

ENVIRONMENTAL SCIENCE

122/123

New Brunswick Department of Education

April 1997



Program Design and Components

Program Overview

The programs for Environmental Science 122 and 123 both emphasize the basis of environmental science and its relationship to sustainability. Each program enables students to become aware of the tremendous impact of science and technology on society. The aim is to promote scientifically literate students who appreciate the delicate balance of nature and the importance of sustainable development. It is intended that students develop decision-making strategies they may use when confronted by the competing demands of the environment, the economy, and health of society.

This program in environmental science may be offered as a 122 and a 123 credit. It is based on four units of study. The principal emphasis is on an introduction to environmental science, sustainable development, pollution, population and resources.

Major concepts are used to encourage connections among the core units.

Unit 1: Introduction	The Forces that Drive Environmental Science Ecosystem Structure Ecosystem Function Ecosystem Change Ecosystem Adaptation Ecosystem Sustainability Lifestyles and Sustainability
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It is expected that Unit 1 will form the core of the course and be 50% of assessment.

Unit 2: Sustainable Development	Population Food Water Soil
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Unit 3: Pollution	Atmosphere Water Soil
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Unit 4: Resources	Endangered Species Endangered Spaces Endangered Resources
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It is suggested that at least one topic from each unit 2, 3 and 4 be studied in detail to form the remaining 50% of the assessment. These topics may be designed for student-centered learning which is self directed in consultation with the teacher. This may include a research project based on a local context or global issue.

Program and Curriculum Outcomes for Environmental Science

A) Program Outcomes

Program outcomes are general statements concerning the attitudes, knowledge, skills, and STS connections that students are expected to achieve in Environmental Science 122/123.

Students are expected to:

- exhibit a general understanding of the concepts fundamental to the development of environmental science
- demonstrate an understanding of the principles of sustainability
- demonstrate an understanding of the relationship between ecosystems locally, regionally and globally that is essential for all citizens in a scientifically literate society
- make informed decisions about further studies and careers in science
- recognize the connections within and between Science, Technology and Society

B) Curriculum Outcomes

Curriculum outcomes are specific statements concerning knowledge, skills and STS connections that students are expected to achieve in Environmental Science 122 or 123.

Outcomes for Environmental Science 122

Students will be expected to:

Knowledge

- explain the structure of an ecosystem
- explain how an ecosystem functions
- illustrate the effects of change within an ecosystem
- describe the concept of sustainability using a model (such as global food production and consumption)

Skills

- plan and perform investigations that relate to both knowledge and process outcomes
- for investigations: identify, collect and record relevant data
- organize and present data for a range of audiences and variety of purposes
- synthesize data from a variety of sources
- design and evaluate courses of action based on available data

Connections Among Science, Technology and Society

- describe how advances in science are applied through technology
- develop the ability to identify and evaluate the effects of technology on society

- demonstrate an understanding that science is unable to provide complete answers to all questions
- recognize there are limitations to scientific applications through technology
- identify where the needs and interests of society have influenced scientific and technological research

Outcomes for Environmental Science 123

Students will be expected to:

Knowledge

- describe the structure of an ecosystem
- describe how an ecosystem functions
- state the effects of change within an ecosystem
- describe how natural systems promote balance and sustainability

Skills

- perform investigations that illustrate both knowledge and process outcomes
- collect and record data during planned investigations
- organize and present data for a given purpose
- select a course of action based on available data

Connections Among Science, Technology and Society

- recognize how technology incorporates scientific advances
- explain the impact of technological change on society
- identify where environmental change has affected both society in general and citizens individually
- recognize there are limits to problem-solving by using science and technology
- illustrate the different ways in which society responds to environmental issues

The outcomes stated in each of the following units should be adjusted to meet the expectations as described previously for Environmental Science 122 and Environmental Science 123.

Sequencing these units and topics is at the discretion of the teacher and subject to the resources being used.

Please note that UNIT 1 is an overview and should not exceed 50% of the course.

Resources to Support Program

Teachers wishing to order additional copies of textual materials are advised to consult the "Catalogue of Instructional Resources". This is published annually and lists titles under Core and Supplementary Sections. The catalogue will be at the school administrative office.

When placing orders for audio-visual material from Instructional Resources, you will need your borrower's client number, the program title, and its order number. You may order

By mail to: Instructional Resources Branch, Department of Education, P.O. Box 6000, Fredericton, N.B. E3B 5H1.

By fax: (506) 453-7974, by telephone: (506) 453-2319

By e-mail when the procedure for remote user system has been established.

Unit 1 INTRODUCTION TO ENVIRONMENTAL SCIENCE

In Unit 1, students are introduced to the purpose of Environmental Science. An understanding of what is recognized as an ecosystem, how the ecosystem works, what causes an ecosystem to change and how adaptations take place. The unit concludes with an overview of ecosystem sustainability and how ecosystems are influenced by human activity.

Teachers should also consult the Atlantic Canada curriculum guide for Biology 112 (Instructional Resources call #840680) which contains a section which considers the themes of change, and flow of energy and matter through systems. Only New Brunswick and Newfoundland (1995) have courses in Environmental Science and these have an impact on the treatment it is given in the Biology courses of those provinces. References made to resources and STS connections in the Biology Curriculum Guide should be considered for use with the New Brunswick Environmental Science 122/123 course.

