Science 2200

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NEWFOUNDLAND
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Foreword

The Pan-Canadian *Common Framework of Science Learning Outcomes K to 12* released in October 1997, assists provinces in developing a common science curriculum framework.

New science curriculum for the Atlantic Provinces is described in *Foundation for the Atlantic Canada Science Curriculum (1998)*.

This curriculum guide is intended to provide teachers with the overview of the outcomes framework for science education. It also includes suggestions to assist teachers in designing learning experiences and assessment tasks.

Introduction

Background

The curriculum described in *Foundation for the Atlantic Canada Science Curriculum* and in *Science 2200 Curriculum Guide* was planned and developed collaboratively by regional committees. The process for developing the common science curriculum for Atlantic Canada involved regional consultation with the stakeholders in the education system in each Atlantic province. The Atlantic Canada science curriculum is consistent with the science framework described in the pan-Canadian *Common Framework of Science Learning Outcomes K to 12.*

Rationale

The aim of science education in the Atlantic provinces is to develop scientific literacy. Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences which provide opportunity to explore, analyse, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, their careers, and their futures.

Program Design and Components

Learning and Teaching Science

What students learn is fundamentally connected to how they learn it. The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies. The teacher is a facilitator of learning whose major tasks include

- creating a classroom environment to support the learning and teaching of science
- designing effective learning experiences that help students achieve designated outcomes
- stimulating and managing classroom discourse in support of student learning
- learning about and then using students' motivations, interests, abilities, and learning styles to improve learning and teaching
- analysing student learning, the scientific tasks and activities involved, and the learning environment to make ongoing instructional decisions
- selecting teaching strategies from a wide repertoire

Effective science learning and teaching take place in a variety of situations. Instructional settings and strategies should create an environment which reflects a constructive, active view of the learning process. Learning occurs not by passive absorption, but rather as students actively construct their own meaning and assimilate new information to develop new understanding.

The development of scientific literacy in students is a function of the kinds of tasks they engage in, the discourse in which they participate, and the settings in which these activities occur. Students' disposition towards science is also shaped by these factors. Consequently, the aim of developing scientific literacy requires careful attention to all of these facets of curriculum.

Learning experiences in science education should vary and include opportunities for group and individual work, discussion among students, as well as between teacher and students, and hands-on/minds-on activities that allow students to construct and evaluate explanations for the phenomena under investigation. Such investigations, and the evaluation of the evidence accumulated, provide opportunities for students to develop their understanding of the nature of science and the nature and status of scientific knowledge.

The Three Processes of Scientific Literacy

An individual can be considered scientifically literate when he/she is familiar with, and able to engage in, three processes: inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanations for phenomena. While there is general agreement that there is no such thing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analysing data, and interpreting data are fundamental to engaging in science. These activities provide students opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of the proposing, creating, and testing of prototypes, products, and techniques in an attempt to reach an optimum solution to a given problem.

Decision Making

The process of decision-making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are not only important in their own right; they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Meeting the Needs of All Learners

Foundation for the Atlantic Canada Science Curriculum stresses the need to design and implement a science curriculum that provides equal opportunities for all students according to their abilities, needs, and interests. Teachers must be aware of and make adaptations to accommodate the diverse range of learners in their classes. In order to adapt to the needs of all learners, teachers must create opportunities that permit students to have their learning styles addressed.

As well, teachers must not only remain aware of and avoid gender and cultural biases in their teaching, they must strive to actively address cultural and gender stereotyping with respect to student interest and success in science and mathematics. Research supports the position that, when science curriculum is made personally meaningful, and socially and culturally relevant, it is more engaging for groups traditionally under-represented in science, and, indeed, for all students.

When making instructional decisions, teachers must consider individual learning needs, preferences, and strengths, and the abilities, experiences, interests, and values that learners bring to the classroom. Ideally, every student should find his/her learning opportunities maximized in the science classroom.

While this curriculum guide presents specific outcomes for each unit, it must be acknowledged that students will progress at different rates. Teachers should provide materials and strategies that accommodate student diversity, and validate students when they achieve the outcomes to the maximum of their abilities.

It is important that teachers articulate high expectations for all students and ensure that all students have equal opportunities to experience success as they work toward the achievement of designated outcomes. A teacher should adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address students' needs and build on their strengths. The variety of learning experiences described in this guide provide access for a wide range of learners. Similarly, the suggestions for a variety of assessment practices provide multiple ways for learners to demonstrate their achievements.

Communicating in Science

Learning experiences should provide opportunities for students to use writing and other forms of representation as ways to learn. Students, at all grade levels, should be encouraged to use writing to speculate, theorize, summarize, discover connections, describe processes, express understandings, raise questions, and make sense of new information using their own language as a step to the language of science. Science logs are useful for such expressive and reflective writing. Purposeful note-making is also an intrinsic part of learning in science that can help students better record, organize, and understand information from a variety of sources. The process of creating webs, maps, charts, tables, graphs, drawings, and diagrams to represent data and results helps students learn and also provides them with useful study tools.

Learning experiences in science should also provide abundant opportunities for students to communicate their findings and understandings to others, both formally and informally, using a variety of forms for a range of purposes and audiences. Such experiences should encourage students to use effective ways of recording and conveying information and ideas and to use the vocabulary of science in expressing their understandings. It is through opportunities to talk and write about the concepts they need to learn that students come to better understand both the concepts and related vocabulary.

Learners will need explicit instruction in and demonstration of the strategies they need to develop and apply in reading, viewing, interpreting, and using a range of science texts for various purposes. It will be equally important for students to have demonstrations of the strategies they need to develop and apply in selecting, constructing, and using various forms for communicating in science.

Assessment and Evaluation

The terms assessment and evaluation are often used interchangeably, but they refer to quite different processes. Science curriculum documents developed in the Atlantic region use these terms for the processes described below.

Assessment is the systematic process of gathering information on student learning.

Evaluation is the process of analysing, reflecting upon, and summarizing assessment information, and making judgments or decisions based upon the information gathered.

The assessment process provides the data, and the evaluation process brings meaning to the data. Together, these processes improve teaching and learning. If enjoyment in learning for students is to be encouraged, now and throughout their lives, strategies must be developed to involve students in assessment and evaluation at all levels. When students are aware of the outcomes for which they are responsible, and the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate their learning.

Regional curriculum in science suggests experiences that support learning within Science-Technology-Society and the Environment (STSE), skills, knowledge, and attitudes. It also reflects the three major processes of science learning: inquiry, problem solving and decision making. When assessing student progress, it is helpful for teachers to know some activities/skills/actions that are associated with each process of science learning. Examples of these are illustrated in the following lists. Student learning may be described in terms of ability to perform these tasks.

Inquiry

- define questions related to a topic
- refine descriptors/factors that focus practical and theoretical research
- select an appropriate way to find information
- make direct observations
- perform experiments, record and interpret data, and draw conclusions
- design an experiment which tests relationships and variables
- write lab reports that meet a variety of needs (limit the production of "formal" reports) and place emphasis on recorded data
- recognize that the quality of both the process and the product are important

Problem Solving

- clearly define a problem
- produce a range of potential solutions for the problem
- appreciate that several solutions should be considered
- plan and design a product or device intended to solve a problem
- construct a variety of acceptable prototypes, pilot test, evaluate, and refine to meet a need
- present the refined process/product/device and support why it is "preferred"
- recognize that the quality of both the process and the product are important

Decision Making

- gather information from a variety of sources
- evaluate the validity of the information source
- evaluate which information is relevant
- identify the different perspectives that influence a decision
- present information in a balanced manner
- use information to support a given perspective
- recommend a decision and provide supporting evidence
- communicate a decision and provide a "best" solution

Assessment Techniques

Assessment techniques should match the style of learning and instruction employed. Several options are suggested in this curriculum guide from which teachers may choose depending on the curriculum outcomes, the class and school/district policies. It is important that students know the purpose of an assessment, the method used, and the marking scheme being used. In order that formative assessment supports learning, the results, when reported to students, should indicate the improvements expected.

Observation (formal and informal)

This technique provides a way of gathering information fairly quickly while a lesson is in progress. When used formally the student(s) would be made aware of the observation and the criteria being assessed. Informally, it could be a frequent, but brief, check on a given criterion. Observation may offer information about the participation level of a student for a given task, use of a piece of equipment or application of a given process. The results may be recorded in the form of checklists, rating scales or brief written notes. It is important to plan in order that specific criteria are identified, suitable recording forms are ready, and that all students are observed in a reasonable period of time.

Performance

This curriculum encourages learning through active participation. Many of the curriculum outcomes found in the guide promote skills and their application. There is a balance between scientific processes and content. In order that students appreciate the importance of skill development, it is important that assessment provide feedback on the various skills. These may include the correct manner in which to use a piece of equipment, an experimental technique, the ability to interpret and follow instructions, or to research, organize and present information. Assessing performance is most often achieved through observing the process.

Journal

Although not assessed in a formal manner, journals provide an opportunity for students to express thoughts and ideas in a reflective way. By recording feelings, perceptions of success and, responses to new concepts, a student may be helped to identify his or her most effective learning style. Knowing how to learn in an effective way is powerful information. Journal entries also give indicators of developing attitudes to science concepts, processes and skills, and how these may be applied in the context of society. Self-assessment, through a journal, permits a student to consider strengths and weaknesses, attitudes, interests and new ideas. Developing patterns may help in career decisions and choices of further study.

Interview

This curriculum promotes understanding and applying scientific concepts. Interviewing a student allows the teacher to confirm that learning has taken place beyond simply factual recall. Discussion allows a student to display an ability to use information and clarify understanding. Interviews may be a brief discussion between teacher and student or they may be more extensive and include student, parent and teacher. Such conferences allow a student to be pro-active in displaying understanding. It is helpful for students to know which criteria will be used to assess formal interviews. This assessment technique provides an alternate method of expression to students whose verbal presentation skills are stronger than their written skills.

Paper and Pencil (assignment and test)

These techniques can be formative or summative. Several curriculum outcomes call for displaying ideas, data, conclusions, and the results of practical or literature research. These can be in written form for display or direct teacher assessment. Whether as part of learning, or a final statement, students should know the expectations for the exercise and the rubric by which it will be assessed. Written assignments and tests can be used to assess knowledge, understanding and application of concepts. They are less successful at assessing skills, processes and attitudes. The purpose of the assessment should determine what form of pencil and paper exercise is used.

Presentation

The curriculum includes outcomes that require students to analyze and interpret information, to identify relationships between science, technology, society and environment, to be able to work in teams, and to communicate information. Although it can be time-consuming, these activities are best displayed and assessed through presentations. These can be given orally, in written/pictoral form, by project summary (science fair), or by using electronic systems such as video or computer software. Whatever the level of complexity, or format used, it is important to consider the curriculum outcomes as a guide to assessing the presentation. The outcomes indicate the process, concepts, and context for which and about which a presentation is made.

Portfolio

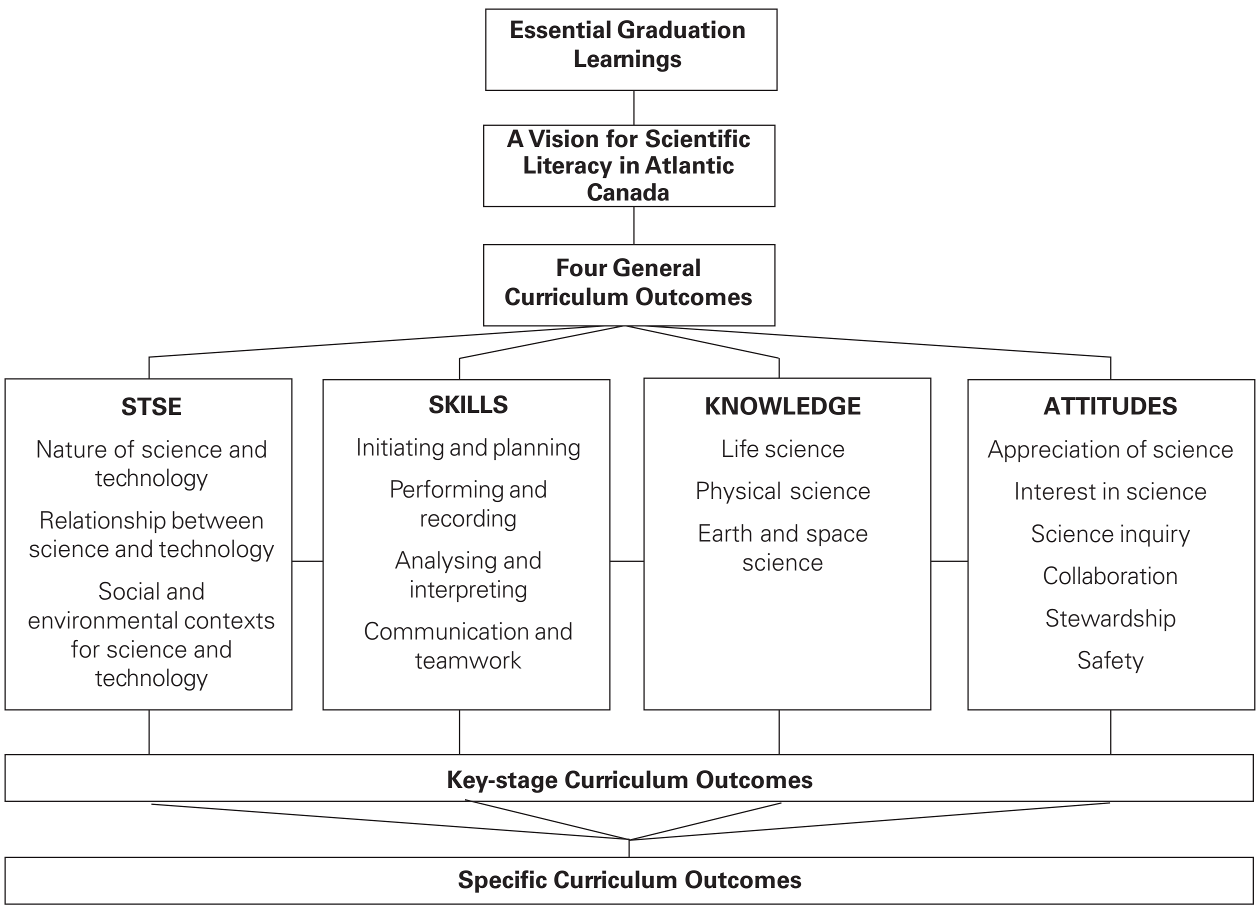
Portfolios offer another option for assessing student progress in meeting curriculum outcomes over a more extended period of time. This form of assessment allows the student to be central to the process. There are decisions about the portfolio, and its contents, which can be made by the student. What is placed in the portfolio, the criteria for selection, how the portfolio is used, how and where it is stored, how it is evaluated, are some of the questions to consider when planning to collect and display student work in this way. The portfolio should provide a long-term record of growth in learning and skills. This record of growth is important for individual reflection and self-assessment, but it is also important to share with others. For all students, but particularly younger students, it is exciting to review a portfolio and see the record of development over time.

Outcomes

Outcomes Framework

The science curriculum is based on an outcomes framework that includes statements of essential graduation learnings, general curriculum outcomes, key-stage curriculum outcomes, and specific curriculum outcomes. The general, key-stage, and specific curriculum outcomes reflect the Pan-Canadian *Common Framework of Science Learning Outcomes K to 12*. The conceptual map shown in Figure 1 provides the blueprint of the outcomes framework.

FIGURE 1



This curriculum guide outlines course-specific curriculum outcomes and provides suggestions for learning, teaching, assessment, and resources to support students' achievement of these outcomes. Teachers should consult the *Foundation for the Atlantic Canada Science Curriculum* for descriptions of the essential graduation learnings, vision for scientific literacy, general curriculum outcomes, and key-stage curriculum outcomes.

Essential Graduation Learnings

Essential graduation learnings are statements describing the knowledge, skills, and attitudes expected of all students who graduate from high school. Achievement of the essential graduation learnings will prepare students to continue to learn throughout their lives. These learnings describe expectations not in terms of individual school subjects but in terms of knowledge, skills, and attitudes developed throughout the curriculum. They confirm that students need to make connections and develop abilities across subject boundaries and to be ready to meet the shifting and ongoing opportunities, responsibilities, and demands of life after graduation. Provinces may add additional essential graduation learnings as appropriate. The essential graduation learnings are:

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.

Spiritual and Moral Development

Graduates will demonstrate understanding and appreciation for the place of belief systems in shaping the development of moral values and ethical conduct.

General Curriculum Outcomes

The general curriculum outcomes form the basis of the outcomes framework. They also identify the key components of scientific literacy. Four general curriculum outcomes have been identified to delineate the four critical aspects of students' scientific literacy. They reflect the wholeness and interconnectedness of learning and should be considered interrelated and mutually supportive.

Science, Technology, Society, and the Environment

Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

Skills

Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

Knowledge

Students will construct knowledge and understandings of concepts in life science, physical science, and earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

Attitudes

Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

Key-Stage Curriculum Outcomes

Key-stage curriculum outcomes are statements that identify what students are expected to know, be able to do, and value by the end of grades 3, 6, 9, and 12 as a result of their cumulative learning experiences in science. The key-stage curriculum outcomes are from the *Common Framework for Science Learning Outcomes K-12*.

Specific Curriculum Outcomes

Specific curriculum outcome statements describe what students are expected to know and be able to do at each grade level. They are intended to help teachers design learning experiences and assessment tasks. Specific curriculum outcomes represent a framework for assisting students to achieve the key-stage curriculum outcomes, the general curriculum outcomes, and ultimately, the essential graduation learnings. Specific curriculum outcomes are organized in units for each grade level.

Curriculum Guide Organization

Specific curriculum outcome statements describe what students should know and be able to do at the end of each course. They are intended to serve as the focus for the design of learning experiences and assessment tasks. Specific curriculum outcomes represent a reasonable framework for assisting students to achieve the key-stage, and the general curriculum outcomes, and ultimately the essential graduation learnings.

Specific curriculum outcomes are organized in units for each course. Each unit is organized by topic. Suggestions for learning, teaching, assessment, and resources are provided to support student achievement of the outcomes.

The order in which the units of a course appear in the guide is meant to suggest a sequence. In some cases the rationale for the recommended sequence is related to the conceptual flow across the year. That is, one unit may introduce a concept which is then extended in a subsequent unit. Likewise, it is possible that one unit focuses on a skill or context which will then be built upon later in the year.

It is also possible that units or certain aspects of units can be combined or integrated. This is one way of assisting students as they attempt to make connections across topics in science or between science and the real world. The intent is to provide opportunities for students to deal with science concepts and scientific issues in personally meaningful, and socially and culturally relevant, contexts.

Unit Organization

All units comprise a two-page layout of four columns as illustrated in Figure 2, p. 16. In some cases the four-column spread continues to the next two-page layout. Each unit comprises outcomes grouped by a topic which is indicated at the top of the left hand page.

Column One: Specific Curriculum Outcomes

The first column lists a group of related specific curriculum outcome statements. These are written in the context of Newfoundland and Labrador Science 2200 and based on the Pan-Canadian *Common Framework of Science Learning Outcomes K to 12.* The statements involve the Science-Technology-Society-Environment (STSE), skills, and knowledge outcomes indicated by the outcome number(s) that appears in brackets after the outcome statement. Some STSE and skills outcomes have been written in an age-appropriate context that shows how these outcomes should be addressed.

Specific curriculum outcomes have been grouped by topic. Other groupings of outcomes are possible and in some cases may be necessary in order to take advantage of local situations. The grouping of outcomes provides a suggested teaching sequence. Teachers may prefer to plan their own teaching sequence to meet the learning needs of their students.

Column Two: Elaborations - Suggestions for Learning and Teaching

The second column provides suggestions for the learning environment and experiences that will support students' achievement of the outcomes listed in the first column. Elaborations of the outcomes may also be included in this column, as well as background information.
The suggestions in this column are intended to provide a holistic approach to instruction. In some cases, the suggestions in this column address a single outcome; in other cases, they address a group of outcomes.

Column Three: Suggestions for Assessment

The third column provides suggestions for ways that students' achievement of the outcomes may be assessed. These suggestions reflect a variety of assessment techniques which include, but are not limited to, informal/formal observation, performance, journal, paper and pencil, interview, presentation, and portfolio. Some assessment tasks may be used to assess student learning in relation to a single outcome, others to assess student learning in relation to several outcomes. The assessment item identifies the outcome(s) addressed by the outcome number in brackets after the item.

Column Four: Resources

The fourth column identifies sources of materials and ideas, which may assist in the learning and teaching of the outcomes. These resources do not address the entire scope of the science curriculum. Since a resource-based learning philosophy is espoused, teachers are encouraged to use other appropriate resources, which will contribute to the achievement of the outcomes.

FIGURE 2
Curriculum Outcomes Organization:
The Four-Column, Two-Page Spread

Topic			
Outcomes • Outcome based on pan-Canadian outcomes (###,###) — clarification outcomes • Outcome based on pan-Canadian outcomes (###) — clarification outcomes — clarification outcomes	**Suggestions for Learning and Teaching** Suggested activities and elaborations of outcome Suggested activities and elaborations of outcome	**Suggestions for Assessment** **Informal/Formal Observation** **Performance** • sample assessment item (###) **Journal** **Paper and Pencil** **Interview** • sample assessment item (###) **Presentation** **Portfolio**	**Resources** Authorized and recommended resources that address outcomes

Unit Overview

At the beginning of each unit, there is a two-page synopsis. On the first page, introductory paragraphs give a unit overview. These are followed by a section that specifies the focus (inquiry, problem solving, and/or decision making) and possible contexts for the unit. Finally, a curriculum-links paragraph specifies how this unit relates to science concepts and skills that will be addressed at later grades so teachers will understand how the unit fits with the students' progress through the complete science program.

The second page of the two-page overview provides a table of the outcomes from the *Common Framework of Science Learning Outcomes K to 12* that will be addressed in the unit. The numbering system used is the one followed in the Pan-Canadian document:

100s - Science-Technology-Society-Environment (STSE) outcomes

200s - Skills outcomes

300s - Knowledge outcomes

400s - Attitude outcomes (see pages 18-19)

These code numbers appear in brackets after each specific curriculum outcome (SCO).

Within each unit Pan-Canadian outcomes are written in the context of Newfoundland and Labrador's Science 2200 curriculum.

FIGURE 3
Unit Overview

Unit Title: Unit Overview		**Unit Title: Curriculum Outcomes**		
Introduction	Synopsis of the unit	**STSE**	**Skills**	**Knowledge**
Focus and Contexts	Focus: inquiry, decision making, or problem solving. Possible contexts suggested	###Science-Technology-Society-Environment outcomes from *Common Framework of Science Learning Outcomes K to 12*	###Skills outcomes from *Common Framework of Science Learning Outcomes K to 12*	###Knowledge outcomes from *Common Framework of Science Learning Outcomes K to 12*
Curriculum Links	Links to concepts studied within the K to 12 science curriculum			

Attitude Outcomes

It is expected that certain attitudes will be fostered and developed throughout the entire science program, entry to grade 12. The STSE, skills, and knowledge outcomes contribute to the development of attitudes and opportunities for fostering these attitudes are highlighted in the *Suggestions for Learning and Teaching* section of each unit.

Attitudes refer to generalized aspects of behaviour that are modelled for students by example and reinforced by selective approval. Attitudes are not acquired in the same way as skills and knowledge. The development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and by creating a readiness for responsible application of what they learn.

Since attitudes are not acquired in the same way as skills and knowledge, outcomes statements for attitudes are written for the end of grades 3, 6, 9, and 12. These outcomes statements are meant to guide teachers in creating a learning environment that fosters positive attitudes.

The following pages present the attitude outcomes from the Pan-Canadian *Common Framework of Science Learning Outcomes K to 12.*

Common Framework of Science Learning Outcomes K to 12
Attitude Outcome Statements

From grades 10 to 12 it is expected that students will be encouraged to . . .

