_1/7/1951/499633.cw/index.html

Climate Discovery Teacher's Guide (National Center for Atmospheric Research)

http://eo.ucar.edu/educators/ClimateDiscovery/ESS_lesson2_10.19.05.pdf

Dichotomous Keys -

www.lnhs.org/hayhurst/ips/dichot/

The Habitable Planet – online Environmental Science Textbook

<http://www.learner.org/courses/envsci/>