Further, it is recommended that in planning an Environmental Science 122/123 course teachers also consult the Atlantic Canada Science Framework Document published in spring 1997. This framework outlines graduation outcomes for students set in the context of science outcomes Entry through Grade 12.

STUDENT OUTCOMES FOR UNIT 1

INTRODUCTION TO ENVIRONMENTAL SCIENCE

KNOWLEDGE: (General)

Students will develop an understanding of the following major topics:

The forces that drive Environmental Science

Ecosystem Structure

Ecosystem Function

Ecosystem Change

Ecosystem Adaptation

Ecosystem Sustainability

Students will be able to:

KNOWLEDGE:

- explain how differently the world is viewed by various societal groups
- identify different types of ecosystems and give examples of each
- explain the relationship of biotic and abiotic factors
- explain why certain ecosystems are unique to different regions
- explain the elements of energy flow and nutrient cycling

- understand the concept of population balance and its implications for a given ecosystem
- explain ecological succession
- understand gene pools and their change
- understand the factors which cause climate change
- explain ecosystem sustainability
- understand how human activities influence the sustainability of an ecosystem

SKILLS:

Students will demonstrate an ability to:

- use the scientific method and evaluate information
- plan and conduct activities that protect an ecosystem
- collect and record environmental data for a given ecosystem
- connect, integrate and synthesize data related to various ecosystems based on the influence of human activities and their interactions in the biosphere

ATTITUDES:**Students will develop:**

- an appreciation for the complexity of the interrelationship of the environment
- an awareness of one's personal responsibility in the maintenance and preservation of various ecosystems
- a sense of responsibility toward sustainability i.e. stewardship
- an awareness of global environmental issues and the contribution of local activity to the resolution of global concerns
- an attitude of participation in planning and shaping the future by employing practical and creative solutions

Unit 1.

Major Concept: The Aim of Environmental Science

Knowledge

Students should be able to:

- describe basic assumptions underlying alternative world views
- describe how these views conflict regarding environmental issues
- describe that world views are subject to change
- define environmental science and its objective

(Review the following from Science 102)

- define science
- name and describe the scientific method
- describe a controlled experiment and explain its function
- distinguish between a hypothesis, theory and law

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- explaining the role technology plays in science
- exploring the connection between science and value judgments
- discussing how both science and values affect environmental policy development
- identify the factors needed to evaluate information
- explain how scientific discovery has promoted technological development

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- designing a controlled experiment
- performing measurements
- designing concept maps
- investigating (planning and design)
- reasoning (interpreting data, formulating generalizations and building and revising models)
- making observations, building hypotheses and developing conclusions
- directing their own learning
- assessing their own progress in the course
- learning techniques for group processing

Resources

Environmental Science, Nebel and Wright: Chapter 1

Investigating Terrestrial Ecosystems, Andrews: Chapter 1

Environmental Science, Person: Unit 1

Strands in the Web, Smith: Part 1

Environmental Science: Miller: Chapter 1

Ecosystems TRB: Herridge & Siamon Introduction

Environmental Science Arms: Chapter 1

Unit 1

Major Concept: Ecosystem Structure

Knowledge

Students should be able to:

- define and contrast biosphere, biome, ecosystem, ecotone, biotic community, and species
- name the major biomes, and give prime biotic and abiotic characteristics
- describe the biome of the school's location
- name and describe various feeding relationships
- define food chains, food webs and trophic levels
- identify and give examples of nonfeeding relationships that exist among organisms
- list abiotic factors and define optimum zones of stress, limits of tolerance, and range of tolerance in terms of the effect on a given species
- define climate and apply the principle of limiting factors to different biomes with different climates

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- describing the origins of the systems developed by humans and contrast it with natural ecosystems in terms of limiting factors and sustainability
- analyzing a case study such as the East Coast Fishery
or
coal/steel industry of Cape Breton
or
salmon fishing in New Brunswick rivers

Skills/Activities

- analyze how competition between different species in the same ecosystem is largely avoided
- analyze the natural distribution of species in terms of limiting factors for species of the two adjacent ecosystems
- analyze the diversity of plant species in an ecosystem in terms of micro climates and limiting factors
- analyze the diversity of insect species within a given ecosystem

Resources

Environmental Science, Nebel and Wright: Chapter 2

Investigating Terrestrial Ecosystems, Andrews: Chapter 2, 7-13

Strands in the Web, Smith: Part 3

Environmental Science, Person: Unit 1

Finding the Balance, Breakwater Books

Environmental Science, Miller: Chapter 4 and 5

Where the Bay Becomes the Sea – video

Instructional Resources 701034, VH

Environmental Science, Arms: Chapter 2

Unit 1

Major Concept: Ecosystem Functions

Knowledge

Students should be able to:

- list the key elements of living organisms and identify where these elements occur in the environment
- give examples of different forms of energy
- compare and contrast energy and matter
- contrast the function of producers and consumers in terms of matter and energy change during photosynthesis and cell respiration
- distinguish between consumers and detritus feeders and decomposers
- describe factors other than cell respiration that contribute to decreases in biomass at high trophic levels
- explain three principles of ecosystem sustainability

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- evaluating the systems developed by humans in terms of the principles of ecosystem sustainability
- analyzing a pond or forest system to identify features and functions of its ecology
- interpret data about a farm (dairy/arable) in terms of an ecosystem

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- presenting an overview of the cycle of life in terms of the movement of matter and energy between living things and the environment.
- contrasting the energy and nutritive roles of food and describing the consequences of over, or under, supply of either.
- developing a diagram to show the pathways of carbon, phosphorus and nitrogen through an ecosystem.
- illustrating the movement of energy through an ecosystem.