Appreciation of science

436 value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not

437 appreciate that the applications of science and technology can raise ethical dilemmas

438 value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds

Evident when students, for example,

- consider the social and cultural contexts in which a theory developed
- use a multi-perspective approach, considering scientific, technological, economic, cultural, political, and environmental factors when formulating conclusions, solving problems, or making decisions on an STSE issue
- recognize the usefulness of being skilled in mathematics and problem solving
- recognize how scientific problem solving and the development of new technologies are related
- recognize the contribution of science and technology to the progress of civilizations
- carefully research and openly discuss ethical dilemmas associated with the applications of science and technology
- show support for the development of information technologies and science as they relate to human needs
- recognize that western approaches to science are not the only ways of viewing the universe
- consider the research of both men and women

Interest in science

439 show a continuing and more informed curiosity and interest in science and science-related issues

440 acquire, with interest and confidence, additional science knowledge and skills, using a variety of resources and methods, including formal research

441 consider further studies and careers in science- and technology-related fields

Evident when students, for example,

- conduct research to answer their own questions
- recognize that part-time jobs require science- and technology-related knowledge and skills
- maintain interest in or pursue further studies in science
- recognize the importance of making connections between various science disciplines
- explore and use a variety of methods and resources to increase their own knowledge and skills
- are interested in science and technology topics not directly related to their formal studies
- explore where further science- and technology-related studies can be pursued
- are critical and constructive when considering new theories and techniques
- use scientific vocabulary and principles in everyday discussions
- readily investigate STSE issues

Scientific inquiry

442 confidently evaluate evidence and consider alternative perspectives, ideas, and explanations

443 use factual information and rational explanations when analysing and evaluating

444 value the processes for drawing conclusions

Evident when students, for example,

- insist on evidence before accepting a new idea or explanation
- ask questions and conduct research to confirm and extend their understanding
- criticize arguments based on the faulty, incomplete, or misleading use of numbers
- recognize the importance of reviewing the basic assumptions from which a line of inquiry has arisen
- expend the effort and time needed to make valid inferences
- critically evaluate inferences and conclusions, cognizant of the many variables involved in experimentation
- critically assess their opinion of the value of science and its applications
- criticize arguments in which evidence, explanations, or positions do not reflect the diversity of perspectives that exist
- insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position taken can be judged
- seek new models, explanations, and theories when confronted with discrepant events or evidence

Common Framework of Science Learning Outcomes K to 12
Attitude Outcome Statements

For grades 10 to 12 it is expected that students will be encouraged to . . .

Collaboration

445 work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas

Evident when students, for example,

- willingly work with any classmate or group of individuals, regardless of their age, gender, or physical and cultural characteristics
- assume a variety of roles within a group, as required
- accept responsibility for any task that helps the group complete an activity
- give the same attention and energy to the group's product as they would to a personal assignment
- are attentive when others speak
- are capable of suspending personal views when evaluating suggestions made by a group
- seek the points of view of others and consider diverse perspectives
- accept constructive criticism when sharing their ideas or points of view
- criticize the ideas of their peers without criticizing the persons
- evaluate the ideas of others objectively
- encourage the use of procedures that enable everyone, regardless of gender or cultural background, to participate in decision making
- contribute to peaceful conflict resolution
- encourage the use of a variety of communication strategies during group work
- share the responsibility for errors made or difficulties encountered by the group

Stewardship

446 have a sense of personal and shared responsibility for maintaining a sustainable environment

447 project the personal, social, and environmental consequences of proposed action

448 want to take action for maintaining a sustainable environment

Evident when students, for example,

- willingly evaluate the impact of their own choices or the choices scientists make when they carry out an investigation
- assume part of the collective responsibility for the impact of humans on the environment
- participate in civic activities related to the preservation and judicious use of the environment and its resources
- encourage their peers or members of their community to participate in a project related to sustainability
- consider all perspectives when addressing issues, weighing scientific, technological, and ecological factors
- participate in social and political systems that influence environmental policy in their community
- examine/recognize both the positive and negative effects on human beings and society of environmental changes caused by nature and by humans
- willingly promote actions that are not injurious to the environment
- make personal decisions based on a feeling of responsibility toward less privileged parts of the global community and toward future generations
- are critical-minded regarding the short- and long-term consequences of sustainability

Safety

449 show concern for safety and accept the need for rules and regulations

450 be aware of the direct and indirect consequences of their actions

Evident when students, for example,

- read the label on materials before using them, interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood
- criticize a procedure, a design, or materials that are not safe or that could have a negative impact on the environment
- consider safety a positive limiting factor in scientific and technological endeavours
- carefully manipulate materials, cognizant of the risks and potential consequences of their actions
- write into a laboratory procedure safety and waste-disposal concerns
- evaluate the long-term impact of safety and waste disposal on the environment and the quality of life of living organisms
- use safety and waste disposal as criteria for evaluating an experiment
- assume responsibility for the safety of all those who share a common working environment by cleaning up after an activity and disposing of materials in a safe place
- seek assistance immediately for any first aid concerns like cuts, burns, or unusual reactions
- keep the work station uncluttered, with only appropriate lab materials present

Unit 1: Ecosystems
Specific Curriculum Outcomes
60 Hours

Unit Overview

Introduction

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

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

Focus and Content

Many outcomes in this unit can be accomplished by using a decision-making focus, thereby moving students to think globally at a more sophisticated level, and to explore the concept of sustainability for the first time. Activities in the unit also provide an opportunity to focus on observation/inquiry. The local environment and economy may be conducive to an extensive ecosystem study.

Curriculum Links

Sustainability of ecosystems connects with other clusters in the science curriculum to varying degrees. In elementary grades students learn about the "Needs and Characteristics of Living Things" and "Air and Water in the Environment," "Exploring Soils" and "Habitats and Communities." "Diversity of Life" in elementary science is directly linked to this unit as it considers how the characteristics of living things permit systems of classification and how varying conditions relate to adaptations. More directly linked is the intermediate science "Interactions within Ecosystems" unit. This unit concentrates on the flow of energy and matter through food webs in observable ecosystems. Consider developing connections between this unit and "Weather Dynamics," as well as "Chemical Reactions" in Science 3200.

STSE

Students will be expected to

Nature of Science and Technology

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

Social and Environmental Contexts of Science and Technology

117-5 provide examples of how science and technology are an integral part of their lives and their community

117-7 identify and describe science- and technology-based careers related to the science they are studying

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

118-2 analyse from a variety of perspectives the risks and benefits to society and the environment of applying scientific knowledge or introducing a particular technology

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

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

Skills

Students will be expected to

Initiating and Planning

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

Performing and Recording

213-5 compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data

213-6 use library and electronic research tools to collect information on a given topic

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

213-8 select and use apparatus and material safely

213-9 demonstrate a knowledge of WHMIS standards by selecting and applying proper techniques for handling and disposing of lab materials

Analysing and Interpretation

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

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

Communication and Teamwork

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

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

215-5 develop, present, and defend a position or course of action, based on findings

215-6 work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise

215-7 evaluate individual and group processes used in planning, problem solving and decision making, and completing a task

Knowledge

Students will be expected to

306-1 describe how energy is supplied to, and how it flows through, a food web

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

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

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

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

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

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

318-11 use the concept of the energy pyramid to explain the production, distribution, and use of food resources

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

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

Diversity in Ecosystems

Outcomes

Students will be expected to

- explain how a paradigm shift, with respect to environmental attitudes, can change scientific world views in understanding sustainability (114-1)

Elaborations—Strategies for Learning and Teaching

This unit reintroduces students to three major themes related to ecosystems: diversity, change and stability, and sustainability. The first theme will reintroduce students to a number of concepts and terms they have addressed in previous grades as well as provide a look at the diversity of organisms found within and between different ecosystems. Students will also have opportunity to refine their understanding of the complexity of the relationships that exist between the organisms in an ecosystem. The second theme aims to develop the concept that both change and stability are characteristics of all ecosystems. Over time ecosystems will undergo changes (both natural and human-caused) that will have impacts on the organisms and their relationships. In the absence of change agents, ecosystems will become stable or balanced. The third theme looks at the ways in which humans interact with and cause changes to ecosystems. Through a study of this theme, students are introduced to the things that can be done to ensure the sustainability of these ecosystems. These three themes are interconnected and should be emphasized throughout the study of this unit.

Throughout this unit the notions of paradigm shift, changes in the attitudes and values related to the environment, and how these all relate to the concept of sustainability should be emphasized. Students should be continually encouraged to examine their own beliefs, values, and attitudes about the environment and to further examine the basis of why they hold these beliefs, values, and attitudes.

Paradigm shifts are very rare occurrences and represent significant changes in the way people view the world. Even when presented with clear supporting evidence for the new view of the world, people will often cling to their current view. Over time, as more and more people come to view the world according to the new understanding, a paradigm shift is said to have occurred. An example of a major paradigm shift was the idea that Earth is round and that it rotates around the sun. When first proposed, many refused to accept it and would not believe the evidence even when they viewed it with their own eyes. Students could explore the notion of paradigm shift by considering whether or not they are in the midst of a paradigm shift related to our ideas of our place in the environment and sustainability. Has the old view that Earth and all the things on it exist for the sole benefit of humans changed? Are we (individuals, provinces, nations, global community) now shifting toward the concept of sustainability? Is this shift real or only perceived? What evidence exists to support their views?

Diversity in Ecosystems

Suggested Assessment Strategies

Portfolio

- Portfolios can be used as a means of assessing the entire unit. Many of the assessment suggestions given throughout the unit can be used as part of an overall portfolio assessment. There are many ways in which portfolios can be assembled as an assessment tool, thus, the number of items and the specific content can be determined by the teacher. Suggestions for content are: experimental results (write-ups, graphs, data, observations, etc.), posters, illustrations, creative writing, videos, making web pages, photos, group projects, reports, responses, critical thinking exercises, self-assessment, etc. A culminating assignment may ask students to respond to the following questions: Describe a past attitude that relates to the environment and sustainability. Describe past activities and/or practices that reflect that attitude. Describe what has happened to cause the general public to shift their way of thinking. Evaluate the new ways people are thinking about sustainability. Do you think they are paradigms yet? Explain. (114-1)

Performance

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

Journal

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

Resources

Science 10,
Concepts & Connections

ST: pp. 6-7

SRL: pp. 2-3

Diversity in Ecosystems *(continued)*

Outcomes

Students will be expected to

- explain how a paradigm shift, with respect to environmental attitudes, can change scientific world views in understanding sustainability (114-1) **Cont'd**
  - compare traditional attitudes and practices to the environment to those embodied in a philosophy of sustainability
  - discuss how attitudes towards our natural environment have changed

Elaborations—Strategies for Learning and Teaching

Teachers could begin this unit by asking students to examine their own paradigms related to the environment. What do they value about the natural environment? What is the value of a forest? Of a lake? Do trees only have value when they are harvested? If they see value in a lake, what is it? Do they think it is important that we take care of our environment? Why/why not? What are some negative effects humans have had on the environment (local, national, international)? Have humans made positive impacts on the natural environment?

During the past forty years we have witnessed a greater appreciation on the part of people for their environment. For example, today many people recycle. Few people will throw wastes from their automobile as they drive along the highway. More people have an appreciation for the "wild environment". Issues like overfishing, pollution, global warming, etc., are all discussed in the popular media and most people know about these issues. Many wish there was something they could do to have an immediate, noticeable impact or, to solve these problems.

Teachers could use the "What do you already know?" questions to determine how much students already know about the ecosystem and sustainability from other grades and to help treat the outcomes for this section. Teachers could have students examine the photos on the bottom of page 6 of the student textbook as a starting point for a discussion on some of the ways we affect our environment. Students could work in groups of 2 or 3 to complete the "Try This" activity on page 7 to further develop the concept of sustainability and interconnectedness of ecosystems.

Diversity in Ecosystems *(continued)*

Suggested Assessment Strategies

Interview

- Teachers could interview students regarding their views on certain environmental issues. This could be done in written, oral, or recorded audio/video format. At the end of the unit teachers could interview the students again to see if their views have changed. (114-1)

Journal

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

Resources

Science 10,
Concepts & Connections
ST: pp. 16-17

SRL: pp. 19 - 20

TR: pp. 1-7 to 1-10

BLM: 1.4a, 1.4b

ST: *Skills Handbook* - p. 286

Forestry Module - pp. 46-54

Fishery Module - pp. 93-130

ST: pp. 6-7

SRL: pp. 2-5

TR: pp. 1-8

Diversity in Ecosystems *(continued)*

Outcomes

Students will be expected to

- explain how a paradigm shift, with respect to environmental attitudes, can change scientific world views in understanding sustainability (114-1) **Cont'd**
  - define "closed system" as a system in which only energy can pass across its borders
  - describe three ways in which Earth is a closed system like a spaceship
    - (i) only the sun's energy can enter and the occasional meteorite (heat can leave)
    - (ii) finite amount of resources which must be used wisely and recycled
    - (iii) nonrenewable resources
  - define sustainability

Elaborations—Strategies for Learning and Teaching

Teachers could read pages 6 and 7 of the student textbook with students, encouraging them to pose answers to the questions raised in this short passage. The introductory paragraph uses the analogy of Earth being like a spaceship. Ask students to consider how they are the same and how they are different. This notion of Earth being a closed system (with the exception of incoming solar energy) provides a good basis for further discussion of ecosystems, changes, human impact, and sustainability. In both the spaceship and Earth, poor choices, lack of management and planning for the future, lack of consideration of the relationships between the "passengers" will have negative results. The money-management analogy in the last paragraph on page 6 of the student textbook can be further expanded to help develop the concept of sustainability (see below).

A sustainable system is one that survives, functions, and is renewed over time. It is a system in which the organisms continue to live and flourish for many generations. In a sustainable ecosystem the changes that occur are not so great as to cause negative long-term impacts to any one group of organism. When human activities (e.g., clear cutting, over fishing, etc) continue to impact a particular aspect of the environment or ecosystem, without allowing that particular aspect to recover (e.g., replanting trees, limiting the number of fish harvested) the system will not be sustainable over the long term. Eventually the system will collapse, just as our financial situation will spiral out of control if we do not manage our money properly and spend beyond our means. (Refer to the Background Information section on page 1-8 of the Teacher's Resource). Whenever possible questions relating to sustainability should be addressed in relation to the major historical industries within this province (e.g., fishing and forestry).

Diversity in Ecosystems *(continued)*

Suggested Assessment Strategies

Presentation

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

Paper and Pencil

- Students could perform Try This Activity - An Ecosystem on the Moon, page 7 of student text and pages 4-6 in the Student Record of Learning. (114-1)

Journal

- Students could write definitions of scientific terms covered. (114-1)
- Students could conduct a print or electronic search on the topic of sustainability. Was there evidence of peer review? They could comment on the importance of peer review of scientific work. Students should conclude that information on the Internet may not have been reviewed by experts. (114-5, 213-7)

Resources

Science 10,
Concepts & Connections

ST: pp. 6-7

ST: pp. 22-25

SRL: pp. 4-6

Diversity in Ecosystems *(continued)*

Outcomes

Students will be expected to

- evaluate relationships that affect the biodiversity and sustainability of life within the biosphere (NLS-1)
- analyze from a variety of perspectives the risks to society of a biodiversity loss (118-2)

Elaborations—Strategies for Learning and Teaching

A CORE STSE component of this unit incorporates a broad range of Science 2200 outcomes. More specifically it targets (in whole or in part) NLS-1, 118-2, 318-1, and 318-6. The STSE component 1-1, *The Diversity of Life*, can be found in Appendix A.

Students will have had some exposure to most of the terminology found in this section. If possible, prior to beginning a treatment of the various terminology, conduct an in-depth study of a local ecosystem (e.g., marsh, bog, wooded area, sea shore, freshwater stream, lake shore, etc). If teachers decide not to cover the detailed study,, students could conduct Investigation 1.5 (page 18, student textbook).

- explain biotic and abiotic factors that keep natural populations in equilibrium and relate this equilibrium to the resource limits of an ecosystem (318-5)
  - define ecology, ecosystem, habitat, population, community, biodiversity
  - define abiotic factors (include space, temperature, oxygen, light, water, inorganic and organic soil nutrients)
  - define biotic factors (include decomposing animals, disease, predator/prey, competition)

While students may not remember the exact definitions for the terms they encounter in this section, they will no doubt recognize them from other science courses they have completed. Teachers could begin this section by making a list of all the terms from pages 8 to 15 in the student textbook (either write list on board, on overhead, or on a poster on the wall). Ask students how many of the terms they recognize. Have students provide verbal definitions or examples for the various terms. As you progress through this section you can provide more detailed definitions as required. Teachers could have students make use of the terms as they discuss ecological issues. This is best accomplished by asking students to work in pairs/groups during various activities/investigations. Pages 14 and 15 of the student textbook contain many of the “ecology terms” for this section. Teachers can use the BLM 1.3 A of the Teacher’s Resource to show the relationship between these terms. Given that students have touched on these terms in previous years, ask them to provide definitions of the term and/or examples to accompany each term. Ask students to refer to Figure 1 on page 14 of their textbook. Use this figure to identify the various abiotic and biotic factors present in this community. Teachers could then use BLM 1.3 B of the Teacher’s Resource to assess each student’s level of understanding of the various concepts presented.

  - explain how biotic and abiotic factors affect ecological interactions

Students should understand that abiotic and biotic factors contribute to the characteristics of an ecosystem. Abiotic factors (e.g., temperature, space, water) have a major influence on the distribution of organisms, e.g., distribution of marine organisms (biotic) is determined by factors like water, salt content, pH and temperature. Biotic factors (e.g., competition, predator-prey relationships, parasitism) are determined by the presence of other living things, e.g., competition will not occur in the absence of one of the living components.

Diversity in Ecosystems *(continued)*

Suggested Assessment Strategies

Presentation

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

Performance

- Students could create and play "Reach for the Top" using BLM 1.3b from Teacher's Resource Guide. (318-5)
- Students could be given index cards and asked to write one ecology term on one side and the definition on the other. Students could then use these in a quiz-quiz-trade cooperative learning activity. (318-5)

Journal

- Students could write definitions of scientific terms covered. (318-5)

Resources

Science 10,
Concepts & Connections

Core STSE 1-1: *"The Diversity of Life"*, Appendix A

ST: pp. 9, 13-14

BLM: 1.3a, 1.3b

Diversity in Ecosystems *(continued)*

Outcomes

Students will be expected to

- explain biotic and abiotic factors that keep natural populations in equilibrium and relate this equilibrium to the resource limits of an ecosystem (318-5) **Cont'd**
  - describe the classification system for at-risk species
  - describe the main causes and effects of extinction

  Causes
  - (i) loss of habitat
  - (ii) pollution of air and water
  - (iii) natural environmental change
  - (iv) climate change
  - (v) competition for food (i.e., space)

  Effects
  - (i) loss of biodiversity
  - (ii) food chain collapse
- compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data (213-5)
- using library and electronic research tools, collect information on a given topic, develop a position or course of action based on the findings, and present, and defend the position (213-6, 215-5)
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (215-6)

Elaborations—Strategies for Learning and Teaching

Teachers could use the "Disappearing Frogs" section (ST p. 8) to lead into the idea that human activities may eventually lead to negative impacts (often unpredictable) on an ecosystem and even to the permanent loss of organisms or of the ecosystem itself. After reading "Disappearing Frogs" teachers could have students work in pairs to complete the seven questions that follow. This section provides an example of human activities that have had a negative impact on a specific species and which may lead to the extinction of many types of frogs. A Newfoundland and Labrador at-risk species, such as the Pine Marten, could be researched and the impact of human activities discussed as well. Use this topic to review some of the key terms students will require as they discuss ecosystems in more detail further on in this unit. Ensure the notion of sustainability is raised again in this context.

Food chains and food webs will be covered in detail later in the unit. It will be necessary, however, to briefly define food chain and indicate its importance in a successful ecosystem.

The skills outcomes 213-5, 213-6, 215-5 and 215-6 are addressed by completing *School Yard Ecosystem* or *A Natural Ecosystem*, CORE ACTIVITY #1.

Students are expected to conduct one of the two investigations: School Yard Ecosystem or A Natural Ecosystem. The lab work for these labs should focus on recording the abiotic factors and how these influence the distribution of living things within the systems being studied. This lab activity can be completed as an introduction to the section as described above. Teachers may choose to do the School Yard Ecosystem activity as the introductory activity to the section and then complete the more detailed field study at a later date.

As an alternative to a field study, students could construct their own ecosystem using jars or pop bottles. The model ecosystem can focus on either a terrestrial or aquatic system. Construction of the ecosystem should include the following considerations: Which organisms should be included and why? What makes the system sustainable?

Diversity in Ecosystems *(continued)*

Suggested Assessment Strategies

Journal

- Much of the assessment conducted in relation to these outcomes can be related to the Core activity – students are expected to conduct one of the two investigations: "School Yard Ecosystem" or "A Natural Ecosystem". This activity serves as an introduction to a complex system and will introduce students to the complexities of a simple ecosystem. There is a significant amount of knowledge to be obtained in relation to these outcomes – the knowledge is important as it will give the students a deeper appreciation of the systems they will be discussing and investigating later in the unit. (318-5)
- Students could write a biography or diary of an organism that exists in the studied ecosystem. (318-6)

Presentation

- Students could present their analysis of the data gathered by the group from the ecosystem Core activity. This could be done either orally or videotaped on-site. Each member of the group would be responsible for a different aspect of the study for presentation (e.g., biotic factors, abiotic factors, human impact, biodiversity). Teachers should ensure students address the sustainability of the ecosystem. Is it sustainable? How do you know? (331-6, 318-5, 318-6)
- Students could research a case study and present findings in the form of a radio or television documentary about a significant environmental issue. (117-3, 118-5, 118-9)
- Students could research one species-at-risk organism and present their findings in the form of a poster, web page, slide show presentation, etc. (117-3, 118-5, 118-9)

Interview

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

Observation

- Teachers could observe student performance of the "Try This" activity - Sampling Populations on page 10 of student textbook. (215-6)

Resources

Science 10,
Concepts & Connections

ST: pp. 8-13

SRL: pp. 7-15

BLM: 1.2

TR: 1-11 to 1-19

ST: *Skills Handbook* - pp. 279-281

Environment Canada Species At Risk Website:
www.speciesatrisk.gc.ca

ST: pp. 18-21

SRL: pp. 21-27

ST: *Skills Handbook* - p. 294

Core Activity #1 (Lab 2.2, p. 77)

Change and Stability in Ecosystems

Outcomes

Students will be expected to

- understand that biodiversity loss due to human activity adversely affects ecosystems (NLS-2)
- analyze social issues related to rates of global extinctions (118-9)
- describe and apply classification systems and nomenclature with respect to trophic levels in ecosystems (214-1, 318-11)
  - define trophic level
  - define producer, consumer, primary consumer, secondary consumer, herbivore, carnivore and omnivore
  - classify organisms as producer, consumer, decomposer, herbivore, carnivore, omnivore
  - distinguish between food chains and food webs

Elaborations—Strategies for Learning and Teaching

A CORE STSE component of this unit incorporates a broad range of Science 2200 outcomes. More specifically it targets (in whole or in part) NLS-2, 215-1, 215-4, 318-5 and 118-9. The STSE component 1-2, *Loss of Biodiversity*, can be found in Appendix A.

Since life cannot exist without energy, an understanding of the flow of energy through a system is important for a clear understanding of the complexity and relationships within a system. In biological systems the energy that maintains the system comes from the sun, which is captured by plants and converted into a chemical form that animals can use to carry out their natural functions (e.g., growth, repair, movement, and reproduction).

As students develop a more complex understanding of food chains and food webs as the mechanism by which energy is transferred from one trophic level to the next, teachers should ensure that the concept of sustainability is reinforced. Draw students' attention to the impacts that major changes at one trophic level can have on the other levels within the system. For example, the removal of a secondary consumer can increase the number of primary consumers which, in turn, could reduce the number of producers. Students should be able to define omnivores as organisms that consume both plants and animals. Throughout this section draw students back to the three themes that run through this unit (Diversity in Ecosystems, Change and Stability in Ecosystems, and Sustainability).

Teachers should ensure that the examples in the student textbook are supplemented with examples of plants and animals from Newfoundland and Labrador. For example: producers - blueberry, birch, moss, lichens, algae, etc.; herbivores - hares (note, they are known as rabbits in Newfoundland and Labrador), moose, caribou, caterpillar; carnivores - fox, mink, seal, owl; omnivores - bear, shrew, crow, trout.

Food chains depict a linear relationship from a single producer to a single primary consumer (herbivore) to a single secondary consumer (carnivore). It is a very simple representation of one set of feeding relationships in an ecosystem. Food webs show all the feeding relationships in an ecosystem. For example, a carnivore such as a fox would eat many different animals, not just one type of species. A food web is a more correct model of what actually takes place in an ecosystem.