Resources

Environmental Science, Nebel and Wright: Chapter 3

Investigating Terrestrial Ecosystems, Andrews: Chapter 2-3

Atlantic Canada Biology C.G.: Biology 112 Curriculum Guide #840860

Strands in the Web, Smith: Part 2 & 3

Environmental Science, Person: Unit 1

Environmental Science, Miller: Chapter 4 and 5

Environmental Science, Arms: Chapter 3.1, 3.2

Unit 1

Major Concept: Ecosystem Change

Knowledge

Students should be able to:

- define and give examples of the factors involved in biotic potential and environmental resistance
- distinguish between reproduction and recruitment, describing what occurs in all populations if conditions are ideal
- describe how population density relates to the balance between biotic potential and the ecosystem's resistance to change
- give examples of natural enemies and how they serve to maintain herbivore populations in nature
- define territoriality and describe how it controls certain populations in nature
- analyze the principle that populations are maintained such that overgrazing does not occur, in terms of mechanism of population balance
- describe ways that enable different plant species to coexist
- give examples of ecological upsets caused by the introduction of foreign species
- give examples of different kinds of ecological succession, and describe the role of fire in the management of certain ecosystems

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- investigating the role of technology in monitoring and controlling "wild" herds
e.g. -N.B. deer and moose
-Wood Buffalo - Wood Buffalo National Park
-Grizzly Bear - Banff National Park
- analyzing the effect of agricultural/forestry monoculture on animal/plant populations
- researching the problem of introduced species
e.g. -Purple Loosetrife (waterways)
-Zebra Mussel (Great Lakes)
- identifying the arguments that defended burning in Yosemite National Park (PBS video-Nova??)
- pressures caused by human over population
- desertification
- clear-cutting forests N.A./Amazon
- sewage disposal (e.g. Mexico City)
- air pollution (e.g. Mexico City)

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- researching and presenting information on a given topic using a variety of media
- writing/illustrating a given issue for a defined audience
- developing a bank of questions about factors that cause ecosystem change
- conducting a debate on a motion such as management of "wild" animal stocks

Resources

Environmental Science, Nebel and Wright: Chapter 4

Investigating Terrestrial Ecosystems, Andrews: Chapter 4

Environmental Science, Person: Unit 1

Environmental Science, Miller: Chapter 5

Environmental Science, Arms: Chapter 3.3

Unit 1

Major Concept: Ecosystem Adaptation

Knowledge

Students should be able to:

- contrast traits and genes, and describe the chemical structure of genes and how they are translated into traits.
- relate variations among individuals to genes and alleles and to the gene pool of a species
- define differential reproduction and describe how it may cause changes in the gene pool and traits observed in a population in subsequent generations
- give examples of selective pressures and relate these to differential reproduction
- describe and contrast selective breeding conducted by humans with natural selection in terms of the process and the results obtained
- define mutations and discuss why they may be beneficial, harmful, or neutral
- describe mutations in natural populations
- define speciation and analyze how it may result from natural selection

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- relating natural selection and speciation to the development of a managed ecosystem
- analyzing the factors that determine whether a species can adapt or will be forced into extinction by the influence of humans
- evaluating which species are most likely and which are least likely to survive impact of development by humans and why
- discussing the implications of diminishing populations and diminishing bio-diversity for the survival of wild species, for agriculture, and its impact on society
 - e.g. -the tiger in wild and in zoos (Calgary Zoo project)
 - cereal crop production wheat/barley in North America and rice in India

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- analyzing the importance of factors that cause and promote adaption within a given population
- researching and preparing a case to support the concept "strength in diversity"

Resources

Environmental Science, Nebel and Wright: Chapter 5

Investigating Terrestrial Ecosystems, Andrews: Chapter 5-6

Strands in the Web, Smith: Part 2 & Part 3 (pp. 88-108)

Atlantic Canada Biology C.G.
Biology 112 Curriculum Guide #840860

Environmental Science, Miller: Chapter 5

Environmental Science, Arms: Chapter 4

Unit 1

Major Concept: Ecosystem Sustainability

Knowledge

Students should be able to:

- explain how ecosystems dispose of waste and replenish nutrients by recycling all elements
- describe how and why ecosystems use sunlight as their source of energy
- explain how ecosystems control consumer populations so that overgrazing does not occur
- understand how ecosystems maintain bio-diversity

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- demonstrating the consequences of not maintaining bio-diversity
- contrasting the ways in which populations are controlled in nature with the methods that are available to humans
 - influence of "management practices" used by Department of Natural Resources

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- preparing a case (for/against) to debate the motion: The population of (YOUR CHOICE) lives sustainably
- analyzing an historical or current case of human communities that were/are sustainable in terms of natural/economic/social factors

Resources

Environmental Science, Nebel and Wright: Chapter 4-5

VISIONS 1, Section 1

From the Ground Up, A-V kit from Manitoba (Instructional Resources)

World Resources 1994-1995
ISBN 0-19-521045-X

Environmental Science, Person: Unit 1

Environmental Concerns (Cambridge)
P.J. Alma
ISBN 0-521-42869-6

Unit 1.

Major Concept: Sustainability and Lifestyles

Knowledge

Students should be able to:

- explain the impact of automobiles, in the second half of the 20th century, on urban structure, urban sprawl and infrastructure design
- analyze environmental degradation caused by urban sprawl
- describe the social consequences of urban migration
- describe policies which make large communities more "livable" and their development more sustainable

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- analyzing, for a selected community, how its automobile traffic patterns have made urban development more/less sustainable
- researching city development planning which promotes sustainability and reduces energy consumption
- investigating how modern technology has improved living conditions for city dwellers by:
 - monitoring air quality
 - reducing the waste stream
 - minimizing energy consumption
 - permitting recycling of buildings and materials

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- designing a community plan which incorporates the tenets of sustainable living
- researching and presenting information on career opportunities that are related to sustainable urban development and urban renewal

Resources

- *Environmental Science*, Nebel and Wright, Chapter 24

STUDENT OUTCOMES FOR UNIT 2

SUSTAINABLE DEVELOPMENT

KNOWLEDGE: (General)

Students will develop an understanding of the following major topics:

Population dynamics

Quality of life differs throughout the world

Human populations affect the sustainability of their environment

Meeting basic food requirements of human populations

The challenge of limiting population growth

Sustainable agricultural practices and soil management

Meeting water requirements of human populations

SKILLS:

Students will demonstrate an ability to:

- collect and analyze population data
- synthesize information to illustrate and support a given thesis or concept

ATTITUDES:

Students will develop:

- an appreciation for the contrast of rich and poor nations
- an understanding of resource use per capita in different nations
- personal practices that improve global human conditions

Unit 2.

Major Concept: Human Population and Environmental Factors

Knowledge

Students should be able to:

- analyze the connections between population size, population density and general economic conditions
- analyze the impact of population growth on ecosystem sustainability
- explain differing life expectations in the developed and developing world

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- analyzing data that show patterns of population growth in various countries
- researching and presenting case studies from selected nations
- synthesizing data that relate national population with various economic and social factors
- illustrating how the material/energy needs of a population can be met by improved infrastructure, use of advanced technology, and changed lifestyles

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- collecting and analyzing population data for a given nation
- presenting data to support a given government policy regarding population growth
- conducting a debate concerning a population factor and its impact on social policy
- preparing an audio-visual documentary report on the effects of unlimited population growth

Resources

Environmental Science, Nebel:
Chapters 6 and 7

One World, Krull: Chapter 5

Strands in the Web, Smith: pp. 127-130

Earth Matters: Studies For Our Global Future, Wasserman & Doyle:
ISBN 0-945219-03-2

The Population Explosion, Ehrlich & Ehrlich - ISBN 0-671-68984-3

World Population - VHS Video from
Zero Population Growth Inc.,
Washington, DC, 1990
Tel: 202-332-2200
Fax: 202-332-2302

World Watch Paper '92
*Poverty and the Environment:
Reversing the Downward Spiral*
ISBN 0-916468-93-3

Environmental Science, Miller:
Chapter 6

Stratagem Game
Instructional Resources/check with
World Issues teacher at your school

Environmental Science, Arms:
Chapter 13

Unit 2.

Major Concept: Developing Food Supplies

Knowledge

Students should be able to:

- identify the factors that limit the growth of food production
- describe successful agricultural practices
- explain the relationship between sustainable agriculture and the level of available technology
- analyze the long-term impact of food aid programs
- food requirements versus control of population growth
- identify and assess the environmental impact of increasing food production to meet the demands of a growing population

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- investigating methods of boosting food production
- comparing agricultural practices in one developed and one developing countries
- analyzing the effect of a selected agricultural aid project
- relating technological solutions to the elimination of food aid
- assessing the impact of technology in boosting food production in a selected country

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- preparing a case study in which significant food production increase has occurred
- investigating if Canadian agricultural practices are transferable to developing countries
- preparing a case study of nation that has adopted "cash crop" production in terms of reasons for and consequences of such a policy
- debating the issue of limiting population growth

Resources

Environmental Science, Nebel:
Chapter 8

One World, Krull: Chapter 7

Race to Save the Planet (VHS): "Save the Earth - Feed the World" - see Instructional Resources catalogue

The Question of Food (MM) from World Food Day Association of Canada
Tel: 613-233-9002
Fax: 613-238-8839

Here to Stay: A Resource kit on Environmentally Sustainable Development, Development Education Centre (Toronto)
Tel: 416-920-2656
Fax: 416-921-0071

Environmental Science, Person: Unit 3

Environmental Science, Miller:
Chapter 14 and 15

Environmental Science, Arms:
Chapter 9

Unit 2.