Change and Stability in Ecosystems

Suggested Assessment Strategies

Presentation

- Students could draw a diagram showing the energy flow through an ecosystem and present in a poster, web page, slide show, etc. (214-1, 318-11)

Paper and Pencil

- Students could complete BLM 1.7a and 1.7b of Teacher's Resource and pages 28 to 32 of Student Record of Learning. (214-1, 318-11)

Journal

- Students could write definitions of scientific terms. (214-1, 318-11)

Resources

Science 10,
Concepts & Connections

Core STSE 1-2: *"Loss of Biodiversity"*, Appendix A

ST -pp. 8-9, 22-25, 300

SRL: pp. 28-32

BLM: 1.7a, 1.7b

TR: 1-35 to 1-39

Science 1206 text - pp. 38-39

Change and Stability in Ecosystems *(continued)*

Outcomes

Students will be expected to

- describe and apply classification systems and nomenclature with respect to trophic levels in ecosystems (214-1, 318-11) **Cont'd**
  - examine the flow of energy in ecosystems using the concept of the pyramid of energy
  - explain how energy availability affects the total mass of organisms in an ecosystem
  - explain how humans have changed the flow of energy in ecosystems

Elaborations—Strategies for Learning and Teaching

Teachers should link the pyramid of energy concept to the notion that at lower trophic levels there are greater numbers and mass of organisms than at higher trophic levels (e.g., based on their dry mass, 9 grams of hawk requires 45 grams of duck to meet its energy needs. 45 grams of duck requires 976 grams of algae). This mass relationship can often be translated into a numerical relationship (e.g., 1 hawk requires 3 ducks which would eat 1000's of algae plants). Not all the energy from one trophic level will be transferred transferred to the next level. Parts of the organism may be indigestible to the animal that eats it; some energy will be lost as heat.

Teachers could have students carry out the "It's Just a Reflection" actvitity (BLM 1-10) to help them get an understanding that not all the energy that strikes Earth is available to us. Much more is reflected away than is absorbed.

If students have not already completed the "Sampling Populations" activity on page 10 of the student textbook, they should do so now. Teachers should help students recognize that the numbers of each "organism" that may be "captured" in the sampling procedure is linked to the pyramid of energy. There are more organisms at the lower trophic levels and less organisms at the higher trophic levels. There is also more energy at the lower trophic levels and less energy available at the higher trophic levels.

Teachers could have students complete the Extension Activity on page 31 of the Student Record of Learning.

Students should understand that the impacts humans have had on energy flows were minimal at first. However, as the population of humans increased so did their need for more energy (food). This increased the need for land and decreased natural plants needed by other animals. Decreasing the producers (lower trophic levels) required by consumers (higher trophic levels) often results in a displacement or complete extinction of the consumers. Teachers may wish to elaborate on the rapid growth of the human population that occurred after the industrial revolution. Much of this growth is due to decreased death rates caused by better nugtrition, more stable food supply (e.g., farming) and better health care. This will be covered more extensively when the topic of "population" is addressed later in this unit.

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Presentation

- Students could research a plant or animal from Newfoundland and Labrador and present in a poster, web page or slide show. (214-1, 318-11)

Interview

- Teacher could interview students formally or informally about their presentation. (214-1, 318-11)

Observation

- Students could invite a guest speaker from the provincial or federal government or from local post secondary institutions, the speaker should present on local examples of energy pyramid and now we have influenced it. (214-1, 318-11)

Resources

Science 10,
Concepts & Connections
ST: pp. 24-25

Native Trees and Shrubs of Newfoundland and Labrador (Ryan, 1995)

Change and Stability in Ecosystems *(continued)*

Outcomes

Students will be expected to

- describe and apply classification systems and nomenclature with respect to trophic levels in ecosystems (214-1, 318-11) **Cont'd**
  - define competition and explain how competition arises among organisms
  - describe the feeding relationships within an ecosystem in terms of competition, food chains and food webs
  - explain how predators such as wolves play an important role in maintaining diversity in ecosystems
  - describe the impacts that removing a predator such as wolves can have on an ecosystem

Elaborations—Strategies for Learning and Teaching

Competition can occur between members of the same species as they compete for food, space and reproductive partners. Moose, for example, compete for food, space and mates. This type of competition usually results in a "survival of the fittest" scenario. Only those who can out-compete their rivals will live to reproduce and pass their "good" characteristics onto the next generation. Competition between different organisms can occur when different species need the same resource to survive. For example, plants need sunlight; the plant that is able to get the most sunlight (by growing taller) will more likely be able to reproduce at a faster pace than shorter plants.

Competition for resources occurs naturally whenever two or more organisms come together in close proximity. This is especially true if resources are limited. Competition is considered a "good thing" for the environment since it limits or removes weaker organisms and thus fosters a healthier population.

Students should be able to describe feeding relationships with respect to who eats who and which organisms will need the same resources (i.e., be in competition with one another)

"What is the value of wolves?" (page 16-17) of the student textbook will provide students with an example of a predator that was removed from the food web of an ecosystem and the negative impact this had on the ecosystem. It will also describe the attempts to restore the wolf population. For the "Take a Stand" activity on page 17, teachers could refer to the Teacher's Resource (page 1-25) for the step-by-step directions of a cooperative learning activity. This cooperative learning activity will help students achieve outcomes (214-3, 215-1, 215-4).

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Paper and Pencil

- Students could create a word search or crossword puzzle using scientific terms from this topic. These can be created using website programs such as edhelper.com and puzzlemaker.com or they can be made from scratch. (214-1, 318-11)
- Students could create a classroom mural of a typical Newfoundland and Labrador ecosystem using the plants and animals researched earlier. (214-1, 318-11)

Performance

- Students could debate the importance of an organism within our local environment by using BLM 1.4a and 1.4b. (214-1, 318-11)

Resources

Science 10,
Concepts & Connections

ST: pp. 14-17

Native Trees and Shrubs of Newfoundland and Labrador (Ryan, 1995)

Change and Stability in Ecosystems *(continued)*

Outcomes

Students will be expected to

- explain how biodiversity of an ecosystem contributes to its sustainability (318-6)
  - demonstrate how the many interrelated food chains give a community stability and identify the conditions required for a stable self sustaining ecosystem

- describe global warming and its impact on our local environment. (215-1)
- describe and predict the nature and effects of changes to terrestrial systems. (331-6)
  - pollution (e.g., excess CO_2)
  - weather change
- analyze the impact of external factors on an ecosystem by describing how humans have altered the carbon cycle and nitrogen cycle in ecosystems. (318-4)

Elaborations—Strategies for Learning and Teaching

In general, if there are more types of organisms present in an ecosystem there will be greater availability of food sources that consumers can use to meet their energy requirements. A very diverse ecosystem will have a lot more food chains than a less diverse ecosystem. For example, in the forest ecosystem depicted in Figure 5, page 23 of the student textbook, the wolf has a variety of organisms upon which it can feed. Because it does not depend on only one organism for its energy supply, it is unlikely that the wolf would suffer greatly if one food source were to disappear. Students could consider a hypothetical ecosystem in which there was only deer for the wolf to feed upon. If the deer died off for some reason, the wolf would also die off and this ecosystem would be changed markedly. Thus, the more diverse the ecosystem the greater the likelihood it will be able to sustain itself in the face of population changes. Teachers should use examples of local habitats and organisms when discussing this topic. Examples might include the fox (which feeds upon numerous smaller animals) and the hawk (which feeds upon many smaller birds and animals).

A CORE STSE component of this unit incorporates a broad range of Science 2200 outcomes. More specifically it targets (in whole or in part) 215-1, 331-6, 318-4, 118-5, 118-9, 212-4 and 213-8. The STSE component 1-3, *Direct Impacts of Biodiversity Loss*, can be found in Appendix A.

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Presentation

- Students could illustrate a food web or nutrient cycle that exists in an ecosystem, in poster or other form. (214-1, 318-1, 318-6)

Journal

- Students could read, summarize, and respond to an article about how the introduction or removal of a species affected an ecosystem. Magazines, newspapers, and archived information may be possible sources. (318-6)

Performance

- Students could take part in a debate between opposing views on how to control the coyote population in Newfoundland. Should they be destroyed or should nature be allowed to control it without human intervention? (318-6)

Resources

Science 10,
Concepts & Connections

ST: p. 23

Science 1206 text - p. 28, Fig.1 &2

Core STSE 1-3: *"Direct Impacts of Biodiversity Loss",* Appendix A

Change and Stability in Ecosystems *(continued)*

Outcomes

Students will be expected to

- compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data (213-5)
  - define succession
  - describe the factors that contribute to succession
  - describe what is meant by the term "climax community"

Elaborations—Strategies for Learning and Teaching

If possible do the "Sampling Populations" activity on page 10 of the student textbook. Teachers could modify this (as described in the Teacher's Resource) instead of choosing three areas in the schoolyard, obtain several large paper sacks. Put the appropriate number of toothpicks in each sack (see Teacher's Resource). Have students shake the toothpicks and then reach in carefully and remove as many toothpicks as they can in one handful. This number is to be recorded as the number of each species found in a three-minute period. Have students replace the toothpicks and repeat the "sampling" procedure twice more.

Teachers should ensure that students understand that ecosystems are constantly changing even though we may not be able to see it over a short period of time (looking at photographs of an ecosystem taken over a 10, 20, or 30 year period will show the change). Students could be asked to recall an area that they played in as a child (e.g., a grassy field). Some will note that the area is now "all grown in". Or perhaps they have noticed an abandoned farm property or field. If it has been abandoned for 10 years or more, they will notice trees growing where crops used to be planted or where hay was once cut. These are examples of succession; a series of changes that have taken place in an ecosystem over time. In most cases the series of changes is predicable.

Succession will occur whenever there are favorable circumstances. Over a long period of time (1000's of years) an area can change from bare rock to a forest (if the abiotic and biotic factors are favorable). This change would take place in a series of steps: small hardy plants such as lichens would gradually break down the surface of the rock. As they grow and die they add organic material to the soil that is forming. As a thin soil forms, other plants will begin to grow there further adding to the soil as they grow and die. Small animals such as worms and insects will move into the area as more and more plants grow there providing food and shelter for the animals. Over time, as the soil becomes richer and deeper, more and larger plants will grow there (e.g., shrubs). If the abiotic conditions are favorable, trees will grow and a forest will now be growing where once bare rock was found.

The final stage in succession is called the "climax community". The climax community has a great diversity of organisms and very complex food chains/webs. Succession can also occur when an ecosystem undergoes a drastic change such as when a forest burns down or a farm is abandoned. In both cases since there is already a soil present, the early stages of only hardy plants are bypassed. In both cases, given enough time, the climax community will reform if the factors are favorable. (More detail on succession can be found in the ecology section of most biology books. In particular, students may be interested to learn about how a forest ecosystem can replace a lake ecosystem, given enough time).

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Paper and Pencil

- Students could draw their own interpretation of succession on a poster, web page, or computer program. (213-5)
- Teachers could give a quiz testing all scientific terms covered in sustainbility. (213-5, 318-6)

Presentation

- Students could research the topic of ecological succession and present in a poster, web page, or slide show. (213-5)

Performance

- Students could create a song, poem, or role play activity representing the different stages of ecological succession. (213-5)

Resources

Science 10,
Concepts & Connections
MHR - Biology text: pp. 209-210

Heath Biology: pp. 807-808

Nelson Biology: pp. 409-413

Biology: The Study of Life: pp. 835-839

ST: p. 10

Change and Stability in Ecosystems *(continued)*

Outcomes

Students will be expected to

- illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking carbon, nitrogen and oxygen (318-1)
  - describe the general process by which matter is cycled through an ecosystem
  - differentiate between organic and inorganic materials
  - explain how photosynthesis and cellular respiration are linked
  - explain the carbon cycle by describing the processes required to cycle from carbon storage to the atmosphere

Elaborations—Strategies for Learning and Teaching

This unit opened with the analogy of Earth as being similar to a spaceship. Teachers could revisit this analogy here, pointing out the differences. For the most part, spaceships bring all the materials of life (food, water, oxygen, etc) for their trip. While some materials can be recycled or manufactured, the length of the trip is limited to the amount of supplies contained on board the ship. Before these materials have been used up the crew must return to Earth or they will die. This spaceship analogy is an example of a closed system, much like Earth. With the exception of solar energy, all the materials/nutrients we need for sustaining life are present in finite amounts. These materials are used to form living things and become bound up in living things. When these living things die, the nutrients are recycled and are available to be used again.

All nutrients are cycled through systems, changing from one form to another and never leave Earth. In general, materials cycle from the atmosphere into the ecosystem and then back into the atmosphere. Living things produce waste and eventually die. Dead organisms and wastes are broken down into smaller parts by decomposers. These smaller parts become nutrients for other organisms such as plants which may be eaten by consumers. Thus, the cycle continues.

Carbon is central to life. All living things contain carbon. Carbon, in the form of carbon dioxide, is also the link that allows plants to transform solar energy (sunlight) into chemical energy. During photosynthesis plants take carbon dioxide and water, in the presence of sunlight, and transform them into sugar. Oxygen is also produced as a by-product. The sugar forms the basic substance that is transferred along food chains (or through the pyramid of energy). As organisms grow they transform the carbon from the sugar (along with other elements) into the living matter of their bodies. As animals digest the foods they eat, the sugars get transported to their cells. In the cells the sugars are used for energy (cellular respiration). A by-product of the breakdown of these sugars is carbon dioxide. This carbon dioxide is expelled from the body when people exhale. Since the amount of carbon dioxide in the atmosphere is very small (about 0.03%) it is essential to the continuance of life on Earth that the carbon contained in the bodies of living things be returned to the atmosphere when they die. Without the carbon cycle the world would quickly run out of carbon dioxide, plants could not trap solar energy, and life on Earth would cease. Figure 3 on page 27 of the student textbook also shows that not only does carbon get tied up in living organisms, but it also is tied up in fossil fuels (released when they are burned) and in some other chemicals.

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Presentation

- Students could add the carbon-oxygen cycle to the classroom mural created earlier or create a new mural. (318-1)

Paper and Pencil

- Students could complete work on pages 33 to 39 of Student Record of Learning. (318-1)
- Students could draw a comic strip to represent the carbon-oxygen cycle, making carbon and oxygen super heroes. OR: Students could use existing cartoon characters to represent the carbon-oxygen cycle. (318-1)

Performance

- Students could create a song, poem, or role play activity representing the carbon-oxygen cycle. (318-1)

Resources

Science 10,
Concepts & Connections
ST: pp. 26-29

SRL: pp. 33-39

BLM: 1.8

TR: 1-40 to 1-44

Change and Stability in Ecosystems *(continued)*

Outcomes

Students will be expected to

- illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking carbon, nitrogen and oxygen (318-1) **Cont'd**
  - briefly describe the nitrogen cycle in terms of nitrogen fixation and denitrification
  - explain why the nitrogen cycle is important to life on Earth
  - recognize that population growth is directly controlled by resources found within an ecosystem
  - describe the significance of global warming

Elaborations—Strategies for Learning and Teaching

The nitrogen cycle is also important in the maintenance of life on Earth. Nitrogen is found in amino acids, proteins and genetic material. Most of the living tissue in animals is protein (protein contains oxygen, carbon, and nitrogen atoms). The chemical processes that occur within the bodies of living things (e.g., digestion, growth, reproduction, etc) are all controlled by special proteins called enzymes. Nitrogen is also a nutrient that plants require. Nitrogen makes up 79% of the atmosphere. However plants can not use it in this gaseous form. The nitrogen cycle is the process by which nitrogen (nitrogen gas from the air, nitrogen in the proteins of dead organisms, nitrogen in the ammonia of urine) is made available to plants in a form they can use (nitrates).

Remind students that the factors which control populations being discussed in this section are mainly natural factors. Human activities also impact populations (e.g., students could be reminded of the wolf population in Yellowstone Park). Teachers could have students brainstorm examples of ways in which human activity has had positive and negative impacts on populations of other species (both plant and animal).

The burning of fossil fuels (coal, oil, gas) produces large quantities of carbon dioxide. At the same time, large amounts of forested land is cleared to provide more grazing and farmland. The reduction in trees (and often the burning of these trees to speed up the clearing of land) reduces the number of plants that are available to use up the carbon dioxide being produced by the burning of fossil fuels. This leads to an increase in the amount of carbon dioxide in the atmosphere. Excess CO_2 helps trap sunlight causing Earth to heat up. This is resulting in a phenomonon called global warming. (Note: CO_2 is not the only gas involved in the global warming process methane (CH_4) has a greater effect. Much of the methane that gets into the atmosphere is produced as a by-product of animal digestion of vegetation in particular from the raising of cattle for beef. The impacts of global warming will be discussed in the “Extreme Weather Events” Section of Unit 2.

As the temperature of Earth increases, plants and animals that are adapted to specific climates and temperatures may not survive. In other cases, some plants and animals may thrive in the warmer temperatures. (e.g., insect populations are controlled by cold temperatures.) Each fall and winter in Canada, insect populations die off due to the cold temperatures. This helps hold their populations in check. If temperatures stay warmer for longer periods (i.e. if fall and winter are shortened) insect populations may increase drastically and the damage they do to plants that humans depend on will also increase.

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Presentation

- Students could add the nitrogen cycle to the classroom mural created earlier or create a new mural. (318-1)

Paper and Pencil

- Students could complete work on pages 40 to 44 of Student Record of Learning. (318-1)
- Students could draw a comic strip to represent the nitrogen cycle, making nitrogen a super hero. OR: Students could use existing cartoon characters to represent the nitrogen cycle. (318-1)

Performance

- Students could create a song, poem, or role play activity representing the nitrogen cycle. (318-1)

Resources

Science 10,
Concepts & Connections

ST: pp. 30-32

SRL: pp. 40-44

BLM: 1.9

TR: 1-45 to 1-46

Change and Stability in Ecosystems *(continued)*

Outcomes

Students will be expected to

- illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking carbon, nitrogen and oxygen (318-1) **Cont'd**
  - describe the significance of algal blooms

Elaborations—Strategies for Learning and Teaching

Teachers may wish to have their students explore the "invasion" of insect species from warmer areas of the U.S. (average temparatures in Canada have increased) and the impacts these have had, or are having, on our ecosystems and economy.

Algae blooms naturally occur in lakes and ponds when conditions are just right. These conditions include lots of nutrients for the algae and warm temperatures. When this occurs, the algae population increases drastically. They outpace their food supply, begin to die off and decompose. This process uses oxygen from the water, and as a result, fish in the water may die. Increased fertilizer use has increased the occurance as well as the impact of algae blooms because excess fertilizers run off into lakes and ponds. Lakes and ponds that are accidentally fertilized by runoff often have fewer types of fish present (in severe cases the fish have died off completely).

- examine the change of matter in ecosystems using the concept of the cycling of matter (318-1)
- analyze the flow of energy in ecosystems using the concept of the pyramid of energy. (306-1)
- classify organisms as producer, consumer, decomposer, herbivore, carnivore, and omnivore. (214-1)
- explain how humans have changed the flow of energy in ecosystems.(118-2)
- explain that Earth is a closed system with regard to matter and an open system with regard to energy. (NLS-3)

A CORE STSE component of this unit incorporates a broad range of Science 2200 outcomes. More specifically it targets (in whole or in part) 318-1, 306-1, 214-1, 118-2, NLS-3, 213-8, 212-4 and 118-5. The STSE component 1-4, *Ecosystem Change*, can be found in Appendix A.

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Presentation

- Students could research the topic of algae blooms and use pictures and diagrams to create a collage with these pictures. (318-1)

Resources

Science 10,
Concepts & Connections

TR, BLM: pp. 1-17

ST: 16-17, 32-37, 52-53

Core STSE 1-4: *"Ecosystem Change"*, Appendix A

Change and Stability in Ecosystems *(continued)*

Outcomes *Students will be expected to*	Elaborations—Strategies for Learning and Teaching
• plan changes to predict the effects of, and analyze the impact of external factors on an ecosystem (331-6, 213-8, 212-4, 118-5, 118-9) - describe how humans have altered the carbon cycle and nitrogen cycle in ecosystems	Students could complete the Extension Activities (see page 33 and page 40 of the Student Record of Learning) to help them further refine their understanding of the role and importance of these two cycles. Students should complete the Applying Inquiry Skills and Making Connections on page 29 of the student textbook. Teachers could group students and have the groups work on the questions posed in the "Work the Web" activities on pages 29 and 33. (Work the Web resources are found on the Nelson Web site. Look under "Companion Sites", click on Nelson Science 10: C&C, then click on "Student Centre"). Students can then present their conclusions to the class.
- define pH scale	Teachers could remind students that pH is the measure of how acidic (pH<7) or basic (pH>7) a substance is. Substances that have a pH=7 are neutral. It is important for students to understand that small changes in pH value indicate very large changes in level of acidity (i.e., pH scale is logrithmic). For example, a solution with pH = 3 is 10 times more acidic than one that is pH = 4 and 100 times more acidic than one that is pH = 5.
• propose and defend a course of action on organic farming (118-9, 118-5, 215-4)	The widespread use of fertilizers has increased the amount of nitrates available to plants, causing serious problems in aquatic ecosystems. Teachers can ask students to read pages 32-33 of their textbook and answer the questions that follow (either individually or in groups). Ask students what they know about pH. Teachers may wish to make an overhead acetate of BLM 1.10A in the Teacher's Resource to help refresh students' understanding of the pH scale. Ask students to share what they know about fertilizers and their uses. BLM 1.10B could help students learn more about the components of fertilizers and the specific effects of the components. Refer to the Teacher's Resource, page 1-51 for teaching suggestions for the Take a Stand activity on page 33 of the student textbook.
• using library and electronic research tools, collect information on organic farming, develop a position or course of action based on the findings, and present, and defend the position (213-6, 215-5) - describe how practices such as organic farming are attempting to negate human impact on these cycles	Teachers could have students use the Internet to research organic farming practices. Students should answer questions such as: What are the benefits? What are the problems or risks? Why don't more farmers grow crops organically? Students could conduct a survey of their peers and parents to determine if organic farming is important to them. Students could decide if they would pay more for organically grow foods. Why/why not?

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Journal

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

Presentation

- Students could debate the merits of organic farming using Take A Stand - Perspectives on Organic Farming on page 33 of student text. (118-9, 118-5, 215-4)

Resources

Science 10,
Concepts & Connections
ST: pp. 29, 32-33

BLM: 1.10a, 1.10b

TR: 1-49 to 1-53

ST: *Take A Stand* - p. 33

SRL: pp. 45-49

BLM: 1.9

TR: 1-45 to 1-46

Change and Stability in Ecosystems *(continued)*

Outcomes

Students will be expected to

- describe the mechanisms of bioaccumulation caused by pesticide use, and explain its potential impact on the viability and diversity of consumers at all trophic levels. (318-2)
  - define bioaccumulation
  - describe how pesticides such as DDT reach higher concentrations as it is transferred to the higher trophic levels of a food
  - identify what a pesticide is by describing the four categories of pesticides
    (i) insecticide
    (ii) herbicide
    (iii) fungicide
    (iv) bactericide
  - examine the use of pesticides over the course of human history
  - outline the pros and cons of water soluble (modern) pesticides

Elaborations—Strategies for Learning and Teaching

Teachers could refer to the Science 1206 textbook for more complete information on the history of pesticides. Bioaccumulation will also occur with heavy metals such as mercury and lead. Students may be interested in hearing about the effects of mercury or lead poisoning. Teachers could spark interest by describing these effects. Both of these metals will accumulate in fatty tissue. Since our brains contain a lot of fat, much of the accumulation occurs there. The result of mercury or lead poisoning will be seen in the early stages as delayed cognitive functioning. Later, as the concentration of the metal becomes higher, the brain will stop functioning properly. First there is loss of control of muscles, then the victim will lapse into a coma and eventually die. Research Minamata Disease for a real world example of the effects of mercury poisoning.

Use the two mini case studies on pages 36 and 37 of the student textbook, along with questions (g) to (n) and 1 to 4, to help students understand that the decision of whether or not to use pesticides is often not always clear. Jobs may be lost, natural resources may be lost, non-target organisms may be killed, food chains may be destroyed, etc. It is important for students to realize that pesticide use is a complex issue.

While water soluble pesticides are much safer and do not remain in the environment for long periods, these chemicals can still have unintended impacts on the environment. Teachers may wish to access members of the community (e.g., environmental groups, forestry workers, lawn care companies, Department of Forestry, doctors, etc) who have knowledge of the issues or possible effects of spraying programs in the students' local area. For example; teachers could have a lawn care professional speak to the class on the proper use (and dangers) of pesticides and how he or she attempts to minimize the unwanted effects of pesticides.