Major Concept: The Role of Water Resources

Knowledge

Students should be able to:

- identify the importance of water and its physical properties
- explain each stage of the water cycle
- identify sources and uses of fresh water
- describe the consequences of over-using fresh water resources
- assess water management systems for urban, rural, and agriculture uses
- develop solutions for water pollution problems and treatment of waste water

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- surveying how fresh water is supplied and waste water is treated at your school/community
- researching the provincial regulations and health/safety standards for water supply and waste disposal
- researching how fresh water supply to a large city is managed
- researching differing methods of waste water treatment by municipalities and large industrial plants
- assessing the social impact of limited fresh water resources and its potential for conflict

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- determining specific heat capacity and latent heats for water
- finding what substances are soluble in water
- analyzing and then purifying a water sample using a variety of appropriate methods
- interviewing a technician from community water authority, well drilling company, waste water management company.
- investigating the long-term effects of agricultural irrigation
- researching the impact on local environments by differing patterns of fresh water use

Resources

See Science 102 Curriculum Guide

VISIONS 1 - Unit 1

Environmental Science, Nebel and Wright: Chapter 11

Environmental Science, Person, Unit 4

Investigating Aquatic Ecosystems, Andrews

Water Literacy Series (SEEDS Foundation)

Tel: 403-424-0971

Fax: 403-424-2444

A Primer on Fresh Water
(Environment Canada)
(in kit from 1995 workshop)

We All Live Down Stream
ISBN 0-9620034-1-7 (pb) \$10 US

Latin America: The Thirsty Cities
(VHS-NFB)

Science in Focus: Waste (VHS)
see Instructional Resources
Catalogue/THA Media Distribution

Finding the Balance, Breakwater Books

Environmental Science, Miller:
Chapter 11

Environmental Science, Arms:
Chapter 5.1

Unit 2

Major Concept: Soil as a Natural Resource

Knowledge

Students should be able to:

- identify mineral nutrients and explain how they are held in different soils
- explain water holding capacity of different soils
- describe the role of oxygen and aeration in soil maintenance
- explain the effect of acidity levels (pH) on soil quality
- identify the role of salt and osmotic pressure
- explain the importance of soil composition and texture
- assess the impact of using different fertilizers and methods of composting
- identify the causes of soil erosion and describe measures of prevention

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- relating the volume and quality of crops to different production/ growing techniques
- researching the food crops and growing techniques appropriate to different cultures and environments
- preparing a presentation on agricultural practices designed to minimize soil erosion in different regions of Canada

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- conducting soil analysis to find its:
 - mineral content
 - water holding capacity
 - pH level
 - organic content
 - particle size
- preparing recommendations to improve soil conditions for given crops based on given soil analysis data
- interviewing professionals such as:
 - horticulturists
 - market gardeners
 - farmers
 - soil specialists
 - fertilizer company representatives

Resources

Environmental Science, Nebel and Wright: Chapter 9

One World, Krull, Chapter 7

Environmental Science, Person, Unit 3

Strands in the Web, Smith, Part 3
pp. 60 - 64

Sowing for Need or Sowing for Greed
(VHS)

Nutrient Cycle: A Guide to Better Forests – Canada Forest Service
Instructional Resources #702515, VH

Fragile Harvest
Instructional Resources #702874, VH

Farming and the Environment
(paperback), Wayland
see Instructional Resources Catalogue

The Spread of Deserts (Wayland)
ISBN 0-7502-0277-7
Instructional Resources Catalogue

Environmental Science, Person: Unit 3

Environmental Science, Miller:
Chapter 12

Investigating Terrestrial Ecosystems
(Andrews)

Environmental Science, Arms:
Chapter 9.2

STUDENT OUTCOMES FOR UNIT 3

POLLUTION

KNOWLEDGE: (General)

Students will develop an understanding of the following major topics:

Water pollutants such as sediments, nutrients and eutrophication

Sewage as a water pollutant

Toxic chemicals in ground water reserves

Types and sources of airborne pollution

Acid Precipitation

Greenhouse gases and their effects on the atmosphere

The causes and consequences of upper atmosphere ozone depletion

A risk-benefit analysis on pollution and its control

Provincial Occupational Health and Safety Act and Regulations

SKILLS:

Students will demonstrate an ability to:

- conduct analytical tests on water and air samples
- make conclusions and recommendations concerning pollution data
- understand the meaning and process of a cost-benefit analysis

ATTITUDES:

Students will develop:

- an appreciation that local action to reduce pollution has global effects
- an understanding that because of energy-matter cycles pollution does not "disappear"
- the concept that risk to self and others can be minimized through good decision-making

Unit 3.