Students may not realize that the chemicals used on lawns and gardens (other than fertilizers) are pesticides. Many municipalities have banned the use of pesticides for lawn care. Teachers could ask students to react to this action. Do they agree with such bans? Why/why not? What are the pros and cons of such a ban? What would be an environmentally friendly way to combat lawn pests? Students could work in pairs to complete BLM 1.11B in the Teacher's Resource (Take a Stand). After each group has completed their pro and con columns, teachers could ask them to report to the class. After every group has presented their pros and cons, ask the class to collectively develop their stand on a total ban. Ask them do they think this will be acceptable to the various stakeholders (town council, lawn care companies, environmentalists, citizens, etc). They may need to compromise on the issue.

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Presentation

- Students could participate in a simulated public meeting. Teachers should ensure that students have gathered the necessary evidence to support their point of view. This would be reviewed by panels of peers and a report would be written by presenters and by each panel. A rating scale could be used to mark the presentation. A student's mark may be composed of two parts- the presentation and panel report. (331-6, 318-4, 214-3, 213-7, 318-2)
- Students could be assessed on their participation in a debate or group project. Checklists, observation records, self-evaluation, and peer evaluation could assist in the evaluation. (118-9, 118-5, 215-4, 318-2)
- Students could work in groups or alone to produce simple web pages that would describe how the use of pesticides affect an ecosystem. (see strategy on p. 11) (318-2)
- Students could research a case study and present findings in the form of a radio or television documentary about pesticide use in our society. (117-3, 118-5, 118-9, 318-2)

Paper and Pencil

- Teachers could give a "matching" quiz, testing all scientific terms covered in energy flow and cycles. (318-2)

Interview

- Students could record or interview of a local scientist to discuss the importance of pesticide use in society. (318-2)

Resources

Science 10,
Concepts & Connections

ST: pp. 34-37

SRL: pp. 50-54

BLM: 1.11a, 1.11b

TR: 1-54 to 1-57

Science 1206 text - pp. 53-55

ST: *Skills Handbook* - pp. 275-278

Change and Stability in Ecosystems *(continued)*

Outcomes

Students will be expected to

- debate the use of fertilizers and pesticides in modern society and their effect on the environment. (117-5)
- describe the potential impact that overuse of fertilizers can have on ecosystems (331-7)
  - describe the effect of chemical fertilizers and pesticides on the nitrogen cycle
- analyze the impact of external factors on the ecosystem (331-6) Include:
  - pollution (e.g., acid rain)
  - agriculture (e.g., use of fertilizers, pesticides)
  - over-hunting of a species (e.g., removal of wolves from Yellowstone)
  - weather change (e.g., global warming)
  - introduced species

Elaborations—Strategies for Learning and Teaching

A CORE STSE component of this unit incorporates a broad range of Science 2200 outcomes. More specifically it targets (in whole or in part) 117-5, 331-7, 214-1, 318-1 and 318-2. The STSE component 1-5, *Ecosystem Balance*, can be found in Appendix A.

Teachers should supplement the case studies in the student textbook [Acid Rain (p 52-53); Fertilizers (p 32-33); Pesticides (p 34-37), Over-hunting (p 16-17)]. Where possible, teachers could use the "Work the Web" resources for supplemental materials. Students could work in groups to answer the Work the Web questions and present their results/decisions to the class. This outcome should not be treated separately from the section in which it is found. Teachers should integrate this analysis of impact on the ecosystem with the knowledge component of the respective sections. As the students grapple with the questions/issues raised in the various case studies, ensure that they continue to think about the three major themes related to ecosystems: diversity, change and stability, and sustainability.

The impact of climate change is discussed in the **STSE unit.** When students investigate the environmental effects of climate change, teachers could make connections to the weather unit (see student textbook, page 220 for a definition of climate and page 242 for the impact of climate change). The introduction of a new species is not presented in the textbook, however, teachers may wish to discuss this as an extension topic. Teachers could assign students to research this and present their findings. There are several examples of species introduced in Newfoundland and Labrador. These include moose, frogs, shrews, and most recently, coyotes (**see STSE Unit**). Many insects, such as the hemlock looper and spruce budworm were also introduced. Students may find it interesting to investigate the environmental, social and economic impacts of the introduction of a non-native species in their own province. Recall that some introductions of new species are intentional while others occur naturally (and others are accidental).

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Presentation

- Students could research the answers to Work the Web questions on pages 33 and 53 of student text and present with a poster, website, or slide show presentation. (331-7, 331-6)
- Students could produce a report on the impact of these external features on the Newfoundland and Labrador ecosystem. (331-7, 331-6)

Resources

Science 10,
Concepts & Connections

Core STSE 1-5: *"Ecosystem Balance",* Appendix A

ST: pp. 32-37, 52-57, 16-17

Change and Stability in Ecosystems *(continued)*

Outcomes

Students will be expected to

- communicate questions, ideas and intentions, and receive, interpret, understand, support and respond to the ideas of others in preparing a report or presentation on the impact of external factors on ecosystem biomes (214-3, 215-1, 215-4)
- explain biotic and abiotic factors that keep natural populations in equilibrium (318-5)
  - define population
  - differentiate between open and closed populations
  - identify and describe the four factors that affect population size
    - (i) birth rate (natality)
    - (ii) death rate (mortality)
    - (iii) immigration
    - (iv) emigration
  - use population histograms to compare and contrast young, stable, and declining populations

Elaborations—Strategies for Learning and Teaching

This outcome is partially addressed as students work in groups to research topics, work on case studies, prepare to "Take a Stand", answer the "Work the Web" questions, etc. This outcome is to be integrated into the appropriate knowledge components of this unit. This outome can be achieved through group research projects with presentations to the rest of the class.

The term "population" has been used in previous sections of the text. This is an opportunity to ensure students understand the term from an ecological perspective. For the majority of students the only population they will be familiar with is the human population. Teachers could start this topic by asking them what are the characteristics of a "population"? Students might suggest it contains members of a specific species and it is found in a particular area. Use this to help them come up with a definition of population as "all the members of a particular species that are living in the same ecosystem or habitat".

Teachers could ask students to describe the pattern of the graph in figure 1, page 38 in the student textbook. For the most part it is a smooth curve that starts very slowly and then increases rapidly from around 1900. Ask them to speculate on the reasons for the slow increases from 10,000 BC to 1900 (lack of medicine, hygiene and knowledge of bacteria prior to the industrial revolution). What are some possible reasons for the sharp dip in population levels around 1500? (diseases such as "The Plague") Can the population growth shown in this graph be maintained? What factors may act to limit the growth of human populations? Students might find that they cannot agree on the answer to this question. Logically, if Earth has limited space upon which humans can live and grow food, then there must be a limit to how large our population can grow. At present, as a species, we are fast out-pacing our available resources in many areas of the planet (e.g., China, India, and Africa). This has led to starvation and civil unrest. Humans are the only species that have the capability of managing our population growth (i.e., we can decide to have fewer children). We are also the only species that can increase food production to support populations that would starve otherwise. Teachers could raise these ideas to spark discussion and debate when discussing the four factors that regulate biotic potential of a species (which comes later in this unit).

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Paper and Pencil

- Students could complete pages 16-17, and 55-58 of the Student Record of Learning. (318-5)
- Students could research the Internet for human population statistics (Teacher's Resource, page 1-59) on Canada's provinces and territories. They could use this information to compare population growth throughout the country. (318-5)

Journal

- Students could write definitions of scientific terms. (318-5)

Resources

Science 10,
Concepts & Connections

ST: pp. 38-39

SRL: pp. 16-17, 57-58, 55-56

TR: 1-58 to 1-60

Change and Stability in Ecosystems *(continued)*

Outcomes

Students will be expected to

- explain biotic and abiotic factors that keep natural populations in equilibrium (318-5) **Cont'd**
  - graph and analyze population data to draw appropiate conclusions
  - define biotic potential, limiting factors, carrying capacity
  - recognize the biotic and abiotic factors that can cause a population to increase or decrease
  - describe the four factors which regulate the biotic potential of a species
    - (i) birth potential
    - (ii) survival capacity
    - (iii) procreation
    - (iv) length of reproductive life
  - explain the difference between density-dependent factors and density-independent factors

Elaborations—Strategies for Learning and Teaching

Teachers should ask students to complete the “Populations” on page 55 of the Student Record of Learning. This activity provides students with an opportunity to graph population data and to draw conclusions based upon this data. Teachers could assign students to collect their own population data for a specific location.

Teachers could use BLM 1.12A in the Teacher’s Resource to demonstrate what happens to a closed population of a species with a high biotic potential when there is plenty of food available initially and what happens when the food supply runs out (boom and bust).

Teachers could use BLM 1.12B in the Teacher’s Resource to review the factors that regulate biotic potential. BLM 1.12C provides an activity which will help students understand exponential population growth. To further help students understand exponential growth teachers could ask students if they would like to receive a $10 per week allowance for one year, or, start with $1 in the first month, double that to $2 in the second month, double that to $4 in the third month, and so on for 12 months (1 year). After students have decided, use a calculator to determine the final amounts for each option: linear growth = $520.00, Exponential growth = $8191.00.

BLM 1.12D in the Teacher’s Resource provides a case study which shows how humans use population data to help maintain a sustainable moose population while allowing hunting to occur. Teachers could use this BLM to help students relate how these factors are applied to real life.

Change and Stability in Ecosystems *(continued)*

Suggested Assessment Strategies

Presentation

- Students could research data on moose licence quotas in Newfoundland and Labrador by contacting the Wildlife Division of the Government of Newfoundland and Labrador. They could present their information in graphical form. Teachers could use BLM 1.12A to 1.12D as a resource. (318-5)

Paper and Pencil

- Teachers could give a quiz testing all scientific terms and graphing skills on populations. (318-5)

Interview

- Students could interview a wildlife biologist from the Department of Environment and Conservation to discuss the how the population of certain animal species in Newfoundland and Labrador affect the ecosystem of the province. (318-5)

Resources

Science 10,
Concepts & Connections

ST: pp. 62-63 (#21 and #23)

Science 1206 text - p. 80 (#4)

ST: *Skills Handbook* - pp. 270, 290-292

ST: p. 40

BLM: 1.12a, 1.12b, 1.12c, 1.12d

Sustaining Ecosystems

Outcomes

Students will be expected to

- explain why ecosystems with similar characteristic can exist in different geographical locations (318-3)
  - define biome
  - describe the four Canadian biomes in terms of the abiotic factors that contribute to their formation/maintenance
  - describe the four Canadian biomes in terms of their representative/dominant plant and animal species
  - discuss how abiotic factors such as light, temperature, and water affect the distribution of organisms on Earth
  - define biogeography
  - discuss the reasons why ecosystems that share similar abiotic features also share similar animal life. Include:
    - (i) amount of precipitation
    - (ii) temperature and climate
    - (iii) soil characteristics
    - (iv) level of sunlight

Elaborations—Strategies for Learning and Teaching

This section provides a cursory examination of the major flora and fauna of the four main biomes found in Canada. Students will compare the abiotic factors and communities within these biomes. The tundra has very little biodiversity and is very vulnerable to environmental damage because the low temperatures make it slow to recover. The boreal forest (taiga) forms the largest terrestrial biome on Earth. It is very vulnerable to diseases and pests that attach to the limited species of trees found there. In the province of Newfoundland and Labrador, the tundra biome is found in northern Labrador. The remainder of Labrador and the entire island portion of the province is boreal forest. The temperate deciduous forest has the greatest biodiversity. Human intervention (farming) has caused extensive change to the grassland biome. Under natural conditions, the grassland should gradually be replaced by forest (succession). Farming and grazing by farm animals prevent this from happening. Teachers could use BLM 1.13A in the Teacher's Resource to review the main features of the four Canadian biomes.

While it is intended that Science 2200 limit the study of biomes to four large biomes of Canada, students may find it interesting to learn there are two other major terrestrial biomes: deserts and rainforest (tropical and temperate). There is a small region of desert in south-central British Columbia. A temperate rainforest biome is also found in the coastal regions of British Columbia. Some textbooks also list the following as biomes: Polar ice cap, tundra, taiga (boreal forest), temperate grassland, temperate deciduous forest, temperate rainforest, desert, tropical rainforest, tropical deciduous forest, tropical scrub forest, tropical grassland, and mountain. In addition there are three aquatic biomes: the marine biomes, freshwater biomes, and estuaries (form where salt water and fresh water meet) such as at the mouth of a river. A good extension activity would be for students (individually or in groups) to investigate one of these biomes and be required to prepare a report on the specific abiotic and biotic factors that contributed to the formation of the biome.

Sustaining Ecosystems

Suggested Assessment Strategies

Journal

- Students could record their experience with, and reaction to, the public meeting process. (214-3, 318-3)
- Teachers could ask students to think about the ecosystem they are going to study. What things do they value about it? What would they hate to see disappear or destroyed? (318-3)
- Students could create a crossword puzzle or word search using scientific terms. (318-3)

Paper and Pencil

- Students could complete pages 59 to 62 of Student Record of Learning. (318-3)
- Students could complete the group activity on BLM 13.A of Teacher's Resource. (318-3)
- Students could design their own quiz on the scientific terms and then let other students take them. (318-3)

Presentation

- Students could research a biome of Canada and present with a poster, website, or slide show presentation. (318-3)

Resources

Science 10,
Concepts & Connections

ST: pp. 42-44

SRL: pp. 59-62

BLM: 1.13a

TR: 1-61 to 1-64

ST: p. 15

Sustaining Ecosystems *(continued)*

Outcomes

Students will be expected to

- select and display evidence and information, from a variety of sources, to explain how external factors such as global warming or other human activities may have an impact on the distribution of biomes within Canada (213-7, 214-3, 215-4)
- describe how soil composition and fertility can be altered and how these changes could affect an ecosystem. (331-7)
  - describe the layered makeup of soils
  - identify the major features of each soil layer
  - describe weathering
  - explain how the percolation of groundwater can have serious impacts on plants
  - explain how soil pH determines the type of plants that can grow in a given area
  - explain how the natural pH of a soil can be altered

Elaborations—Strategies for Learning and Teaching

After climate, soil is the most important abiotic factor that determines what biome will develop in a particular location. Students have already learned about soil formation in their junior high program. This section provides a review of what they have learned and looks at the role of soil in the formation of a sustainable ecosystem. Teachers may want to obtain some photographs of various soil profiles (including local) to show the layers.

Teachers could use BLM 1-15B as an introduction to this topic. Students will have studied soils in previous grades, therefore, there is an opportunity to build on this knowledge. Students could be placed in teams to attempt to answer as many of the questions on the BLM 1.15 as they can. Their results could be written on the board for class discussion.

Sustaining Ecosystems *(continued)*

Suggested Assessment Strategies

Observation

- Teachers could assess student lab skills during the core activity by using page 71 of the Student Record of Learning. (213-7, 214-3, 215-4)

Paper and Pencil

- Students could complete pages 64 to 74 of Student Record of Learning and BLM 1.15b of the Teacher's Resource. (331-7)

Journal

- Students could draw or sketch a clearly labelled diagram showing all soil layers. (331-7)

Resources

Science 10,
Concepts & Connections

SRL: pp. 60-61

ST: pp. 46-47

SRL: pp. 67-74

BLM: 1.15a, 1.15b

TR: 1-71 to 1-74

Sustaining Ecosystems *(continued)*

Outcomes

Students will be expected to

- compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data (213-5)
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (215-6)
- evaluate individual and group processes used in planning, problem solving and decision making, and completing a task (215-7)

Elaborations—Strategies for Learning and Teaching

The skills outcomes 213-5, 215-6 and **215** are addressed by completing *Selecting Soil for a Sports Field*, CORE ACTIVITY #2.

In addition to providing students with opportunity for hands-on manipulation of various apparatus and further experience with conducting scientific experiments, this investigation also shows them quite clearly that soils have different properties and are not equal in their ability to support plant life. Teachers could set this activity to model a real-life activity: ask the students to take on the role of employees of a company that has been hired to research four possible locations for a sports field. Working in groups, they conduct the tests and analysis of the four soil samples provided. After they have completed their tests (e.g., classifying soil particles, air content, and humus content), they would then submit a report recommending one of the three locations. When preparing soil samples, ensure that at least one sample has fine clay particles and another has good humus content. Teachers could have students complete the "Extension Activity" on page 71 of the Student Record of Learning. Rather than use the data provided, ask students to set up the appropriate apparatus and record the percolation rates for their soil samples.

Sustaining Ecosystems *(continued)*

Suggested Assessment Strategies

Observation

- Teacher could assess student lab skills during the core activity by using page 71 of the Student Record of Learning. (213-7, 214-3, 215-4)

Paper and Pencil

- Students could complete pages 64 to 74 of Student Record of Learning and BLM 1.15b of the Teacher's Resource. (213-7, 214-3, 215-4)

Journal

- Students could draw or sketch a clearly labelled diagram showing all soil layers. (213-7, 214-3, 215-4)

Resources

Science 10,
Concepts & Connections
ST: pp. 48-49

SRL: pp. 67-74

TR: 1-71 to 1-74

Sustaining Ecosystems *(continued)*

Outcomes

Students will be expected to

- explain why the ecosystem may respond differently to short-term stress and long-term change (318-4)
  - describe the potential impact that a large scale clear-cut logging project could have on various native species. Include:
    - (i) temperature increase
    - (ii) water loss
    - (iii) food web disruption
    - (iv) habitat loss
    - (v) nesting site loss

Elaborations—Strategies for Learning and Teaching

This section will present an opportunity to study how human activities affect the forest biomes in Canada. Students should be able to evaluate the relative impacts of clear cutting and selective cutting. Logging of vast areas of land (especially clear cutting) is always a controversial topic. Teachers could supplement this section with reports from the local and national media. The student textbook briefly mentions negative environmental effects. However, these issues are often complex. Proponents of clear cutting say that it most closely resembles the natural replacement of a forest after a fire in that it allows the forest to regenerate itself with new, healthy trees. Students may think that if the logging company replants trees (silviculture) this is good for the ecosystem.

However, logging companies usually only replant trees that are valuable to them (e.g., spruce and fir). This produces a forest with less biodiversity than a natural forest. Such a forest is very susceptible to insect and pest damage (in fact, similar to a crop of corn or wheat). Teachers could ask members of the local community to present on this topic. Provincial Department of Forest and Lands employees could provide local information and rationale on logging methods in the province. Environmentalists from the Protected Areas Association can provide alternate arguments. Again, the issue of sustainability should be stressed. Students can work in groups to explore the logging controversy in Canada through the Work the Web resources. Teachers could have students work in pairs to answer the questions that follow the Extension Activity on page 75 of the Student Record of Learning and then share their conclusions with the class.

Sustaining Ecosystems *(continued)*

Suggested Assessment Strategies

Journal

- Students could record their perceptions and observations of a case study in resource management. (118-1, 116-1, 318-4)

Interview

- Students could interview representatives from logging companies, the Department of Natural Resources in the provincial government, or the Canadian Forest Service of the Department of Natural Resources in the federal government to determine the relative impact of selective cutting vs clear cutting practices. (318-4)

Performance

- Students could debate the pros and cons of clear-cutting. (318-4)
- Students could debate the pros and cons of logging from the perspective of the logging companies, First Nations people, and environmental activists. Refer to pages 77 to 79 of the Student Record of Learning. (318-4)

Resources

Science 10,
Concepts & Connections
ST: pp. 50-51

SRL: pp. 75-79

TR: 1-75 to 1-79

Forestry Module pp. 46-49

Sustaining Ecosystems *(continued)*

Outcomes

Students will be expected to

- understand that sustainable development is a shift in the way people view resource development (114-1)
- compare the risks and benefits to the environment of applying new logging technology like clear-cutting (118-1)
- describe the potential impact that that a large clear-cut logging operation could have on native animal species (318-4)
- propose and defend a course of action on a river watershed with respect to resource harvesting or conservation (118-9, 118-5, 215-4)
- communicate questions, ideas and intentions, and receive, interpret, understand, support and respond to the ideas of others in preparing a report about ecosystem change (215-1)

Elaborations—Strategies for Learning and Teaching

A CORE STSE component of this unit incorporates a broad range of Science 2200 outcomes. More specifically it targets (in whole or in part) 114-1, 118-1, 318-4, 118-9, 118-5, 215-4 and 215-1. The STSE component 1-6, *Sustainable Development*, can be found in Appendix A.

Sustaining Ecosystems *(continued)*

Suggested Assessment Strategies

Resources

Science 10,
Concepts & Connections
Core STSE 1-6: *"Sustainable Development"*, Appendix A

Sustaining Ecosystems *(continued)*

Outcomes

Students will be expected to

- compare the risks and benefits to the biosphere of applying new scientific knowledge and technology to industrial processes (118-1)
  - using the technologies that produce acid rain, explain how these technologies are often seen as a "double-edged sword"
  - define acid precipitation
  - list the gases that dissolve in water to create acid precipitation. Include:
    - (i) nitrogen oxides
    - (ii) sulfur oxides
  - describe the effects of acid precipitation on. Include:
    - (i) man-made materials
    - (ii) humans
    - (iii) ecosystems
  - describe how the increasing number of automobiles contributes to the effect of acid precipitation

Elaborations—Strategies for Learning and Teaching

The case study "The Greening of Sudbury" (p. 56 of the student textbook) provides students with an example of an ecosystem that underwent negative ecological changes due to the impact of human activities. This case study also shows that it is often possible to return the environment to a more natural state. This outcome is best addressed as students work in groups to research topics as they work on this case study. This outcome provides an excellent opportunity for student group work.

This outcome should be integrated into the study and discussion on other topics in the student text. These topics include pesticide and fertilizer use, logging of forests, acid precipitation, and the greening of Sudbury case study. Use BLM 1.18B in the Teacher's Resource to ask students to investigate some attempts to reduce acid emissions.

Students should conduct a research project that results in the production of a report or presentation. In addition to global warming, other topics include: clear-cut logging, factory farming, over-fishing, and acid precipitation.

Sustaining Ecosystems *(continued)*

Suggested Assessment Strategies

Performance

- Students could research the effects of acid precipitation in Sudbury and debate how the development of similar factories in Newfoundland and Labrador would benefit or harm the province. (118-1)

Paper and Pencil

- Students should complete BLM 1.18b of Teacher's Resource and page 89 of Student Record of Learning. (118-1)
- Students could write a quiz on the scientific terms in soil, logging, and acid precipitation. (118-1)

Resources

Science 10,
Concepts & Connections
ST: pp. 52-53, 56-57

SRL: pp. 87-89

BLM: 1.18a, 1.18b, 1.18c

TR: 1-80 to 1-82

Sustaining Ecosystems *(continued)*

Outcomes

Students will be expected to

- demonstrate a knowledge of WHMIS standards by selecting and applying proper techniques for the safe handling and disposing of lab materials and equipment (213-8, 213-9)
  - use Material Safety Data Sheets (MSDS) to identify the precautions, safe handling, disposal, and first aid of chemicals being used
  - compare and contrast the various Workplace Hazardous Materials Information System (WHMIS) symbols with the various Consumer Product Safety symbols.
  - use WHMIS symbols and CPS symbols to make appropriate safety decisions regarding the appropriate precautions and safe handling of chemicals/substances being used
  - use appropriate techniques when heating substances (e.g., in test tube, on hot plate, etc)
  - use appropriate protective equipment when conducting investigations. Include:
    (i) safety eyeware
    (ii) lab coats
    (iii) gloves

Elaborations—Strategies for Learning and Teaching

This outcome is to be addressed as students prepare to conduct laboratory investigations. Teachers should provide students with an introduction to the necessary safety information contained in an MSDS (material safety data sheet). Given that some of the chemicals used in laboratory investigations are consumer products, ensure that students are knowledgeable of both WHMIS symbols and Consumer Product Symbols (Refer to pages 252-253 of the student textbook). Teachers should spend time ensuring students are familiar with WHMIS requirements and MSDS. Students should be able to gain information from a MSDS necessary to protect themselves from accidents, or learn what to do in case an accident occurs. Students should be able to identify and understand the meaning of WHMIS and CP symbols. Students should know all emergency laboratory procedures and be able to identify potential hazards. Teachers should indicate the location of safety equipment in the laboratory (e.g., eye wash, safety blanket, fire exit, etc.)

Students will require additional practice in the safe handling of chemicals. They will also require practice in appropriate laboratory techniques (e.g., heating with a Bunsen burner, heating liquids in a test tube, etc). (Refer to pages 254 – 256 in the student text). Students should be aware of and use appropiate laboratory terminology (e.g., names of various equipment and glassware). Teachers should review all safety procedures, expectations, and possible dangerous situations prior to performing any laboratory activity. Teachers should ensure students are knowledgable about how to protect themselves and others from accidents. Students should practise the techniques outlined on pages 253-254 of the student textbook. Students should be able to read thermometers and balances. They should practise doing mass measurements using a balance (the appropiate techniques would depend on type of balance and accuracy required). Techniques should include weighing by difference (weighing container and substance, re-weighing the emptied container, then using subtraction to determine the mass of substance delivered). Students should be able to explain the advantages of the weighing by difference technique.

Sustaining Ecosystems *(continued)*

Suggested Assessment Strategies

Observation

- Teachers could observe students' safety skills and knowledge of WHMIS standards. (213-8, 213-9)

Paper and Pencil

- Students could create WHMIS badges that represent all symbols. (213-8, 213-9)

Performance

- Students could create and perform a song, poem, or skit that covers some aspect of WHMIS. (213-8, 213-9)

Resources

Science 10,
Concepts & Connections
ST: *Skills Handbook* - pp. 72, 252-256

Sustaining Ecosystems *(continued)*

Outcomes

Students will be expected to

- compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data (213-5)
  - simulate, analyse, and describe some effects of acid precipitation on specific materials and living things.
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (215-6)
- evaluate individual and group processes used in planning, problem solving and decision making, and completing a task (215-7)
- propose and defend a course of action on a multi-perspective social issue (118-9, 118-5, 215-4)
- identify and describe science- and technology-based careers related to the study of ecology (117-7)

Elaborations—Strategies for Learning and Teaching

The skills outcomes 213-5, 215-6 and **215** are addressed (in whole or in part) by completing *The Effects of Acid Precipitation*, CORE ACTIVITY #3.

This two-part lab activity provides students with the opportunity to investigate the effects of acid precipitation on both abiotic and biotic aspects of the environment. This activity will provide students with the opportunity to refine and use a variety of laboratory techniques. Ensure WHMIS is covered prior to conducting this activity.

Teachers can ask students to research and report on the employment opportunities that relate to the study of ecology. This could include the post-secondary institutions that offer training, the requirements for acceptance into the various programs, guest speakers, etc. A good source of information is the College of the North Atlantic calendar of study.

Sustaining Ecosystems *(continued)*

Suggested Assessment Strategies

Paper and Pencil

- Students could complete pages 83 to 86 of Student Record of Learning. (213-5, 215-6, 215-7)

Observation

- Teachers could assess student's understanding of core activity by observing inquiry and WHMIS skills. (213-5, 215-6, 215-7)

Presentation

- Students could research careers in ecology and present with a choice of format, such as, poster, web page or slide show presentation. (117-7)

Performance

- Students could create and perform an ecology game (e.g., similar to Wheel of Fortune, Jeopardy, Hollywood Squares) covering topics from the whole unit. (213-5, 215-6, 215-7)

Interview

- Teachers could re-interview students regarding their views on certain environmental issues. This could be done in written, oral, or recorded audio/video format. Teachers and students could compare responses from the beginning of unit to the end and make reflections. (213-5, 215-6, 215-7)

Resources

Science 10,
Concepts & Connections
ST: pp. 54-55

SRL: pp. 83-86

TR: 1-83 to 1-85

ST: pp. 45

SRL: pp. 63

TR: 1-65 to 1-67

Unit 2
Earth and Space Science:
Weather Dynamics
60 Hours

Unit Overview

Introduction

Global climate and local weather patterns are affected by many factors and have many consequences. This unit asks students to consider questions such as “What decisions do we face because of weather conditions?”; “How are our lives affected by changing weather conditions (short-term) and changing climate (long-term)?”; and “What causes these weather patterns?”

In Atlantic Canada weather patterns change frequently. Each season provides interesting weather conditions that influence how we dress, how we feel physically and psychologically, and how we interact socially. The direction from which air masses move, and the atmospheric pressures and temperatures in those air masses contribute to changes that can be quite significant in any given season. Rapid temperature rises in spring may cause significant snow melt; clear and dry weather in summer raises the risk of grassland/forest fires; autumn sees the arrival of storms from the Caribbean; winter snowfall and temperature variations depend upon the north/south drift of the atmospheric jet stream. These changes influence Atlantic Canadians in a variety of ways.

Focus and Content

By considering questions that teachers and their students generate, various learning and assessment activities will meet specific curriculum outcomes. Although this unit focuses on decision making, there are opportunities for observation and inquiry as well as problem solving and design technology. Sections in the unit ask students to consider heat energy and its transfer, energy exchange within and between systems, and to observe weather data and the impact of weather forecasting.

Curriculum Links

“Weather Dynamics” connects with other clusters across many grade levels, such as “ Populations, Energy Flow, Cycles within Ecosystems”, “ Energy and Energy Transfer”, “The Earth and Its Atmosphere” (primary science); “Weather” (elementary science); “Heat Transfer”, “Measuring Temperature” and “Oceanaography” (intermediate science). This unit will support optional studies in high school such as Science 3200: “Chemistry”; Biology: “Interaction of Living Things”; and Earth Systems: “The Earth’s Systems”.

STSE	Skills	Knowledge
Students will be expected to	*Students will be expected to*	*Students will be expected to*
Nature of Science and Technology 114-6 relate personal activities and various scientific and technological endeavours to specific science disciplines and interdisciplinary studies 115-2 illustrate how science attempts to explain natural phenomena 115-6 explain how scientific knowledge evolves as new evidence comes to light **Relationships between Science and Technology** 116-1 identify examples where scientific understanding was enhanced or revised as a result of the invention of a technology **Social and Environmental Contexts of Science and Technology** 117-7 identify and describe science- and technology-based careers related to the science they are studying 117-10 describe examples of Canadian contributions to science and technology	**Initiating and Planning** 212-1 identify questions to investigate that arise from practical problems and issues 212-8 evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring, and decision making **Performing and Recording** 213-2 carry out procedures controlling variables and adapting or extending procedures where required 213-3 use instruments effectively and accurately for collecting data 213-5 compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data 213-6 use library and electronic research tools to collect information on a given topic 213-7 select and integrate information from various print and electronic sources or from several parts of same source 213-8 select and use apparatus and materials safely **Analysing and Interpreting** 214-3 Compile and display evidence and information, by hand or by computer, in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots 214-6 apply and assess alternative theoretical models for interpreting knowledge in a given field 214-11 provide a statement that addresses or answers the question investigated in the light of the link between data and the conclusion 214-14 construct and test a prototype of a device or system and troubleshoot problems as they arise 214-16 evaluate a personally designed and constructed device on the basis of criteria they have developed themselves 214-17 identify new questions or problems that arise from what was learned **Communication and Teamwork** 215-5 develop, present, and defend a position or course of action, based on findings	330-4 analyse the interactions between the atmosphere and human activities 330-6 describe the dominant factors that produce seasonal weather phenomena 331-1 describe and explain heat transfer within the water cycle 331-2 describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents 331-4 describe and explain the effects of heat transfer within the hydrosphere and atmosphere on the development, severity, and movement of weather systems 331-5 analyse meteorological data for a given time span and predict future weather conditions, using appropriate methodologies and technologies

Local Weather

Outcomes

Students will be expected to

- explain how scientific knowledge evolves as new evidence comes to light (115-6)

Elaborations—Strategies for Learning and Teaching

In this section, *Local Weather*, students learn to collect weather-related data using instruments they construct. In later sections students will learn how to interpret data collected by weather forecasters and to use this weather-related data to make predictions and inferences about various weather-related events. As with the previous unit in this course, teachers may expect students to feel they have" “already done this" or "know all about it". To some degree this is correct. All people have an interest in the weather and to some degree, are aware of how forecasts are made. In short, everyone talks about the weather to some degree or another. Students could be assured that much of what they already know will help them with the content in this unit. It should also be made clear to them that, by the end of this unit, they will have a better appreciation for weather (and everything related to it) and will know even more than they currently do. They will learn the tools and terminology of the weather forecaster as well as develop an understanding of how global weather patterns affect everyone.

Prior to starting this unit, teachers may want to get an idea of how much students already know about weather forecasting. One way to do this is to create a "mind map" (for more information see www.mind-map.com). Start by putting the term "weather" in the center of a circle. For each idea or concept generated by students, draw a line out from the circle and record the point. Elaborations or examples of the various points are shown by drawing lines from the individual point and writing the elaboration there. Alternatively, teachers could generate a concept map (similar to a mind map but indicates relationships between various concepts/points, creating a web-like structure). A simpler method might be to use a KWL chart (Know, Want to know, Learned) to record what students feel they already know, what they would like to learn, and after instruction, what they have learned (Refer to pages 297-298 of the *skills handbook* of the student textbook for these and other graphic organizers).

Teachers could begin this unit by discussing weather variability, the difficulty of making accurate weather predictions, the importance of having accurate weather data/predictions, etc. Teachers could ask students to read page 198 in the student textbook. While the terms "weather" and "climate" will be defined at a later date, ask students to identify the differences/similarities between the two terms. Teachers may ask students to complete the weather trivia sheet from the Student Record of Learning (answers pp. 4-9 of Teacher’s Resource). Teachers could use this trivia sheet to start students thinking about this unit to gauge how much they know already.

Local Weather

Suggested Assessment Strategies

Paper and Pencil

- Students could create a KWL chart to record what they already know about weather and what they would like to know about weather.(214–3, 115-6)
- Students could list at least two times in their life that weather has interfered with their family's plans. (115-6)

Journal

- Students could make an entry in their journal about their current weather forecasting knowledge and compare this to their knowledge or understanding of weather forecasting at the end of the unit. (115-6)

Presentation

- In a group students could compare the characteristics of the 4 seasons and speculate on the causes of each. Each group could then present their results to the class. (212-1, 115-6)

Portfolio

- In groups students could brainstorm and create a mind map of what they know about weather and climate phenomena. (214-3)

Resources

Science 10,
Concepts & Connections

General Weather Information and Links: http://www.stemnet.nf. ca/ CITE/canadaweather.htm

ST: p. 198

SRL: pp. 297-298, 304-305

TR: pp. 4-8

Local Weather *(continued)*

Outcomes

Students will be expected to

- explain how scientific knowledge evolves as new evidence comes to light (115-6) **Cont'd**
  - compare the relative accuracy of weather forecasting by folklore versus scientific methods
  - compare the ways older generations forecasted weather (folklore) with the scientific methods used today

Elaborations—Strategies for Learning and Teaching

Students could chart the forecasted weather for their area. Teachers could use BLM 4.GS or a similar table to investigate the accuracy of long-term forecasts. This activity could be repeated several times during this unit to give students a better idea of the accuracy of long-term forecasts. Questions that might arise include: Was the original forecast accurate? What changes were made as the week progressed? How might an individual's outdoor plans have changed due to any inaccuracies in the forecast? Students could use data from old newspapers to check accuracy during different seasons and determine if one season is more prone to error than another.

Ask students if they have any folklore (local sayings, etc.) that can be used to predict weather (e.g., "red sky at night, sailor's delight"; "lots of dogberries in the fall mean harsh winter ahead"; "little flakes big snow, big flakes little snow"; etc.). Ask students to reflect how accurate these folklore methods are at predicting weather (i.e., many are good for predicting weather in the next 12 to 24 hours but are more 50/50 for predicting beyond that). Do not try to convince students that folklore does not work (some folklore weather forecasting has a scientific basis). Lead them towards thinking about the more scientific means of predicting weather patterns and how these have improved in terms of their accuracy in recent years. Teachers could use "Forecasting the Weather" on page 308 of the Student Record of Learning to extend this topic. More old weather sayings and proverbs can be found at the websites listed in sources, or in the STSE module. How many have students heard before? Students could try to explain what the sayings mean.

Teachers may want to ask students to use their folklore methods to predict the weather for the coming days. Does a red sky at night mean a clear day is coming? Use weather maps from newspapers or from online sources, to chart weather patterns in your area over these same days. Which was the more accurate predictor? Teachers should ask students to complete the "Interpreting Weather Maps" activity on page 199 in the textbook. Ask students to discuss their answers to the questions that follow. Teachers could follow this up with a study of pages 200-201. Use the "Forecast Sayings" activity (p. 201 of the student textbook) to identify more folklore used to predict weather. Ask students to collect more such folklore from parents/grandparents. Students could explain each of the sayings meaning, and, identify if they are best at predicting short or long-term weather patterns.

BLM4.1 in the teacher's resource can be used to explore the "gems of truth" that often are part of folklore.

Local Weather *(continued)*

Suggested Assessment Strategies

Paper and Pencil

- Students could write a 200-word article for the magazine "The Folklore Times" that describes several folklore methods of forecasting weather. They should include how prevalent the various folklore methods are and whether they are intended to forecast short-term or long-term weather conditions. (115-6, 114-6, 213-7)

Presentation

- Using the folklore they collect from various sources, students could prepare a presentation on the variety of folklore used to forecast the weather. (213-7, 114-6)
- Students could pick one or two pieces of folklore and then create a collage to describe what each means. This could include a statement or conclusion about the accuracy of the folklore method. They could then present this to the class. (213-7, 114-6)

Portfolio

- Students could research the sources of common folklore used to predict weather and create a report. (214-3, 214-11)
- Students could give an example that illustrates the limitations of predicting weather conditions (117-10, 118-7)

Interview

- Students could conduct interviews of several older members of their family (e.g., grandparents, aunts, uncles, etc) or community and record the different weather folklore. (214-3, 214-11)

Performance

- Using a chart record the ways in which people (e.g., fisherman, loggers, hunters, etc) would have tried to predict the weather 50 years ago. Compare this with how they would do it today. Debate which was/is more accurate. (Students might automatically think that the more modern methods are better. However, they should consider the costs involved, the time required to get an up to the minute forecasts, the different equipment needed, etc. They should see that it is a matter of perspective). (214-3, 115-6)

Resources

Science 10,
Concepts & Connections

ST: pp. 198-201

SRL: pp. 308-312

TR: pp. 4-10, 4-11

BLM: 4.3

Canadian meteorological and Oceanographic Society (Weather Lore) http://www.cmos.ca/weatherlore.html

Weather Lore and Sayings http://www.coldal.org/weather.htm

Local Weather *(continued)*

Outcomes

Students will be expected to

- discuss the relative accuracy of weather forecasting by folklore and scientific methods (115-2)
- compare the ways older generations forecasted weather (folklore) with the scientific methods used today (115-6)
- relate personal activities and technology used with meteorology in the design of a weather station (114-6)
  - identify and explain the function of instruments used in a weather station. Instruments include:
    (i) thermometer
    (i) hydrometer
    (ii) aneroid barometer
    (iii) wind vane
    (iv) anemometer
    (v) rain gauge
  - define the terminology related to the instruments used in a weather station including:
    (i) warm front
    (ii) cold front
    (iii) humidity
    (iv) relative humidity
- evaluate and select appropriate instruments for collecting weather data (212-8)

Elaborations—Strategies for Learning and Teaching

A CORE STSE component of this unit incorporates a broad range of Science 2200 outcomes. More specifically it targets (in whole or in part) 115-2, 115-6, 116-1, 212-1 and 330-4. The STSE component 2-1, *Weather Lore*, can be found in Appendix A.

Teachers could address this outcome by listing the various terminology related to the instruments of a weather station and with the Activity 4.2 on page 202 of the student textbook. Then ask students which terms they recognize and which they do not. Can they provide definitions? (Don't worry if they can not at this point as these will be further developed as they work through the activity). Actual instruments or their pictures would be useful during this introductory activity.

Local Weather *(continued)*

Suggested Assessment Strategies

Portfolio

- Students could create a chart which records each instrument used in a weather station and explain what each measures.(114-6)

Paper and Pencil

- Students could explain in several written paragraphs how a hygrometer can indicate a warm front, cold front, humidity and relative humidity. (114-6)

Presentation

- Student could visit a forecast website(www.ec.gc.ca/canada_e.html) to read the current forecast to find reference to warm fronts, cold fronts, humidity and/or relative humidity. They may orally present their findings to the class. (114-6)

Journal

- Students could list each instrument used in the weather stations and record a possible limitation of each. (212-8)

Resources

Science 10,
Concepts & Connections

Core STSE #2-1: *"Weather Lore",* Appendix A

ST: pp. 202-205

TR: pp. 4-14

Local Weather *(continued)*

Outcomes

Students will be expected to

- construct, test, and evaluate a weather station and troubleshoot problems as they arise according to specific criteria (214-14, 214-16)
  - using readily available materials, construct a weather station to measure and collect data related
    - (i) temperature
    - (ii) wind speed
    - (iii) atmospheric pressure
    - (iv) humidity
  - evaluate the accuracy of the student-constructed weather station according to accepted values (e.g., weather reports)
- evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving (212-8)
  - make accurate (one decimal place) measurements of temperature

Elaborations—Strategies for Learning and Teaching

The skills outcomes 214-14, 214-16, 212-8 and 213-3 are addressed (in whole or in part) by completing *Build A Weather Station*, CORE ACTIVITY #4.

Students should work in groups of 3 or 4 to complete Core Activity #4. Prior to beginning construction of the various instruments, students should be required to submit a proposal for how they will construct the various instruments. A cardboard box can be used to house the instruments. If using a cardboard box, students should cut slits in the cardboard to ensure air can circulate without allowing sunlight to shine directly on the instruments. Alternatively, several class weather stations could be constructed, with each group of students responsible for building one of the instruments. A barometer could be purchased or borrowed so that accurate measurements of air pressure can be made. The PBS website (Public Broadcasting Service) provides instructions for constructing a simple barometer which can be used to record gross increases or decreases in pressure.

As much as possible, students should collect their data several times a day at roughly the same time each day. Weather stations should be stationed approximately 1.5 meters above ground level. While students will be familiar with some of the instruments in a weather station (e.g., thermometer) they will require practice with taking readings. In particular, students should be taught how to estimate to one decimal place on all of their readings. Where necessary modifications could be made to the equipment to improve results. Alternatively, an electronic weather station could be used to validate or compare data collected.

The website: http://www.pbs.org/weta/roughscience/discover/weather.html contains information on how to construct several meteorological instruments including a simple barometer, compass, and how to find the dew point.

The website: http://school.discovery.com/lessonplans/activities/weatherstation/ provides simple step by step instructions on how to construct instruments to collect weather data, including a rain gauge.

Local Weather *(continued)*

Suggested Assessment Strategies

Performance

- Once the experiment has been designed and completed, students could be assessed on their actual performance. Do they follow the plan, use correct techniques, and work safely? (214-3, 214-11)

Paper and Pencil

- Prepare a report to summarize the findings collected over the 5 day period. (212-8)

Portfolio

- Students could create a chart which compares the readings collected by their station and the current weather reports. (214-14, 214-16)
- Students could describe how changes in air density and air pressure cause movement of weather systems. (214-14)

Presentation

- Students could create a forecast based on their findings over the five day period`(persistance forecast TR 4-15). The forecast could be presented as role-play, with the student as the reporter. (214-14, 214-16)
- With group members, students could prepare a chart or concept map that shows the points of energy transfer in the water cycle. They could design questions to help other students indicate the direction of energy flow and the forms it takes. (212-1)
- A group could present the comparison of data from the previous exercise. It is important that they illustrate the developing patterns through the five-day period. Teachers could assess the quality of report findings, comparisons made, and if students appreciate that readings from a given location illustrate the dynamic nature of weather patterns. (114-6, 331-5)
- Students could produce a weather chart: weather feature (wind velocity); measuring instrumnet (anamometer); recorded data (50 km/hr, from west); and date. (114-6)

Interview

- Student could explain to the teacher how accurate measurements are obtained (one decimal place).(214-14, 214-16)

Resources

Science 10,
Concepts & Connections

ST: pp. 202-205

SRL: pp. 313-316

BLM: 4.5

Constructing weather station tools

http://www.pbs.org/weta/roughscience/discover/weather.html

http://school.discovery.com/lessonplans/activities/weatherstation/

Local Weather *(continued)*

Outcomes

Students will be expected to

- use weather instruments effectively and accurately for collecting local weather data (213-3)
  - use a thermometer, barometer, hygrometer, and an anemometer to collect local weather data
  - record local weather data in an appropriate manner
  - graphically represent local weather data for a given period of time
- identify questions to investigate that arise from the operation and findings of the weather station (212-1)

Elaborations—Strategies for Learning and Teaching

Students should apply their knowledge of weather instruments to set up a weather station. Schools may opt to purchase a weather station kit or construct one using the materials students are using. The weather data that students collect should be recorded in a class chart. Where students are collecting weather data at home, it will be important to identify the location of these "home weather stations" so that later analysis can be made of the data collected within the class as well as with that available from local and regional weather stations. This may require the use of maps to determine the approximate elevation of a student's home. Are any of the weather stations set up near large bodies of water? Are their readings the same as the readings made by their peers further inland? Teachers may wish to collaborate with schools in other communities to develop a more "regional" weather forecast. There are many possibilities for Internet-related projects using the Core Activity #4 as the basis.

Teachers should review how readings are made using the various scales on these instruments. This is a good opportunity for students to practise scientific skills. Attention should be given to how to estimate to one decimal place beyond the values on the scale (see ST pp. 267-268).

From the changes in observed weather patterns, the recorded data, and any data provided by classes outside their school, students should generate questions they would like to have answered about changes in the weather or techniques used to collect the weather data. Many of their questions will be answered as they learn about the various things that affect or cause weather changes as well as develop a more sophisticated understanding of how weather data is collected and analyzed.

Local Weather *(continued)*

Suggested Assessment Strategies

Presentation

- Students could represent graphically the data collected with the homemade weather station. Graphs may be drawn by hand or with the use of a computer program. Students determine which graph type is most appropriate. (213-3)

Interview

- As students work on the weather station, the teacher could record questions which arise. These may be displayed on a poster. (212-1)

Presentation

- Students could debate the merits of establishing a weather station in their local community. (212-1)

Resources

Science 10,
Concepts & Connections
ST: pp. 202-205, 267-268

SRL: pp. 313-318

Environment Canada Current Weather Data http://weather.ec.gc.ca/canada_e.html

Copyright Information

http://www.cmec.ca/else/copyright/matters/indexe.stm

The Weather Network Glossary of Weather Terms http://www.theweathernetwork.com/inter/help/glossary/index.htm

General Weather Information and Links http://www.stemnet.nf.ca/CITE/canadaweather.htm

Local Weather *(continued)*

Outcomes

Students will be expected to

- describe the dominant factors that produce seasonal weather phenomena (330-6)
  - define and recognize a weather system
  - define air mass
- identify air masses and compare their movements across North America. Include:
  - (i) maritime tropical
  - (ii) maritime polar
  - (iii) continental polar
  - (iv) continental tropical
  - identify weather conditions associated with maritime polar, maritime tropical, continental polar, continental tropical air masses
  - define a front
  - define and distinguish between warm fronts, cold fronts, and stationary fronts
  - define weather map and explain how it is created

Elaborations—Strategies for Learning and Teaching

Teachers could approach this topic by asking students to watch a couple of segments of a weather forecasting channel such as "The Weather Network" or an online weather forecasting service such as Environment Canada weather forecasting site. Teachers should refer to http://www.cmec.ca/else/copyright/matters/indexe.stm or the CANCopy policy for specific details on how they can use recorded broadcasts. Students could record the weather-related terms that they hear during the segments. Teacher could ask students to write their own definitions of the terms based on the weather forecast in the segment. This could be followed with a discussion of the four air masses that affect North America. After students have refined their understanding of weather system terminology, teachers could then refer back to a weather forecasting channel. Turn the sound down and ask students to provide the "voice over" for the segment.

Teachers could use Activity 4.3 of Student Record of Learning to review and consolidate the concepts and terminology of this section. BLM 4.3c in the teacher's resource could be used for review.

Teachers could begin by asking students to describe possible changes that could result as a cold/warm front approaches. Alternatively, ask students how a stationary front might affect weather. Students may quickly respond that warming or cooling takes place, but may forget to include humidity changes. Stationary fronts tend to cause conditions to linger longer than usual.