Major Concept: Atmospheric Pollution

Knowledge

Students should be able to:

- explain that air pollution comes in various forms at different locations
- identify major airborne pollutants and their sources
- describe why the Maritime Provinces are subject to air pollution from the United States industrial heartland
- illustrate how air pollution affects:
 - human health
 - flora and fauna
 - agricultural crops
 - forestry plantations
 - buildings and material structures
- explain how air pollution is produced by:
 - energy generation plants
 - industrial processes
 - vehicle emissions
 - mines and ore refining
 - petro-chemical plants
- identify trends that suggest the Greenhouse Effect may be contributing to climate change

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- studying the efforts made at the following installations to reduce emission of air pollutants:
 - Coleson Cove (NB Power)
 - Belledune (NB Power)
 - Brunswick Smelting (Bathurst)
 - St. Anne-Nackawic Pulp & Paper Mill
 - Repap Mill (Newcastle)
 - Potash Mines (Sussex)
 - Irving Oil Refinery (Saint John)
 - Point Lepreau (NB Power)
 - Heating Plant (UNB)
- researching areas in New Brunswick in which radon gas is prevalent in basements, explaining the source of this radioactive gas, and its consequences
- analyzing the economic and social costs of atmospheric pollution
- research the Clean Air Act of New Brunswick and its Regulations

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- designing apparatus to measure the particulate solids carried in the air
- collecting precipitation samples and measuring pH and relating results to weather conditions and prevailing wind direction
- monitoring the effects of high atmosphere ozone depletion and low atmosphere ozone production
- collecting evidence of the effects air pollution has on plants
- researching and presenting findings of human health conditions caused by air pollution
 - in work places
 - within houses/apartments

Resources

Environmental Science, Nebel and Wright: Chapters 15 and 16

Environmental Science, Person, Unit 2

One World, Krull, Chapter 6, 8 & 9

Strands in the Web, Smith, pp. 135 - 141

A State of the Environment Report - Canadian Perspectives on Air Pollution
ISBN 0-662-17805-X

Rain of Troubles: The Science and Politics of Acid Rain
ISBN 0-02-775370-0

Urban Air Pollution in Megacities of the World, WHO
ISBN 0-631-18404-X

Heath Environmental Literacy Program: *Protecting the Ozone Layer*
ISBN 0-669-95458-6

Climate in Danger: What Can We Do?
(VHS)
Video Productions, Edmonton, AB

Fragile Earth: A Change in the Air
(VHS)
THA Media Distributors

Environmental Science, Person: Unit 2

Environmental Science, Miller:
Chapter 9 and 10

State of the Environment in the Atlantic Region
World Resources 95/96

Environmental Chemistry (Cambridge)
ISBN 0-521-42156-X

Weather Works (at your school)
VISIONS Chapter 3

Environmental Science, Arms:
Chapter 6

Unit 3.

Major Concept: Water Pollution

Knowledge

Students should be able to:

- identify and explain oligotrophic and eutrophic water conditions
- identify and describe the processes employed to restore a natural balance to a water ecosystem
- explain how sediments entering a water ecosystem will affect both plant and animal forms
- identify the changes to watersheds and watercourses which minimize the inflow of sediments and nutrients
- explain how urban and rural activity has an impact on watercourse quality
- describe why untreated sewage is both an environmental and health hazard
- explain how waste water management and sewage treatment systems reduce potentially polluting effects

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- selecting a stream/pond/lake near the school and analyzing its water quality
- using a case study to determine why a certain body of water is oligotrophic/eutrophic and how this may be treated
- investigating provincial regulations that are designed to protect groundwater supplies from contamination by sewage and other pollutants

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- performing analysis on freshwater samples from a variety of sources to determine the solutes present and the potential harmful effects
- determining why some pollutants are harmful at ppm and others at higher concentrations
- document research, and/or interviewing experts to compare the effectiveness of different methods of sewage treatment
- comparing waste water treatment techniques of large municipalities and industrial complexes

Resources

See resources listed in the "Water Resources" section of UNIT 2, many of these also address the issue of pollution.

Environmental Science: Nebel and Wright, Chapter 12

Environmental Chemistry (Cambridge)
ISBN 0-521-42156-X

"*Rivers to the Sea*" (VHS) (NFB)

"*The Underlying Threat*"
Instructional Resources #702111, VH

"*Uranium*" (VHS) (NFB)

"*Perspectives in Science*"
VHS/Laser Disk
Instructional Resources
The Program in Action #701990, VH
Toxic Waste #701991, VH
Water #701992, VH

Environmental Science Activities Kit
M. L. Roa (book, see Boreal Catalogue)

Environmental Science, Arms:
Chapter 5.2, 5.3

Unit 3.