Local Weather *(continued)*

Suggested Assessment Strategies

Journal

- Students could describe the seasons in Newfoundland in Labrador, in terms of the contrasting weather conditions. (330-6)
- Students could use their descriptions of the weather in Newfoundland and Labrador to create an overall picture of the climate of our province. (330-6)

Paper and Pencil

- Students could obtain a written transcript of a current weather forecast. All weather terminology should be highlighted, and then defined. (330-6)

Interview

- Teachers could interview students about how often they listen to a weather forecast, dress accordingly, and make plans based on it. (330-6)

Presentation

- Students could work in groups, each choosing a different air mass (maritime polar, maritime tropical, continental polar, continental tropical). Each group should present its finding to the class. (330-6)

Portfolio

- Students could create two mind maps © which record their knowledge of air masses and fronts. These maps would be reviewed at the end of the unit, with the growth in knowledge indicated. (330-6)

Resources

Science 10,
Concepts & Connections
ST: pp. 206-207

SRL: pp. 317-319

TR: pp. 4-17, 4-18

BLM: 4.8

Local Weather *(continued)*

Outcomes

Students will be expected to

- use print and electronic sources to collect and analyze weather data from regional and national weather observational networks and predict future weather conditions (213-6, 213-7, 331-5)
  - collect weather data from newspapers, television, radio, and Internet sources
  - organize data in properly labelled tables and graphs
  - prepare a report in which the student will collect local weather data for a five-day period
  - analyze local weather data to make predictions on further weather events
  - recognize and explain weather symbols seen on weather maps. Include symbols for:
    (i) rain
    (ii) freezing rain
    (iii) snow
    (iv) warm front
    (v) cold front
    (vi) high pressure system
    (vii) low pressure system
    (viii) jet stream
  - using regional and national weather observations and maps, chart and predict the weather in various parts of North America over a five-day period

Elaborations—Strategies for Learning and Teaching

After completing Case Study 4.4, (pages 208-209 of the student textbook) teachers could require students to collect local weather data for five or more days. Depending upon their resources, students could collect television weather reports, newspaper reports, or online weather reports. The data collected should include: wind speed and direction, barometric pressure, precipitation (types and amounts), temperature, cloud cover, and relative humidity. After each day's data is collected, students could be asked to comment on the forecaster's prediction for the next day. Questions that may arise could be: Why aren't all the measurements made by different students the same? If there is more humidity in the air, does this predict a snow/rain fall? (Teachers could have students collect this data using their weather stations and compare it with the professional data.)

Teachers could follow this section with a series of data for a particular area (or the local area). Using the weather maps (e.g., these could copied to overhead acetate or photocopied for students) and meteorological data provided in the series, teachers could ask students to predict the next day's weather conditions. They could then show them the next day's data with the actual weather event. Teachers could record local or national weather conditions from television over a five-day period. With the broadcaster's commentary muted, these could be used with students in the same way the weather maps could be used.

Teachers could make an overhead acetate of BLM 4.4a in the teacher's resource and use it to review weather map symbols (either cover up the legend when in use or photocopy without the legend). It is important for students to be familiar with weather map symbols so that they can more easily read a weather map.

Teachers should use a variety of weather maps (available in most newspapers). The intent is that students are able to use the maps to identify and describe the information contained on the map.

Local Weather *(continued)*

Suggested Assessment Strategies

Portfolio

- Students could create a weather map for a particular forecast day, using electronic media as sources of data. (213-6, 213-7, 331-5)
- Students could create a Venn Diagram, which shows the relationship between the different air masses. (213-6, 213-7, 331-5)

Presentation

- Students could create a poster which illustrates each type of front, its description and its symbol.(213-6, 213-7, 331-5)
- Students could develop their own local forecast, and present it on video, using maps and symbols.(213-6, 213-7, 331-5)
- Students could do group presentations to compare the data collected over the five-day period. (213-6, 213-7, 331-5)

Performance

- Students could write a poem, rap or song that describes the differences between the air masses. (213-6, 213-7, 331-5)
- Students could develop a set of flash cards which illustrate the weather symbols seen on weather maps. The reverse of each card could contain the explanations of each symbol. These cards could be used in a Quiz-Quiz-Trade Cooperative learning activity (213-6, 213-7, 331-5)

Paper and Pencil

- Students could sketch and describe each weather symbol. (213-6, 213-7, 331-5)
- Teachers could form student groups and assign the following:
  - Collect the following weather data (for a given location and at specific times) over a five-day period: air temperature, air pressure, relative humidity, cloud cover, wind velocity
  - Organize these data in a chart
  - Place these data on a single set of graph axes in order to allow comparisons over the time period.
  - Compart the record of their group with information presented by local newspaper/radio/television/reports

  Teachers could assess the process to organize data collection, graphical presentation, and the way in which the presentation was made. (213-6, 213-7, 331-5)

Journal

- Students could report on the accuracy of a 5(7)(14) day forecast.(213-6, 213-7, 331-5)

Resources

Science 10,
Concepts & Connections

ST: pp. 208-209

ST: *Skills Handbook* - pp. 270-272

TR: pp. 4-20, 4-21

BLM: 4.9, 4.10

ST: pp. 208-209

ST: *Skills Handbook* - pp. 270-272

Local Weather *(continued)*

Outcomes

Students will be expected to

- define terms related to weather forecasting. (115-6, 212-1, 330-6)
- describe some of the methods of weather forecasting. (331-5)
- apply the effects of ocean currents, air currents and latitude on the climate of Newfoundland and Labrador. (115-2, 331-4)

Elaborations—Strategies for Learning and Teaching

A CORE STSE component of this unit incorporates a broad range of Science 2200 outcomes. More specifically it targets (in whole or in part) 115-6, 212-1, 330-6, 331-5, 115-2 and 331-4. The STSE component 2-2, *Weather Forecasting*, can be found in Appendix A.

Local Weather *(continued)*

Suggested Assessment Strategies

Resources

Science 10,
Concepts & Connections

Core STSE #2-2: *"Weather Forecasting",* Appendix A

Local Weather *(continued)*

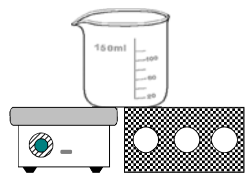
Outcomes

Students will be expected to

- illustrate how science attempts to explain seasonal changes, and variations in weather patterns for a given location (115-2)
  - describe localized air movements and their effect on regional weather. Include:
    - (i) thermals
    - (ii) sea breezes
    - (iii) land breezes
  - describe the formation of lake-effect/ocean-effect snow and Chinook winds
  - describe how the lake-effect/ocean-effect snow and Chinook winds can affect the local weather of an area

Elaborations—Strategies for Learning and Teaching

Teachers may wish to review the concept of convection currents. There are many excellent convection current lesson plans on the world wide web (see resources). Effective demonstrations of convection can be found in an introductory chemistry text. Teachers could use one of the activities described in the web resources to ask students to investigate convection currents. To demonstrate convection currents arrange a beaker of water, hot plate and brick as shown in the following diagram:



Place a crystal of potassium permanganate (or other coloured, water soluble crystal) in the bottom of the beaker that is on the hot plate (use a drinking straw to drop the crystal directly on the bottom of the beaker). Caution: potassium permanganate will react with skin and stain it.

The teacher could demonstrate a thermal updraft by holding a piece of paper over a 60 watt light bulb (caution: do not touch the light bulb). As the bulb heats up the surrounding air, the air rises. This will be visible as the paper begins to flutter.

For most students in Newfoundland and Labrador, ocean effect snow will be a much more common experience than lake effect snow (both are formed by the same conditions). Students in this province, if they live close to a coastline, might often hear a forecast like, "Snow flurries possible where winds blow on shore". This refers to the ocean-effect on Newfoundland and Labrador's weather. Teachers may want to refer to the following website for more detailed background information: http://meted.ucar.edu/norlat/snow/lake_effect/1_lo_snow_basic_ingredients.htm.

More detailed information on Chinook winds can be obtained at http://www.mountainnature.com/Climate/Chinook.htm.

As an extension, teachers could use BLM 4.5b in the Teacher's Resource to show that many places in the world have names for winds that only occur in their region.

Local Weather *(continued)*

Suggested Assessment Strategies

Performance

- Students could interpret a weather map, making specific reference to the symbols it contains. (213-6, 213-7, 331-5)
- Students could role-play a hot air balloonist, sailor, fisherperson or windsurfer. Each would describe the influence of weather on his/her activities. (115-2)

Paper and Pencil

- Students could write a short paper, describing where in Canada a winter-sports enthusiast should live. Reference should be made specifically to the Great Lakes region, the Rockies, and Newfoundland and Labrador. (115-2, 331-2)

Paper and Pencil

- Students could explain the affect of sea breezes on a water-related sporting event, such as kayaking, the St. John's Regatta, sailing. (115-2, 331-2)
- Students could evaluate the relationship between sea breezes and the lake-effect snow and ocean-effect snow. (115-2)

Presentation

- Students could indicate on a map of Newfoundland and Labrador the amounts of snow received in each area. An explanation of the cause of the variation would be included. (115-2, 331-2)
- Students could investigate the effects of the Chinook Winds on the 1988 Calgary Olympics. (115-2)

Portfolio

- Students could create a comparative chart on the respective features of the lake-effect snow and ocean-effect snow. (115-2)

Resources

Science 10,
Concepts & Connections

ST: pp. 210-211

SRL: pp. 328-329

TR: pp. 4-24, 4-25

BLM: 4.11

Lake Effect Snow http://meted.ucar.edu/norlat/snow/lake_effect/1_lo_snow_basic_ingredients.htm.

Chinook winds http://www.mountainnature.com/Climate/Chinook.htm.

Convection Current Demonstration http://www.uen.org/Lessonplan/previous.cgi?LPid=2308

Global Weather

Outcomes

Students will be expected to

- identify questions to investigate that arise from considering the energy transferred within the water cycle (212-1)
  - using a diagram, provide a brief description of the water cycle
  - identify solar energy (sun) as the driving force behind the water cycle
  - define and explain evaporation, condensation and precipitation
  - define hydrosphere
  - describe and distinguish between the main types of precipitation. Include:
    (i) drizzle
    (ii) rain
    (iii) freezing rain
    (iv) snow
    (v) hail
    (vi) dew
    (vii) frost
  - explain how relative humidity is related to the dew point and how each is influenced by temperature
  - describe how humidity affects our comfort in different weather conditions

Elaborations—Strategies for Learning and Teaching

Students will have studied the water cycle in previous grades and may be familiar with some of the terminology. Teachers should relate this cycle back to the previous cycles the students' have studied (e.g., Carbon and Nitrogen cycles). How are these cycles similar/different? The carbon and nitrogen cycles are dependent on living organisms while the water cycle is not. The water cycle relies mainly on heat energy from the sun to cycle water. All cycles convert matter from one physical state (solid, liquid, gas) to another. Students may have a misconception that water is "used up". Use the concept of recycling to help them understand that this is not the case. The water on Earth today is the same water (no more and no less) than we have had 100 years ago; a 1000 years ago, etc.

Teachers could utilize the Water Cycle at Work web page to refine their understanding of this cycle and to explore its role in recycling "dirty water". This site provides many activities and information that will be useful in teaching this topic.

Teachers should do the "Finding the Dew Point" (page 215 of the student textbook) activity as a demonstration. Several students should take the measurements. Students should relate this activity to mirrors "steaming up" during a hot shower or the fogging of car windows during rainy weather.

Global Weather

Suggested Assessment Strategies

Presentation

- With group members, students could prepare a chart or concept map that shows the points of energy transfer in the water cycle. They could design questions to help other students. (212-1, 214-3, 214-11)

Journal

- Students could enter in their journals two concepts they have learned about energy exchanges that take place during the water cycle. (212-1)

Paper and Pencil

- Students could write a paragraph (200 words max.) to describe the autobiographical account of a water molecule, together with its "friends", as it experiences a phase change in the water cycle. (212-1)

Portfolio

- Students could develop a written essay or a photo-essay to describe a significant example they have experienced of the connection between water cycle (phase change) - a weather phenomenon. (212-1)

Presentation

- Student groups could prepare and present to the class a demonstration/description of a weather phenomenon. These might include dew point, change of state, pressure gradient, humidity and formation of precipitation. Assessment should be on the parameters given, preparations of materials, creative use of equipment, type of medium, understanding of concepts. (212-1)

Resources

Science 10,
Concepts & Connections

The Water Cycle at Work http://www.epa.gov/OFWDW/kids/cycle.html

Environment Canada Water Cycle Information: http://www.ec.gc.ca/water/en/nature/prop/e_cycle.htm

ST: pp. 212-213

TR: pp. 4-27, 4-28

BLM: 4.14

SRL: pp. 330-333

BLM: 4.15, 4.16

ST: pp. 214-215

SRL: pp. 334-336

TR: pp. 4-30, 4-31

Global Weather *(continued)*

Outcomes

Students will be expected to

- compile and organize data, using tables to facilitate interpretation of the data (213-5)
- use a thermometer and balance effectively and accurately for collecting data (213-3)
- select and use apparatus and materials safely (213-8)

Elaborations—Strategies for Learning and Teaching

The skills outcomes 213-5, 213-8 and 213-3 are addressed (in whole or in part) by completing *What Affects the Evaporation of Water?*, CORE ACTIVITY #5

When planning for Core Activity #5, teachers could arrange students in groups of two or three. Prior to asking students to conduct the activity (i.e. during the preceding class), ask each group to form a hypothesis (prediction) for each of the three activities. As a class discuss their predictions. Discuss with the class how best to record their data. Prepare the data tables in advance. Before each group begins making measurements, the teacher should ensure they know how to read the balance scale. The teacher may wish to have Part 3 done using one setup for the class. Each group could make their measurements before the water is heated and again after heating for 45 minutes (depending on the length of your class period, this time frame may have to be reduced to 30 minutes). Similarly, the number of measurements in Parts 1 and 2 may have to be reduced to fit within a class period and to provide time for cleanup. During the next class after students have completed the questions at the end of each part of the activity, the teacher should relate the results of this activity to the water cycle and weather in general.

Global Weather *(continued)*

Suggested Assessment Strategies

Performance

- Once the experiments have been designed and the intentions declared, there is an opportunity for assessing how students actually perform the intended activity. Do they follow the plan, use correct techniques, and work safely? (213-5, 214-11)
- Students could investigate the humidex as relationship between air temperature and humidity. (213-3)
- Students could compare their rates of evaporation with those obtained at significantly different altitudes. (213-5)

Interview

- As students plan CORE ACTIVITY #5, teachers could interview them about their plans and how they intend to measure identified variables. Understanding of the tasks, clarity of thought, and creative ways to solve practical problems could be assessed. (214-10)

Presentation

- Students could present their data and conclusions from CORE ACTIVITY #5. They could explain why they made certain decisions in planning and conducting the experiment. They could ask other groups to offer improvements in design and data collection and add them to their notes. (214-3, 214-11)

Portfolio

- Teachers could ask students to design a "Factors that affect the Evaporation of Water" concept or mind map for their portfolio . They should explain how this map improves their understanding of the topic. (213-5, 331-2, 115-2, 115-6)

Paper and Pencil

- Students could evaluate the relationship between drying time and relative humidity. (213-5)

Resources

Science 10,
Concepts & Connections

ST: pp. 216-217

ST: *Skills Handbook* - pp. 265-266

SRL: pp. 337-343

TR: pp. 4-34

Global Weather *(continued)*

Outcomes

Students will be expected to

- describe benefits of weather satellite imaging and identify examples where improved data gathering has resulted in better understanding of weather systems and of forecasting (116-1, 117-10)
  - define weather satellite, weather balloon
  - briefly describe how weather satellites function to collect weather data
  - describe the role of meteorologists
  - describe why the accuracy of weather forecasts has improved in recent years
  - describe the role weather satellites, weather balloons, and radar play in improving long-term weather forecasts
  - describe the major weather patterns that indicate what weather is likely to arrive the following day
  - distinguish between weather and climate

Elaborations—Strategies for Learning and Teaching

Teachers should relate the topic of current technology for collecting meteorological data back to the folklore that was used in the past. While some folklore is good at predicting the weather in the next 12 to 24 hours (e.g., "red sky at night sailor's delight"; i.e. if the sky is red when the sun sets, the next day will be clear and nice) the data collected by satellites, radar, and weather balloons allows for more accurate, longer term predictions. Teachers could use satellite images from television or online sources to show the data that meteorologists use to predict weather events. Teachers could ask students to chart how accurate the forecaster's predictions are for 3 days in the future and 5 days in the future. Compare that with their own predictions (or their parents'/grandparents') of what the weather will be like based on observable conditions or local folklore.

Teachers could show students a current radar image of Canada or specific locations by accessing Environment Canada's Weather Radar Site. Teachers could invite a local meteorologist or weather watcher to talk about their job and the education level they need in this occupation.

Students should note that a meteorologist is a highly trained individual who has spent many years in training and education. Meteorologists study atmospheric conditions using a vast array of technologies in an effort to understand weather patterns and climate. The information they gather is used to forecast day-to-day weather and predict severe weather events.

Teachers could use examples from local, national, and international locations to help distinguish between weather and climate. Teachers should ensure that the distinction between weather and climate as well as the interconnectedness of these two terms is clear to students. Teachers should relate the day-to-day weather events to the overall climate of an area. Teachers should relate the factors that affect the climate in a particular area to the type of weather conditions that area can expect to experience during the year.

Global Weather *(continued)*

Suggested Assessment Strategies

Paper and Pencil

- Students could create a table that delineates the characteristics of weather balloons, satellites, and radar as they are used to collect weather data. (116-1, 117-10)
- Students could prepare a brief article/flyer that explains the advantages of weather satellite technology compared to methods used in the mid-20th century. (117-10)
- Teachers could give students a sequence of weather satellite images for their region. Students should study the sequence of satellite images provided, complete one of the following, and give reasons for their conclusions:
  - Describe the weather conditions at the indicated locations.
  - On the blank map indicate the cloud conditions one would expect to see six hours later.
  - As a farmer-fisher-forester, what are the positive-negative consequences of these images?
  - As a sports or tourist director, what are the positive-negative consequences of these images? (117-10)

Observation

- During a discussion intended to distinguish weather from climate, teachers could identify students who can clearly express their ideas and make the distinction. (116-1)

Interview

- Students could give an example of Canada's contribution to meteorology and how it benefits society. (117-10, 118-7)
- Students could give an example that illustrates the limitations of predicting weather conditions. (117-10, 118-7)

Presentation

- Student groups could give a four-minute presentation about a technology that has improved the accuracy of weather forecasting. Students should use a variety of media during the presentation. (116-1, 117-10)

Journal

- Students could compare daily weather conditions in their area with the predicted daily averages that should occur due to the climate of the area. (116-1, 117-10)

Resources

Science 10, *Concepts & Connections*

Environment Canada's Weather Radar Site http://www.weather.ec.gc.ca/radar/index_e.html

ST: pp. 218-219

SRL: pp. 344-346

TR: pp. 4-36, 4-37

BLM: 4.17

TR: pp. 4-40

ST: pp. 220-221

SRL: pp. 347-351

Global Weather *(continued)*

Outcomes

Students will be expected to

- describe benefits of weather satellite imaging and identify examples where improved data gathering has resulted in better understanding of weather systems and of forecasting (116-1, 117-10) **Cont'd**
  - briefly describe how the following factors affect the weather and climate of a particular area:
    (i) latitude
    (ii) ocean currents
    (iii) wind and air masses
    (iv) elevation
    (v) relief
    (vi) closeness to water
- using scientific theory, describe and explain heat transfer and its consequences in both the atmosphere and hydrosphere, relating this science to natural phenomena (115-2, 331-2)
  - identify and describe the principle characteristics of the four layers found in the atmosphere. The layers include:
    (i) troposphere
    (ii) stratosphere
    (iii) mesosphere
    (iv) thermosphere
  - identify the distribution of common atmospheric gases (oxygen, nitrogen, water vapour, carbon dioxide)

Elaborations—Strategies for Learning and Teaching

In general the further north you go (increasing latitude) the colder it becomes as compared to more southerly locations. Winds generally cool a location. Winds carry weather conditions from one place to another. Warm ocean currents (originate in warm areas) warm the land as it flows by. Cold currents cool areas down. When warm and cool air currents meet, fog and rain develop. Teachers could use local examples to describe these effects. For example, if students live next to water their local temperatures could be explained by referring to the Labrador current (if on the eastern side of the province).

While students will have encountered the concept that air has mass and takes up space, many will still have difficulty with this concept. Teachers could carry out the following demonstration activity to help clarify this concept. Weigh a rubber balloon. Record this value. Inflate the balloon. Weigh it again. You will notice that the weight of the balloon has increased. Since the only difference is the amount of air inside the balloon (apparent because the balloon is inflated) the additional weight (mass) must be due to the air. Deflate the balloon. Weigh it again. Its mass may be slightly higher than it was initially due to the moisture in your breath. Note: a top loading balance is best for this demonstration. Another simple demonstration to show the effect of air pressure can be found at the Canadian Space Agency's website under "activity 4" available at http://www.space.gc.ca/asc/eng/youth_educators/educators/resources/packages/spacesuit.asp#activity4.

Global Weather *(continued)*

Suggested Assessment Strategies

Presentation

- Students could create a collage of the factors that affect the weather and climate in their area.(214-3)

Journal

- Students could reflect on how the oceans influence our weather. (116-1, 117-10)
- Students could reflect on the next question about weather they would like answered. (116-1, 117-10)

Portfolio

- Students could design and produce an entry for their portfolio. This entry is to comprise text and visual images. It could be in paper or electronic form. The entry is to illustrate and explain the link between ocean currents, atmospheric jet streams and coastal weather patterns. (214-3, 331-2, 115-2, 115-6)

Resources

Science 10,
Concepts & Connections

ST: pp. 220-221

SRL: pp. 347-351

Canadian Space Agency http://www.space.gc.ca/asc/eng/youth_educators/educators/resources/packages/spacesuit.asp#activity4.

ST: pp. 222-225

SRL: pp. 352-355

TR: pp. 4-43, 4-44

BLM: 4.18

Global Weather *(continued)*

Outcomes

Students will be expected to

- using scientific theory, describe and explain heat transfer and its consequences in both the atmosphere and hydrosphere, relating this science to natural phenomena (115-2, 331-2) **Cont'd**
  - investigate the relationship between altitude, temperature and atmospheric pressure
  - explain how atmospheric pressure is related to weather
- conduct experiments to compare the specific heats of common Earth materials and draw conclusions about the effect of solar radiation on water and land surfaces (213-2, 214-11)
- compile and organize data, using tables to facilitate interpretation of the data (213-5)
- use a thermometer effectively and accurately for collecting data (213-3)
- select and use apparatus and materials safely (213-8)

Elaborations—Strategies for Learning and Teaching

Students may also have difficulty accepting that the air exerts a pressure on us. They may wonder why we don't notice this pressure/weight. The simplistic answer to this is that we, and all other plants and animals on earth, are adapted to where we live. Ask if any of them have dived deeply under water. If so, they will have noticed the pressure on their ears. That is because we are not adapted to living 2 or 3 meters under water. We experience pain because when we are underwater we have the pressure of the air on us plus the extra weight (pressure) of the water. Some of them may have witnessed what happens to fish that are normally found in deep water. If they are brought to the surface they will "blow up like a balloon". The "popping" of ears or pain that may be experienced during take off and landing in a jet plane is an example of moving to an area of lower air pressure.

Teachers could ask a couple of students (or the whole class) to do the Try This Activity "Atmospheric Pressure" on page 224 of the student textbook as a demonstration for the rest of the class. A couple of drops of food coloring could be added to the water to improve the visibility of the various levels of water in the beaker.

The skills outcomes 213-2, 214-11, 213-5, 213-3 and 213-8 are addressed (in whole or in part) by completing *The Earth's Tilt and Seasons*, CORE ACTIVITY #6.

Prior to having students do the Core Activity #6, teachers could use a physical model to demonstrate how the earth revolving around the sun creates the seasons. This may be accomplished in a darkened classroom by positioning a lamp (shade removed) in the centre. Using a globe or ball, the teacher slowly walks around the "sun" (lamp or flashlight) holding the globe at the appropriate angle. In the darkened classroom, students will more clearly see how the Northern and Southern hemispheres receive more or less light at different times of the year. Teachers may also want to draw students' attention to the fact that the amount of light remains the same at the equator year round. Teachers could access satellite views of the earth showing a variety of information including night/day views at www.fourmilab.to/cgi-bin/uncgi/Earth

Teachers could extend this activity by setting up another set of boxes and then covering the soil in each box with a white substance (a sheet of paper or cotten balls will suffice) to simulate snow. Compare these measurements with those for the bare soil. In particular, Box B and Box C will more closely represent most land areas in Canada during the winter season. Ask students how the length of winters in Canada would be different if we had more or less snow during the winter. (With less snow, more sunlight would reach the soil, heating it up faster thus shortening the length of the winter.)