Major Concept: Soil Pollution

Knowledge

Students should be able to:

- explain how contaminants can leach through soils and rock with ground water
- identify and explain the chemical reactions that may occur within soil and between pollutants
- describe how contaminants may enter the food chain through plants during the normal water/nutrient cycle

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- locating and analyzing a New Brunswick case study in which soil has become polluted/contaminated
e.g. - abandoned gas station storage tanks
- unregulated garbage dumps
- industrial oil spills
- agricultural effluent
- waste from mining/ore refining processes
- waste from sawmill/wood processing plants
- by-products from paper mill or power generating facilities
- investigating why the NB Departments of Natural Resources and Health advises not to consume the liver of moose and deer harvested in this region
- investigating provincial regulations that limited the consumption of lake and river fishes
- assessing the New Brunswick regulations regarding use of chemicals in agriculture
- assessing the New Brunswick regulations regarding the use/disposal of agricultural waste products by farmers

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- designing the experiment and conducting soil analysis to find its:
 - mineral content
 - water holding capacity
 - pH level
- preparing recommendations to improve soil conditions for given crops by assessing soil analysis data
- interviewing people whose careers relate to soil protection and conservation

Resources

Environmental Science, Nebel and Wright: Chapters 9 and 13

One World, Krull, Chapter 7

Environmental Science, Person, Unit 3

Strands in the Web, Smith, Part 3
pp. 60 - 64

Sowing for Need or Sowing for Greed (VHS)

Nutrient Cycle: A Guide To Better Forests – Canada Forest Service
Instructional Resources #702515, VH

Fragile Harvest
Instructional Resources #702874, VH

Farming and the Environment (paperback), Wayland
see Instructional Resources Catalogue

The Spread of Deserts (Wayland)
ISBN 0-7502-0277-7
Instructional Resources Catalogue

Environmental Science, Miller:
Chapter 12

Environmental Chemistry (Cambridge)
ISBN 0-521-52156-X

Unit 3.

Major Concept: Risks & Their Analysis

Knowledge

Students should be able to:

- describe how cost-benefit analysis contributes to decision-making
- identifying and explaining the factors considered when estimating costs
- describe how the factor of time contributes to estimating benefits
- illustrating how the interpretation of cost-benefit analysis can be subjective and open to influence

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- studying and reporting on the cost-benefit analysis of developing a regional land fill and solid waste treatment facility
- seeking information on the cost-benefit analysis of the N.B. Beverage Containers Act and Regulations
- analyzing the short and long term effects of community recycling programs
- collecting information to perform a cost-benefit analysis on the N.B. Environmental Trust Fund
- explaining how individuals may contribute to cost-benefit analyses of importance at both local and regional levels

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- selecting an important issue within the school or local community and designing a cost-benefit analysis to assess how the issue should be treated
- using a case study of a cost-benefit analysis to identify who paid the cost and who gained the benefits from a given decision

Resources

Environmental Science, Nebel and Wright: Chapter 17

One World, Krull, Chapter 1, 4, 5

Decision-Making Practices for Sustainable Development
Canadian National Roundtable on Environment & Economy
ISBN 1-895643-05-8

Earth Facts
ISBN 0-919091-71-7

Local Round Tables on Environment and Economy: A Guide
ISBN 0-7729-8925-7

Environmental Science, Person: Many case studies in this book consider risk analysis

Environmental Science, Miller: Chapter 2 and 8

Stratagem Game
Instructional Resources/EEENB

Fishbanks Inc.
Instructional Resources

Taking Stock: NFB
Instructional Resources #704645, VH

Environmental Science, Arms: Chapter 1.3

UNIT 4

RESOURCES

OVERVIEW

Science Themes: Endangered species, spaces, resources and lifestyle

In Unit 4, students will investigate our diminishing resources of biota, refuse, energy and land.

STUDENT OUTCOMES FOR UNIT 4

KNOWLEDGE:

Students will develop an understanding of the following major topics:

Undisturbed natural environments

Value of natural species

Bio-diversity

Saving wild species

Biological systems in a global perspective

Ecosystems under pressure

The solid waste crisis and solutions

Energy sources and uses

The energy crisis of declining reserves

Options for the future

Nuclear power

Solar energy

Renewable energy options

Urban sprawl and car dependency

Moving toward a sustainable society

SKILLS:

Students will demonstrate an ability to:

- complete research using multimedia
- collect information, synthesize the data and debate relevant issues
- develop and propose plans of action

ATTITUDES:

Students will develop:

- an appreciation of the natural environment
- an awareness of responsible decision-making by consumers
- an appreciation of species endangerment
- a sense of responsibility or stewardship toward the use of the environment

Unit 4.

Major Concept: Endangered Species: Diversity and Protection

Knowledge

Students should be able to:

- distinguish between instrumental and intrinsic value when assigning worth to natural species
- define bio-diversity and estimate the extent of current bio-diversity
- document the extent of bio-diversity losses
- analyze the ways in which habitat conversion, fragmentation and simplification affect bio-diversity loss
- describe the different ways exotic species have an impact on bio-diversity

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- explaining how natural species are important in agriculture, forestry, aquaculture and animal husbandry, medicine, recreation, science and aesthetic enjoyment, and commercial trade
- discussing the attempts to assign intrinsic value to wild species
- explaining how human population growth, pollution, and overuse of wild species are involved in bio-diversity loss
- exploring the possible consequences of species extinction
- describing the relationship between game animal management and bio-diversity

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- researching an example of N.B. flora or fauna to assess its instrumental and intrinsic worth
- analyzing practices of the N.B. forest industry to illustrate its trends in bio-diversity
- analyzing the factors relating to exploitation and species diversity in the east coast fishery
- conducting a round table discussion on the merits of establishing a federal/provincial park (e.g., Kouchibouqac)

Resources

Environmental Science, Nebel & Wright: Chapter 18

Finding the Balance, Breakwater Books

Environmental Science, Person: Unit 1 and 3

Environmental Science, Miller: Chapter 16 and 17

Environmental Science, Arms: Chapter 10

Fishbanks Inc. – Instructional Resources

Unit 4.

Major Concept: Endangered Spaces

Knowledge

Students should be able to:

- describe the important natural services performed by ecosystems
- explain the tragedy of exploiting the "common pool resources" and give an example of how it operates today
- explain the concept of maximum sustainable yield and the difficulties of applying it
- identify examples of the use and abuse of public/"crown" lands

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- distinguishing between conservation and preservation
- understanding why forests are cleared and the consequences of clearing
- describing the problems caused by rainforest destruction, particularly recent developments in Brazil
- tracing recent trends in exploitation of the ocean fisheries
- understanding how and why whales are killed, the current moratorium on killing of them, and the emergence of whale watching
- describing the recent history of wetland losses and the current problem of defining wetlands
- evaluating land trusts as a means of protecting natural lands

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- analyzing N.B. forest management practices in early and late 20th century
- researching the variety of factors which are causing rainforest destruction
- researching and preparing a presentation on the Canadian "Model Forest" program (e.g., Fundy Model Forest, H.Q. in Sussex)
- assessing the factors introduced by participants in the debate over logging the Christmas Mountains in New Brunswick

Resources

Environmental Science, Nebel:
Chapter 19

N.B. Forestry Data – Department of Natural Resources and School Library

Environmental Science, Miller:
Chapter 16

State of the Environment in the Atlantic Region

Forestry on the Hill
(Government of Canada)

Environmental Science, Arms:
Chapter 8.1, 8.2

Unit 4.

Major Concept: Energy Resources: Traditional

Knowledge

Students should be able to:

- explain how solid waste can be a mass/energy drain but also a resource
- describe how the major sources of energy use have changed from 1800 to the present
- describe how electric power is generated, why it is called a secondary energy source, and what primary energy sources are used to generate it
- list the major categories of energy use and name what primary energy sources are currently used to supply each
- name the major fossil fuels and describe their origin
- contrast the outlook for nuclear power in the 1960's with the present outlook

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- describing the features required for new sanitary landfills
- describing some of the costs and limitations of landfills
- describing how refuse may be converted to energy
- discussing the concept of integrated waste management
- researching environmental problems associated with generation of electrical power
- researching and presenting the consequences of burning fossil fuels on a local/global scale

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- researching the net energy/resource loss associated with solid waste "dumping"
- interviewing a representative of a local Solid Waste Commission to discover the features of its integrated waste management plan
- comparing resource use and, "waste" generation, by advanced societies with those of underdeveloped nations
- analyzing the relationship between degree of industrialization, level of GNP, and per capita energy consumption

Resources

Environmental Science, Nebel & Wright: Chapter 20 and 21

See Global Education Centre resource list

Meeting Future Energy Needs, P.J. Spratt & Associates (at each high school)

Environmental Science, Miller: Chapter 13 and 19

Environmental Science, Person: Unit 4

Environmental Science, Arms: Chapter 11.1, 11.2

State of the Environment in the Atlantic Region

Teaching About Sustainability: Classroom Strategies

Hazardous Waste Resource Kit (at each High School)

Ontario Federation of Naturalists

Unit 4.

Major Concept: Energy Resources: Non-Traditional

Knowledge

Students should be able to:

- explain the principles of energy generation using nuclear fuels
- describe the general design of a nuclear reactor and a nuclear power plant
- list the environmental advantages and disadvantages of nuclear power in contrast to coal or oil fuels
- contrast active and passive solar heating systems and giving their advantages and disadvantages
- evaluate sources of energy that are considered indirect forms of solar energy

STS connections

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- researching what happened at Three Mile Island and Chernobyl and discussing the consequences of those accidents
- discussing Canadian regulations to maintain nuclear power safety - see Atomic Energy Control Board
- describing the hazards associated with radiation from radioactive sources
- discussing the challenges related to "permanent" disposal of radioactive wastes
- identifying ways to reduce energy consumption individually and collectively

Skills/Activities

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- researching and presenting the generation of electrical energy by a CANDU station (e.g., Point Lepreau)
- comparing cost effectiveness data for nuclear powered generating stations compared to those using fossil fuels
- developing a presentation on solar heating systems that are viable in New Brunswick
- investigating the secondary industries developing in N.B. that result from using nuclear power and alternative energy sources

Resources

Meeting Future Energy Needs, P.J. Spratt & Associates

Reports from N.B. Power and fossil fuel industry

Publications from Conservation Council of N.B.

Data published by N.B. Department of Industry and Tourism

Environmental Science, Nebel & Wright: Chapter 21, 22 and 23

Environmental Science, Miller: Chapter 18

Environmental Science, Person: Unit 4

Environmental Science, Arms: Chapter 11.3

GEO CD Rom

Stratagem Game – Instructional Resources

Teaching About Sustainability: Classroom Strategies