Global Weather *(continued)*

Suggested Assessment Strategies

Paper and Pencil

- Students could create a summary table that shows the altitude, density, composition, temperature, etc. of the various layers of the atmosphere. (214-3, 115-2, 331-2)
- Students could generate a series of "what if" questions (thought investigations) relative to Activity 4.12. (331-1, 213-2)

Presentation

- Students could create a rap, song, or poem that describes the characteristics of the 4 layers of the atmosphere. (331-2)
- Students could state a hypothesis about weather patterns in Atlantic Canada. They should make a three-minute oral presentation about a significant weather event, giving where, what, when, and its importance to people. Students should illustrate how it relates to their hypothesis. (115-2, 331-2)
- Students could use models (print, three-dimensional) and/or drama to illustrate how a high-pressure region moving across Atlantic Canada affects atmospheric flow laterally and vertically. They should show where significant energy transfers are taking place. (214-3, 331-2, 115-2)
- Using a flashlight (sun) and globe or ball (Earth), students could describe and illustrate the relationship between light source position and density of radiation incident to the surface of the globe/ball at various locations. Consider:

  a) daily changes with globe axis fixed

  b) seasonal changes with change in globe axis

  Assessment should include the competency of the explanation, clarity of the concept, and appreciation for limitations of the model. (115-2)

Performance

- Students could create a drama of what people would experience as they climbed a very high mountain. (331-2)

Portfolio

- Students could record the weather conditions for major locations in North America and Australia. (214-3)
- Students could record the different times for sunset and sunrise in Newfoundland and Labrador. Explain the differences and identify how this could impact daily activities. Make observations for different times of the year. (214-11)

Resources

Science 10,
Concepts & Connections

ST: pp. 222-225

SRL: pp. 352-355

TR: pp. 4-43, 4-44

BLM: 4.18

ST: pp. 226-227

SRL: pp. 356-358

TR: pp. 4-46, 4-47

BLM: 4.19

Earth: View from Sun

htt://www.fourmilab.to/cgi-bin/uncgi/Earth

Global Weather *(continued)*

Outcomes

Students will be expected to

- using scientific theory, illustrate and explain heat energy transfers that occur in the water cycle (115-2, 331-1)
  - describe cloud formation
  - identify and define the three main categories of clouds: convective, frontal, orographic
  - classify clouds into their two general types: cumulus and stratus
  - describe the conditions necessary to form fog
  - describe how cloud cover helps maintain the energy balance on earth
- use weather data to describe and explain heat transfers in the hydrosphere and atmosphere showing how these affect air and water currents (214-3, 331-2)
  - define jet stream, prevailing winds, ocean currents, El Nino, hydrosphere, atmosphere
  - identify the different prevailing winds around the Earth
  - describe the formation of "global winds"
  - explain the importance of convection and the Earth's rotation in causing prevailing winds
  - describe how each of the following is formed:
    - (i) Alberta clipper
    - (ii) Colorado low
    - (iii) weather bomb
    - (iv) nor'easter

Elaborations—Strategies for Learning and Teaching

Teachers should have students complete the "Try This" activity "Observing Clouds" on page 229 of the student textbook. Several methods of making clouds may be found at the National Science Digital Library Website. Teachers should relate cloud formation to the water cycle and have students identify the impacts clouds have upon weather.

Teacher may wish to use BLM 4.13a of the teacher's resource to show the variety of clouds within the general classification of cumulus and stratus. BLM4.13b can be used to evaluate the general classes of clouds. An excellent extension activity would be for students to investigate more specific cloud classifications for the general classes of clouds. While an examination of the more specific classification and names of clouds can be done for enrichment or in response to student interest, teachers should not require students to know the more specific classification.

Teachers could use the global winds activity outlined on the NASA website to help students identify the locations and names of the various global winds. Teachers may wish to refer to the University of California website for more detailed information on the various global winds.

Students should realize that many of the global winds impact our weather and climate, even though they are thousands of kilometres away. For example, the mid-latitude westerlies bring a lot of unsettled weather in from the south. Also, these winds carry pollution from the industrial areas of the eastern United States to our shores.

To demonstrate the formation of prevailing winds ask students to take a non-permanent marker and try to draw a straight line up from the 30^{o} N latitude of a globe spinning counter clockwise. Repeat this but, draw the line down from the 30^{o} N latitude. This will show the direction of wind deflection in the northern hemisphere, i.e., the prevailing westerly winds.

Global Weather *(continued)*

Suggested Assessment Strategies

Journal

- In their journal, students could record their observations of cloud types and predict the weather for the next 12 hours.(214-3, 115-2)

Presentation

- Using various materials, students could make models of different cloud types. Students would then explain their model to the class. (214-14, 215-5)
- Students could create a poster or multimedia presentation on the various types of clouds and cloud formations. (215-5, 331-1)

Paper and Pencil

- Students could describe the effects of the jet stream on air travel. Compare the time of a direct flight from east to west and west to east. (214-11, 214-3, 331-2)
- Students have seen a video that describes cloud formation and how lakes and oceans are sources of water vapour. From the notes, the teacher could ask them to identify the important factors in cloud formation. (212-1)
- They could describe an investigation that tests the assumptions made in the video about each of these factors. (212-1)

Journal

- Students could track the position of the jet stream and make weather observations and draw conclusions about the effect of the jet stream's position on local/regional weather conditions. They could record this in their journal. (331-2, 214-3, 214-11)

Presentation

- Students could prepare an explanation of why, even though Newfoundland and Labrador does not have a lot of heavy industry, there is still a significant amount of acid precipitation. (331-2, 214-11)

Resources

Science 10,
Concepts & Connections

National Science Digital Library http://avc.comm.nsdlib.org/cgi-bin/wiki.pl?Making_A_Cloud

ST: pp. 228-229

SRL: pp. 359-361

TR: pp. 4-49, 4-50

BLM: 4.20, 4.21

ST: pp. 230-233

SRL: pp. 362-367

TR: pp. 4-53

BLM: 4.22

NASA Website Re: Global Winds: http://kids.earth.nasa.gov/archive/nino/global.html

Global Winds Information at University of California: http://calspace.ucsd.edu/virtualmuseum/climatechange1/08_1.shtml

Global Weather *(continued)*

Outcomes

Students will be expected to

- explain how scientific knowledge evolves about changing weather patterns with new evidence about changes in ocean temperature (115-6)
  - identify three factors that are responsible for causing ocean currents. Include:
    (i) solar energy
    (ii) wind
    (iii) water density
  - identify the three ocean currents that impact the weather and climate in Canada. Include:
    (i) Alaska current
    (ii) Labrador current
    (iii) Gulf stream
  - describe two effects ocean currents have on weather and climate. Include:
    (i) temperature change
    (ii) precipitation change
  - describe how the El Nino effect is created
  - describe the effect of El Nino on North American weather
- apply and assess a global model for weather which interprets the influences of:
  (i) solar energy
  (ii) cloud cover
  (iii) Earth's rotation
  (iv) global winds
  (v) ocean currents
  (v) land and water masses (214-6)

Elaborations—Strategies for Learning and Teaching

Students will have encountered the term "density" before. Teachers should ensure students have the correct concept of density. Teachers may wish to define density as the amount of material in a set sample of a substance. The more material present the greater the density (e.g., an equal volume of water is denser than that of the same volume of air). Density is related to mass (weight) in that an equal volume of a higher density substance (e.g., block of lead) will weigh more than an equal volume of a less dense substance (e.g., block of Styrofoam). Cold air is denser than warm air so it sinks while warm air rises (this creates a convection current). Cold air is denser than warm air because the cold air has less energy, thus the air particles are closer together.

Teachers could use BLM 4.15 in the teacher's resource, to ask students to draw and label the cold and warm ocean currents that affect Canada. (For clarity, students should use different colours.)

Similar to global winds, ocean currents often exert an impact on coastal communities at great distances away from where they originate. Teachers can find detailed information on the effects of El Nino in many popular news magazines, on Environment Canada's website, or the general weather information website. Teachers could demonstrate ocean currents using the enrichment activity of the Teacher's Resource, p. 4-56.

In this section it is important for students to understand that there is no single event that creates weather or climate. Weather and climate are influenced by many factors which are summarized in this section.

Global Weather *(continued)*

Suggested Assessment Strategies

Observation

- Students could take on the role of a storm tracker. They could track the movement of a low pressure system as it moves across North America. (214-3)

Paper and Pencil

- Students could research the impact that the ocean currents play in the fishery of Newfoundland and Labrador (e.g., impact on spawning, migration patterns, food supply, etc). (115-6)
- Students could research the role ocean currents played in early exploration or in environmental problems such as oil spills. (115-6, 214-11)

Presentation

- Students could create a "who am I" card with three identity hints, similar to BLM 4.16. They could then take turns trying to guess the identity on each other's card by receiving hints. (331-2)
- Students could prepare a report or presentation on the relative impacts of ocean currents have to places that are of similar latitude (e.g., Baie Verte, NL and Lands End, England) in terms of their climate and vegetation. (115-6, 215-5)
- Solve the mystery! A young girl drops a bottle containing a note in the water off Bonavista and months later another young girl in Scotland picks it up off the beach and reads it. Explain how this event occurred in terms of ocean and wind currents. (214-11)

Resources

Science 10,
Concepts & Connections

ST: pp. 230-233

SRL: pp. 362-367

TR: pp. 4-55, 4-56

BLM: 4.23

ST: pp. 234-235

SRL: pp. 368-371

TR: pp. 4-57, 4-58

BLM: 4.24

Extreme Weather Events

Outcomes

Students will be expected to

- describe and explain the effects of heat transfer on the development, severity, and movement of weather systems (331-4)
  - distinguish between weather watch, weather advisory, weather warning
  - define and identify the main features of the following extreme weather events:
    (i) thunderstorms
    (ii) tornadoes
    (iii) hurricanes
    (iv) blizzards
    (v) floods
  - describe the three main features of a thunderstorm. Include:
    (i) updrafts (developing stage)
    (ii) heavy precipitation (mature stage)
    (iii) reduced precipitation (fizzle stage)
  - distinguish between flash flood and broadside floods
  - describe how each of the following have such major effects on weather in Atlantic Canada:
    (i) Alberta clipper
    (ii) Colorado low
    (iii) weather bomb
    (iv) nor'easter

Elaborations—Strategies for Learning and Teaching

To start this section, teachers could bring copies of newspaper stories that describe some extreme weather event. Ask students to discuss the various types of extreme weather events that they have experienced. Which type of extreme weather event is the most destructive? Teachers could ask students to access Environment Canada Weather Watches, Warnings, and Advisories website to help them develop an understanding of the difference between a watch and a warning as well as the different types of weather conditions that are involved. Teachers could also use Environment Canada's "Top 10 weather stories" site to ask students to look at the most extreme weather events of the previous year (or for other years in the archive).

Teachers and students can refer to the Environment Canada website and/or the Weather Network for information and definitions.

Using two 2L pop bottles (inverted and taped together which contain approximately 1.5 L of water, see diagram) students could demonstrate a tornado by spinning the water and inverting the bottles. The vortex, that demonstrates the movement of air, can be easily seen as the water moves from one bottle to another.

These events have a tremendous impact on Canada's weather. Students could research these terms and the folklore surrounding them on the Internet. The Alberta Clipper is a low pressure system that travels eastward from the prairies across the Great Lakes, picks up moisture and energy, finally making its way to eastern Canada. A Colorado Low is an intense low pressure system originating in the south central United States and travels to the eastern seaboard. A weather bomb occurs when two or more low pressure systems combine to cause severe weather. A Nor'easter is a tropical low pressure system, heavily laden with moisture and energy, that travels in a northeasterly direction along the eastern seaboard.

Extreme Weather Events

Suggested Assessment Strategies

Performance

- Students could create a poster display that shows the impact of El Nino on weather far removed from Peru. (115-6, 214-3)

Paper and Pencil

- Assuming an extreme weather advisory was issued for your area, what precautions could you take to prepare for the impending storm? Include a list of items that would be necessary for emergency purposes. (331-4, 214-16)
- Pick a popular movie that has a weather-related theme (e.g., The Perfect Storm, Twister, etc). Critique the accuracy of the movie's portrayal of the weather event (i.e. is it scientifically sound and/or believable? etc). (331-4, 215-5)

Journal

- Students could make a journal entry in which they document their recollection of the biggest storm or most severe weather event of the year or which they experienced first hand. (214-3)

Presentation

- Students could create and perform an interpretative dance, poem, rap, or song that describes the "life cycle" of a thunderstorm. (215-5)
- Students could prepare a presentation (multi-media or other) on the main features of one type of extreme weather event. (215-5)

Resources

Science 10,
Concepts & Connections

ST: pp. 238-240

SRL: pp. 379-383

TR: pp. 4-60, 4-62, 4-63

BLM: 4.6, 4.7

Environment Canada (Severe Weather Watchers Handbook) http://www.msc-smc.ec.gc.ca/education/severe_weather/index_e.cfm

Environment Canada Weather Watches: http://www.msc-smc.ec.gc.ca/cd/brochures/warming_e.cfm#1

Environment Canada "Top 10 Weather Stories": http://www.msc.ec.gc.ca/media/top10/index_e.html

The Weather Network http://www.theweathernetwork.com/inter/help/glossary/index.htm

Extreme Weather Events

Outcomes

Students will be expected to

- select and integrate information about weather from a variety of sources. Compile and display this information to illustrate a particular hypothesis about weather in the Atlantic region (213-7, 214-3, 215-5)
- analyze the interactions between the atmosphere and human activities (330-4)
  - describe how human activities can impact global weather patterns
  - describe the causes and impact of the greenhouse effect
  - identify how human activities may increase the number and intensity of extreme weather events
  - describe the impact of climate change on economic, social, and environmental conditions
  - describe the economic and social impacts of extreme weather events
- identify and describe science- and technology-based careers related to weather (117-7)

Elaborations—Strategies for Learning and Teaching

The skills outcomes 213-7, 214-3 and 215-5 are addressed (in whole or in part) by completing *Extreme Weather in the News*, CORE ACTIVITY #7.

Teachers could arrange students in groups of 2 or 3 to complete Core Activity #7. Students could create a poster or a multi-media presentation to report/summarize their findings.

Teachers could ask students to refer to Environment Canada's "Severe Weather Watchers Handbook" for more information.

Teachers should relate this topic back to the study of the environment in Unit 1 specifically to the impacts of humans on natural cycles. Students could be required to do some research to determine the relative impact of the "power of one" philosophy as it relates to environmental issues.

Students could get involved in climate change activities (e.g., one tonne challenge, recycling, and so on). Students could also develop a program or advertising campaign to try and get their school and community involved in reducing the causes of global warming/climate change.

Teachers could access up to date information about climate change, Canadian data, etc. at the Universtiy of Moncton Ecosage website.

Teachers could require students to explore their contributions to climate change by calculating their Ecological footprint. Students complete "work the week" activity to calculate their CO_2 contributions. This calculator can also be accessed through the Government of Canada's climate change site which has lots of supporting activities and informations.

The websites provide range in their level of sophistication. Teachers should preview them to ensure they are appropriate to the academic level of their class.

Extreme Weather Events

Suggested Assessment Strategies

Paper and Pencil

- Students could write a newspaper article from the point of view of a person who is involved in an extreme weather event (e.g., emergency services person, a person whose house was washed away in a flood, a news reporter, etc). (331-4, 213-7, 214-3)

Portfolio

- Using extreme weather events as a starting point, create a board game similar to "The Game of Life" (e.g., the player draws a card with "your house is hit by a tornado, lose $20,000 and go back 5 spaces", "school is closed today due to a weather bomb, you get to go back to sleep and then go ahead two spaces", etc.). (114-6, 215-1)
- Students could describe the typical "day in the life" of a meteorologist. (215-5)
- Students could create a collage of news reports about extreme weather events that have occurred in the recent past. (213-7, 214-16)
- Students could access photos of people doing various seasonal activities. They could then be asked to identify how these activities could be affected due to climate change. (330-4, 215-5)

Journal

- Students could write a list of personal actions they could take to reduce CO_2 emissions. (330-4, 215-5)
- Students could write a journal entry in which they identify those activities that will be lost if the current trend in climate change continues (e.g., skating, ice fishing, etc.). (215-5)

Presentation

- Students could become involved in the One Tonne Challenge and develop a presentation and/or promotional materials that they could use to get more members of the school and general community involved. (215-5, 330-4)

Performance

- Students could calculate their Ecological Footprint and record a reflection in their journal. (330-4, 213-7, 214-3)
- Students could organize or be involved in a debate around the issue of climate change, incorporating social, economic, and environmental impacts. (215-5)

Resources

Science 10,
Concepts & Connections

ST: pp. 236-237

SRL: pp. 372-378

TR: pp. 4-62, 4-63

ST: pp. 242-243

SRL: pp. 385-387

TR: pp. 4-67, 4-68

BLM: 4.25

University of Moncton Ecosage: http://www.umoncton.ca/ecosage/climatechange.htm

Climate Change and Extreme Weather events: http://www.worldwildlife.org/climate/extreme_weather.pdf

Ecological Footprint Calculator: http://www.bestfootforward. com/footprintlife.htm

Environment Canada Climate Change Links: http://www.msc-smc.ec.gc.ca/education/scienceofclimate change/links/index_e.html

Government of Canada Climate Change Site: http://www.climatechange.gc. ca/english/students/games.asp

ST: p. 241

SRL: p. 384

TR: pp. 4-65, 4-66

Extreme Weather Events

Outcomes

Students will be expected to

- analyze a possible cause for extreme weather and describe some of the effects. (214-11, 214-17, 330-4, 331-4)
- describe the cause and effects of seasonal weather events such as localized flash flooding (212-1, 330-6)
- integrate global climate change to local weather patterns. (213-7)

Elaborations—Strategies for Learning and Teaching

A CORE STSE component of this unit incorporates a broad range of Science 2200 outcomes. More specifically it targets (in whole or in part) 214-11, 214-17, 330-4, 331-4, 212-1, 330-6 and 213-7. The STSE component 2-3, *Severe Weather*, can be found in Appendix A.

Extreme Weather Events

Suggested Assessment Strategies

Interview

- Students could interview older members of their family and community to determine how often they were affected by "sudden weather events" such as an unexpected storm (i.e. how well their methods of predicting weather events worked for them versus how well the current weather satellite imaging works). (115-6, 215-5, 114-6)

Resources

Science 10, *Concepts & Connections*

Core STSE #2-3: *"Severe Weather",* Appendix A

APPENDIX A: STSE

Important Notes

1. These STSE modules are intended for teacher reference. Each is designed to target specific outcomes within Science 2200. It should be noted that the activities associated with each module are NOT mandatory. They are suggested activities to be used at the discretion of the teacher.
2. These STSE modules and the associated supplements can be found at www.gov.nl.ca/edu/science_ret/sp/sci2200.htm

1-1 The Diversity of Life

Outcomes:

1. Evaluate relationships that affect the biodiversity and sustainability of life within the biosphere. (NLS-1)
2. Analyze from a variety of perspectives the risks and benefits to society and environment of applying scientific knowledge or introducing a particular technology (e.g., analyze the risks and benefits of using insecticides such as DDT). (118-2)
3. Illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking carbon, nitrogen and oxygen. (318-1)
4. Evaluate the importance of biodiversity to life on Earth. (318-6)
5. Explain how biodiversity of an ecosystem contributes to its sustainability. (318-6)

Introduction

When studying ecosystems, ***biologists*** use the term ***biodiversity*** to describe the types of plants and animals found in an area. Biodiversity is the total of all living organisms in an area like a park, a lake or a whole province. In Newfoundland and Labrador, this might include bears, wolves, spruce trees, trout, frogs, and eagles. It would not include elephants, tigers, crocodiles, or palm trees since these organisms are not normally found here. All living things on our planet are connected. No one thing can live in isolation from other living things. Plants need the sun to make their food then animals eat plants and other animals. Living things die and ***decomposers*** break them down so that new plants can make food. This has been the cycle of life for billions of years.

Biologists: A person who studies living things and where live

Biodiversity: The different types of living things in an area

Decomposers: Things like mushrooms, worms and insects that breaks down dead organisms

Ecosystem: A place where organisms live together sharing their physical environment

An ***ecosystem*** is the interaction of living organisms (plants and animals) and their physical environment like water, soil and sunlight. Without biodiversity, these systems of life would not work properly or survive. Having a wide diversity of life on Earth is important for three reasons:

1. *Ecological Values*

All living things are supported by the way plants and animals use their environment. Loss of biodiversity makes ecosystems ***unstable***, more vulnerable to extreme events, and weakens its natural cycles. For example the ***carbon/oxygen cycle*** balances the amount of carbon dioxide and oxygen on Earth through living things like plants and animals. Carbon and oxygen move through living things by animal breathing and plant decay. Even the burning of fossil fuels generates carbon dioxide (CO_2) in the atmosphere. An example of this would be, when gasoline is burned in cars or when garbage is burned in incinerators. Trees and plants use CO_2 to make food (in the form of sugar) that is necessary to grow. Then they release oxygen (O_2) back into the atmosphere, which gives air to breath.

Unstable: Not able to continue without help

Carbon cycle: Natural cycle of carbon from living things to the atmosphere and back

Oxygen cycle: Natural cycle of oxygen from the atmosphere to livings things (breathing) and back

2. *Economic Values*

Many different living organisms in the environment provide humans with the things needed to live. This forms the basis for our economy. Everything we buy and sell originates from the natural world. For example, the lumber that we build our homes with comes from trees in our forests. The food we eat comes from both the natural world and on man made farms where fruits, vegetables, and animals are raised. About 40% of the drugs used for medicine are developed in some way from the variety of wild plants and animals in our world. This often includes the weeds we consider pests and things that are poisonous to us. Before the making of ***synthetic*** drugs, humans used natural medicines and in many places of the world this is still true. For example, dandelion root can be use to make a laxitive while morphine is obtained from poppy flowers.

Synthetic: Not occurring naturally; made by man

3. *Cultural Values*

Most people feel connected to nature, often for reasons that can be hard to explain. Some people love the woods and others love the ocean. Both are heavily connected to the culture of Newfoundland and Labrador. In our province, the lifestyles of past generations depended on the natural environment. The ocean provided fish for food and for money, the land provided wood for shelter and heat, and wild animals provided extra meat during the long winters. Today, the people in our province still show a connection to the environment. In fact, the people from Newfoundland and Labrador are well known across North America for their special connection with nature. We use it for recreation, sport, hunting and fishing, hiking, camping, and many more activities. Thus our cultural diversity is strongly linked to our province's biodiversity.

Analysis

1. a) What is biodiversity?

   b) Why is it important to the cycle of life?

2. a) What is an ecosystem?

   b) How are ecosystems connected to biodiversity?

3. Explain three reasons why diversity of life is important to people.

4. Make a list of the many plants, animals and other living things that make up the biodiversity in your area. When you have finished, use the following tables to organize your list.

Plants - Write in the names of some local plants and indicate the group they belong to by placing an X in the appropriate block.

Plant Name	Conifer	Deciduous	Shrub	Grass	Moss	Other

Animals - Write in the names of some common animals and indicate the group they belong to by placing an X in the appropriate block.

Animal Name	Insect	Herbivore	Bird	Pedator	Fish	Rodent	Other

Extension

1. Many everyday things come from our environment. Check out this activity online to see if you can identify all the things made of wood. Go to the following website: http://www.cppa.org/english/info/paperch.htm and try the activity.

References

Biodiversity, Conservation and Forest Management (http://www.wri.org/biodiv/)

A Great Destruction (http://collections.ic.gc.ca/cod/histor10.htm)

http://isis.csuhayward.edu/alss/geography/mlee/envt2000/biodivf99.htm

THE IMPORTANCE OF BIODIVERSITY TO CANADA (http://www.globalcentres.org)

http://www.ology.amnh.org/biodiversity/

1-2 Loss of Biodiversity

Outcomes:

1. Understand that biodiversity loss due to human activity adversely affects ecosystems. (NLS-2)
2. Analyze social issues related to rates of global extinctions. (118-9)
3. Communicate questions, ideas, and intentions, and receive, interpret, understand, support, and respond to the ideas of others. (215-1)
4. Identify multiple perspectives that influence a science-related decision or issue. (215-4)
5. Explain various ways in which natural populations are kept in equilibrium and relate this equilibrium to the resource limits of an ecosystem. (318-5)

Introduction

How are we contributing to the loss of biodiversity around the world? As the number of human beings increases so does our dependence on technology. This causes an increased need for energy to power that technology. This puts greater pressures on both our ***local*** environment and even on the ***global*** environment. Because our North American society is strongly connected to economics and the importance of making money, our ever-increasing demand on our environment is adding to biodiversity loss. In fact the rate of loss is now higher than it ever was before.

Local: The environment close to us

Global: Refers to the whole planet

Extinction: When all of one organism has completely disappeared

Extinction can be defined as the permanent disappearance of an organism. In other words, all the members of one type of organism have died. This means a loss of biodiversity. According to the David Suzuki Foundation, we are endangering the existence of living things to the point where we are losing at least one per cent of existing species per decade. This means we are losing at least two species an hour. That is 2,500 times greater than the rate due to other natural processes.

When organisms become extinct they are gone forever. Their contributions to other organisms are also gone forever. Food, shelter, and medicines linked to many organisms are lost forever. Considering there may be potential cures for some cancers and other diseases, it seems unfortunate we would allow this to happen. The movie "Medicine Man" starring Sean Connery shows just how important these plants and animals are to the world.

In our province we have lost the great Auk, the sea mink, and the Labrador duck. The full impact on their disappearance is not known. Others are ***threatened*** or ***endangered*** like the pine marten, the piping plover, and the wolverine. If they go the way of the great Auk, what will the effects be?

Threatened: decreasing in number, close to endangered

Endangered: continuing to decrease, close to extinction

Analysis

1. What is contributing to biodiversity loss around the world?
2. What does the term "extinction" mean?
3. What does the David Suzuki Foundation say is the current rate of extinction? How much greater is this compared to the past?
4. List three ways that biodiversity loss can affect us in Newfoundland?
5. a) List the names of three organisms that have become extinct in Newfoundland and Labrador.

   b) List three organisms that are threatened or endangered.

Extention

1. Read the importance of biodiversity and the effects of losing it at http://www.ology.amnh.org/biodiversity/index.html.

References

Encyclopedia of Biodiversity

(http://www.biodiversity.nl/encyclopedia.htm)

The David Suzuki Foundation

(http://www.davidsuzuki.org/WOL/Biodiversity/Importance.asp)

http://www.ology.amnh.org/biodiversity/

1-3 Direct Impacts of Biodiversity Loss

Outcomes:

1. Defend a decision or judgement and demonstrate that relevant arguments can arise from different perspectives. (118-5)
2. Propose a course of action on social issues related to science and technology, taking into account human and environmental needs. (118-9)
3. State a prediction and a hypothesis based on available evidence and background information (e.g., predict the impact of fishing or harvesting resources such as seaweed, after examining an aquatic ecosystem; predict the impact on an ecosystem of supplying an excess of food for a particular organism). (212-4)
4. Describe the significance of global warming. (215-1)
5. Explain why different ecosystems respond differently to short-term stresses and long-term changes. (318-4)
6. Analyse the impact of external factors on an ecosystem. (331-6)

Climate Change

Humans are destroying the tropical rainforest in Brazil. This may seem to be an unimportant event far removed from the everyday life of the average Newfoundlander and Labradorian, but its loss is very significant to us.

When these rainforests are destroyed, plants and animals die because they lose their ***habitat***. Also, destroying trees releases large amounts of carbon dioxide (CO_2) into the atmosphere. This significantly increases the warming of Earth. Plants naturally use carbon dioxide to make their food in a process called ***photosynthesis***. This process uses the energy from sunlight to make sugars that plants and animals use for food.

When plants make their food they also produce oxygen (O_2) that we breathe to survive. Unfortunately, the extra carbon dioxide adds to the ability of the earth's atmosphere to trap heat from the sun. This effect of making our planet a little bit warmer each year is called the ***Greenhouse Effect***. For us, this means many things, the most important being changes to our climate and weather patterns. Most climate scientists agree that human activity is changing our climate. As Figure 1shows, there has been a significant increase in greenhouse gases in the last 100 years.

Habitat: Where an organism lives or its home

Photosynthesis: Carbon dioxide + water → sugar + O_2

Greenhouse Effect: The effect of increasing the temperature of Earth by increasing greenhouse gases like carbon dioxide in the atmosphere

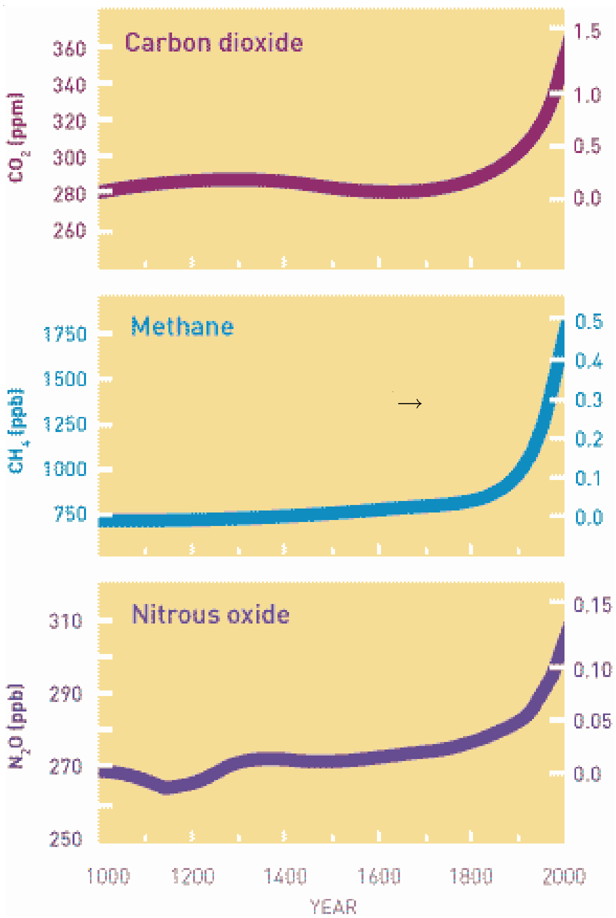


Figure 1: Gobal atmospheric concentrations of three well-mixed greenhouse gases.

The graphs show that there has been a significant increase in the levels of these three greenhouse gases since the year 1900. The carbon dioxide levels in particular have tripled from the year 1900 to 2000.

The ***pollutants*** we pump into our atmosphere are changing its make-up and preventing heat from escaping Earth's surface. Today's atmosphere contains 32 per cent more carbon dioxide than at the start of the industrial era about 150 years ago.

> **Pollutants:** Things that make the environment dangerous to life

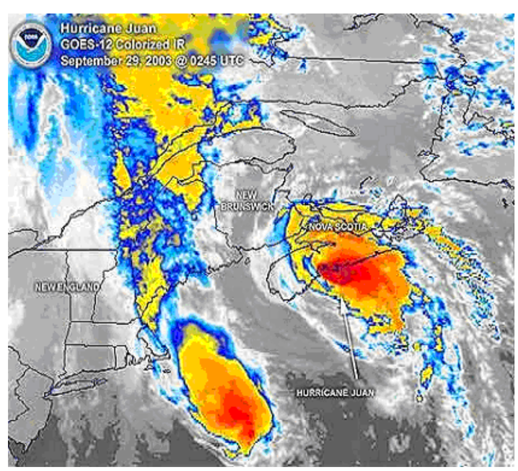
The result is climate change. This means long-term changes in weather patterns. One example is global warming, a rise in the average global temperature. This is a good measure of climate change. And it has already begun. Global average temperature has risen by almost 1 degree Celsius since 1900, and the northern hemisphere is substantially warmer now than at any point during the past 1000 years. This may not seem like much; however, it may be enough to melt the polar ice caps!

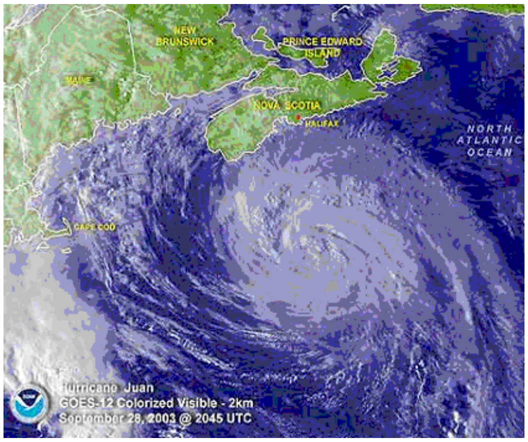
Burning fossil fuels such as coal, oil and gas is largely responsible for the climate change. ***Deforestation***, particularly of the rainforests, and modern farming methods also contribute to the problem.

> **Deforestation:** The process of removing trees from an area

A recent weather event in Atlantic Canada gives some proof of our changing climate. On September 29, 2003, Hurricane Juan hit Halifax, Nova Scotia. Although it is not uncommon to have hurricanes hit Nova Scotia or Newfoundland and Labrador, what made this one different, according to the Canadian Hurricane Centre, was its intensity as it moved from the ocean to the land.

Hurricane strength is measured in categories numbered 1 through to 5 with a category 1 being the least powerful and a category 5 the most powerful. Hurricane Juan as it came ashore was barely a category 2 hurricane with maximum sustained wind speeds of 158 km/h. Based on hurricane records during the past 100 years, it appears that such a strong hurricane in Nova Scotia occurs only once in 50 years. This means we may see more hurricanes more often in Atlantic Canada.





So what made Juan so powerful when it reached Nova Scotia? The answer to that question has a lot to do with the unusually warm water temperatures at the surface of the ocean during the tail end of September 2003. Hurricanes need 26° C (Celsius) water to grow stronger. Once they move over colder waters, they begin to weaken. The rate at which they weaken depends strongly on the water temperature. The general water temperatures between the Gulf Stream and the Nova Scotia coast on September 28th were about 18° C. The normal temperatures are around 15° C for this date, so this meant a 3° C increase. Juan was very powerful because the warmer-than-normal water did not allow the hurricane to weaken as it hit Halifax.

There is more to the story than just water temperatures. Hurricane Juan actually did not weaken much at all when it headed across the cooler shallow waters south of Nova Scotia. The hurricane actually accelerated. As a result, the hurricane spent less time over the cooler waters because it was moving so fast. This meant there was less time for the storm to weaken.

The warmer-than-normal water can have two effects. First, it can keep the hurricane going a little longer than it normally would. Second, it made the winds stronger because the air above the ocean was unstable. This meant stronger winds reaching the ground and ocean. If stronger winds reach the ocean, then these winds can help fuel the storm with more moisture and energy from the water. There are indications that hurricane Juan may have been 20-30 km/h weaker than when it hit Nova Scotia under normal conditions. That means it probably would have been about a 130 km/h storm, making Juan less violent and distructive. When you factor in the increased stability of the atmosphere over 15° C water (as opposed to the 18 ° C water it was), then this may account for 10-20 km/h less wind at the surface. The result is a weaker hurricane hitting the coast, with less damage.

More work may need to be done in order to measure the influence of ocean surface water temperature on the intensity of hurricanes in Atlantic Canada. If the seemingly small change of water temperature from 15° C to 18° C makes a large impact on storm strength, then we should be very concerned about long-term trends in ocean temperatures. This could happen with an increasingly warmer climate or with changes in the ocean water temperatures of the Gulf Stream. We may see even warmer waters moving toward Nova Scotia and the rest of Atlantic Canada.

We are not sure if changing climate conditions in Newfoundland and Labrador are directly linked to loss of biodiversity in regions like the Brazilian rainforest. What we are sure of is that our yearly weather patterns are changing and more severe weather is predicted to occur in the near future. Conserving existing ecosystems must be a priority in all regions of our planet if we are to see a settling of climatic conditions. See **STSE 1-3 Supplement A** for a first hand account of hurricane Juan's effects.

Analysis

1. a) Identify three greenhouse gases.
   b) Which one is linked directly to the loss of the rainforest?
   c) What effect do these gases have on the atmosphere?
2. When did Hurricane Juan hit Halifax? Why was this date so important?
3. Why was this a significant storm for our region?

Extension

1. Research how hurricanes form and where they are most common.

Economic and Cultural Effects

In June 1497, John Cabot arrived in Newfoundland waters. He reported to the King of England that the fish were so plentiful you could catch them in baskets. In July of 1992, the Government of Canada closed a fishery that was nearly 500 years old and was the backbone of rural Newfoundland and Labrador. The Northern cod stocks were deemed to be so low that an immediate ban was placed on all cod fishing in hopes that the cod population would recover.

There were 5 contributing factors to the cod population decline. These were:

1. Excessive offshore fishing by foreign fishing fleets and Canadian fishing vessels;
2. Improvements in fishing technology e.g. Factory trawlers and fish finders;
3. Decline in cod food sources e.g. over-fishing of capelin which is one of the cod's main foods;
4. Changing water temperature;
5. General mismanagement of the resource by setting quotas too high.

On July 2, 2002, government officials and various ***stakeholders*** in the fishery marked the tenth anniversary of the closure of the Northern cod fishery. The Premier at the time, Roger Grimes, was quoted as saying:

> **Stakeholders:** Those who have an investment of money or employment

> "The Northern Cod Moratorium was a significant event in Newfoundland and Labrador. Despite the moratorium, the people in the province endured and worked even harder, to diversify and revitalize the fishery. This has been a powerful testament to the spirit and tenacity of Newfoundlanders and Labradorians, and today we honour our people in the fishery."

The provincial government, along with FANL (Fisheries Association of Newfoundland and Labrador) and the FFAW (Fishermen, Food and Allied Workers), unveiled a plaque, which reads:

> *For nearly 500 years the fishery sustained, employed, and defined the people of Newfoundland and Labrador. Generations of coastal people built a fishing society along thousands of kilometres of rugged coastline. On July 2, 1992, five centuries of fishing activity was abruptly halted. The northern cod moratorium altered the fabric of our province - economically, socially and culturally. Yet the people of our fishery endured. We honour their strength, determination and perseverance.*

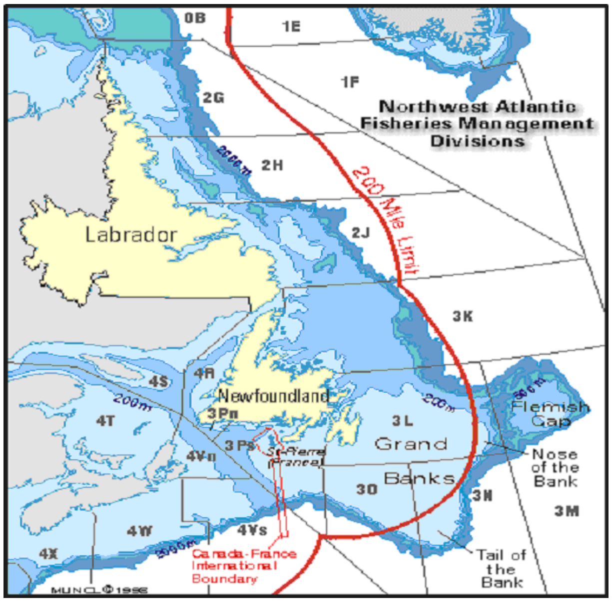
The loss of the cod fishery delivered a significant blow to the Newfoundland and Labrador economy and it shaped the fishery of the 21st century. The term ***underutilized species*** became common to describe a new and diversified fishery. Marine species and products such as snow crab, shrimp, sea urchins, scallops, capelin roe, surf clams and mussels are now being fished or harvested that historically were not. People did not need to fish them because cod was so abundant.

> **Underultilized:** An organism not normally caught or taken by people

The loss of the northern cod as a valuable commercial fish has resulted in increased fishing pressures on these so-called underutilized species. The new fishery has fewer people employed but the technology now available makes fishing and processing faster and more efficient. More money is being made but by a smaller section of outport Newfoundland and Labrador.

Already, the fear of over-fishing crab and shrimp species has arisen. In a CBC news story, ***Fishermen see warning signs in crab report***, it was noted that the latest stock assessment of snow crab has fishermen wondering whether the crab could go the way of the cod. Will there soon be a crab moratorium?

A federal report on crab stocks released in 2003 indicates the amount of crab available has dropped significantly off southern Labrador and Newfoundland's south coast in particular. In the stock status report, scientists estimate the amount of crab available to be fished in Division 2J, (a fishing zone off southern Labrador), decreased by 94 per cent between 1998 and 2002.



Another obvious effect on the Newfoundland and Labrador economy and culture has been the ***out-migration*** of people directly linked to the cod fishery. Between the 1970's and 1980's about 3 700 people per year moved from the island of Newfoundland. Since 1993 and the closure of the fishery, that number has almost tripled. Specifically, in the years 1997-1998, out-migration reached about 11 000 people. The impact has been felt almost entirely in outport communities where fewer people are left to work or carry on local traditions.

> **Out-migration:** When people leave their community or province

With a loss of young people in our province comes an increase in the percentages of older individuals. This in turn results in an aging workforce, increased medical costs, reduced school populations, and a general cultural deterioration.

The near loss of one marine species, in this case the northern cod fish, has increased human predation pressures on marine organisms not normally fished, in particular, marine organisms like cod, crab and shrimp. This has affected the provincial economy, reduced our net population and in turn affected our cultural well-being. Obviously, the lifestyle of the people in our province is directly linked to the biodiversity of our region.

However, with better monitoring, improved technology and an educated fishing industry, the aim is not to repeat the mistakes of the past. In 2003, the fishing industry in Newfoundland and Labrador exceeded 1 billion dollars in total value to our economy. This was a mark never reached when the cod fishery dominated.

See **STSE 1-3 Supplement B and C** for two specific effects that resulted from the loss of the cod fishery.

Analysis

1. a) Which fishery was closed in July 1992?
   b) Has it recovered in 2003?
2. a) Why was this fishery closed?
   b) What led to its closure?
3. a) How has this closure affected the people Newfoundland and Labrador?
   b) How has it affected other marine organisms?
4. What does the term "underutilized species" mean? Give three examples.
5. Explain how the loss of biodiversity has had a negative effect on the people of Newfoundland and Labrador.

Extension

1. What other organisms are at risk in Newfoundland and Labrador? Research one of them to determine their current condition, what is being done to help, and their probable future? The following website may help http://www.speciesatrisk.gc.ca/default_e.cfm.

Ecological Effects - The Appearance of a New Species

On March 29, 1985, three visitors were seen coming ashore from pack ice off Marches Point on the Port au Port Peninsula on the west coast of the island of Newfoundland. Although the presence of three unexpected visitors is usually not something to make particular note of, in this case, however, it was. The three in question were thought to be wolves. Additional sightings of others similar to these were made from 1986 to 2000, including trappings. This information proved them to be the eastern coyote (*Canis latrans*). As of 2004, they have been sighted in almost every area of the island of Newfoundland.

A likely competitor for the coyote would have been the Newfoundland wolf (***Canis lupus beothucus***), but it disappeared in the 1920's. Humans hunted it because some felt it was a threat to both sheep and human populations. Yet, to this day, in North America, there has not been a single, proven case of a person being killed by a healthy, unprovoked wolf.

Newfoundland wolf (***Canis lupus Beothuscus***)

Ned Pratt Photo

So, how are the two events related? The answer lies in the changes to our biodiversity.

With the absence of a native wolf population to act as a ***natural control*** on coyote populations, there may be increased predation rates on woodland caribou, arctic hare, and the endangered Newfoundland pine marten by coyotes. As well, there may be increased competition with lynx and red fox for food and space when coyote numbers rise.

> **Natural Control:** Things in the environment that keep populations low, like predators, disease and lack of food

There has been one documented observation of a coyote hunting arctic hare and several unconfirmed reports of predation on caribou. The addition of another significant predator on the snowshoe hare may cause a change in natural population cycles and cause reductions in the yearly catch by people. Caribou young are especially vulnerable to coyote predation and a large proportion of calf mortality has been caused by coyotes in a small caribou herd in southern Quebec.

As reported elsewhere, the increasing coyote populations may also result in reductions in red fox numbers. However, it remains unclear how these two species will interact in this Province. Management of red fox and lynx may have to be re-evaluated when coyotes become well-established in Newfoundland and Labrador. Although the sheep industry in Newfoundland is small, there are implications for individual farmers. There have been two coyote-sheep related predation incidents reported, with several sheep killed in each instance. Ref :("Range Expansion by the Eastern Coyote (***Canis latrans***) to Insular Newfoundland" Government of NL and Lab, Dept. of Tourism, Culture and Recreation)

The seemingly insignificant loss of one animal, the Newfoundland wolf (which could have controlled the coyote population), now has a potentially greater impact 70+ years later. Perhaps maintenance of the wolf population rather than the destruction of it may have been a wiser course of action. Although the wolf population, it appears, was never really large, it was in balance with its environment. Wolf numbers were as large as its habitat could support. It seems the wolf was never a real threat to people. In fact, they helped keep a healthy balance of predator/prey in our environment. The rapid decline in the caribou, in the early 1900's resulted in decline in wolf numbers. This fact, combined with things like disease, habitat loss, and competition, which are ***natural limiting factors***, plus the ***bounty*** on wolves, which is not a natural limiting factor, ultimately led to their extinction.

> **Limiting Factors:** Things in the environment that reduce the numbers of an organism
>
> **Bounty:** A price paid for the capture of animals

Now, 70 years later, the arrival of three visitors to our western shore may force the ecosystems on the island of Newfoundland into a new balance: a balance that may have very few animal species like the snowshoe hare, caribou and fox. The final results are yet to be seen. Nonetheless, its impact on humans, in one way or another, will be measurable.

Eastern Coyote (***Canis latrans***)

See **STSE 1-3 Supplement D** for more information on the Eastern coyote.

Analysis

1. Who were the "visitors" that came to the island of Newfoundland on March 29, 1985? Have they left as of 2003?
2. a) What animal did humans make extinct in the 1920's on the island of Newfoundland?

   b) How did it happen?
3. How has the loss of that animal become important with regard to the "visitors" of 1985?
4. What animals might be negatively impacted by these visitors?
5. In this unit, we have identified that biodiversity is important. Identify three other ways we are destroying it and three ways we can protect it.

Extension

1. New species to an area often have negative results as people see it. Yet, on the island of Newfoundland a number of new animals have been purposely introduced. Research one of these to determine if the introduction was successful ecologically, economically and culturally. (Note: Canadian Geographic has an excellent video on the introduction of moose to Newfoundland)

References

The Atlantic Climate Centre

http://atlantic-web1.ns.ec.gc.ca/climatecentre/

The Canadian Hurricane Centre (Chris Fogarty, Hurricane Researcher, Canadian Hurricane Centre)

http://www.ns.ec.gc.ca/weather/hurricane/juan/intensity_e.html

CBC radio Web One: The One That Got Away

http://www.cbc.ca/webone/cod/index.html

Fishermen see warning signs in crab report

WebPosted Apr 2 2003 11:25 AM NST

http://stjohns.cbc.ca/regional/servlet/View?filename=nf_crab_20030402

http://www.k12.nf.ca/stmarks/grassroots/2001-02/research/outmigration/paper.htm

Range Expansion by the Eastern Coyote to Insular Newfoundlandhttp://www.gov.nl.ca/tcr/wildlife/wildlife_r_m/coyote.htm

The Newfoundland Wolf
http://www.nfmuseum.com/notes8.htm

Coyote - National Park Service
http://www.yellowstonenationalpark.com/coyote.htm

http://www.ctv.ca/servlet/ArticleNews/story/CTVNews/20020630/nfld_cod_anniversary020630/Canada?s_name=

http://www.ctv.ca/servlet/ArticleNews/story/CTVNews/1051872714497_24/?hub=Canada

http://www.ology.amnh.org/biodiversity/

1-4 Ecosystem Change

Outcomes:

1. Examine the change of matter in ecosystems using the concept of the cycling of matter. (318-1)
2. Explain that Earth is a closed system with regard to matter and an open system with regard to energy. (NLS-3)
3. State a prediction and a hypothesis based on available evidence and background information. (212-4)
4. Describe and apply classification systems and nomenclature used in the sciences (e.g., use terms related to abiotic and biotic components in a report of an ecosystem study). (214-1)
5. Explain how humans have changed the flow of energy in ecosystems. (118-2)
6. Defend a decision or judgment and demonstrate that relevant arguments can arise from different perspectives. (118-5)
7. Analyze the flow of energy in ecosystems (306-1)

Introduction

Earth has been circling the sun for more than four billion years. During that time, the matter or materials on our planet keep changing form. For example, water ***evaporates*** from the ocean as a gas, goes into the clouds, ***condenses*** and falls as snow or rain. Igneous rocks are born in volcanoes and spit out as lava, then cooled until solid. Over time they are broken down into dirt. This is washed as ***sediment*** into rivers. In turn, it is compressed back into rock. Another example could be plants taking carbon dioxide (CO_2) gas from the atmosphere and converting it into solid sugars and oxygen. Animals use both for their life processes and produce carbon dioxide.

Evaporates: When a liquid slowly changes to a gas

Condenses: When a gas changes to a liquid, like steam to water

Sediment: A small piece of rock or dirt that sedimentary rocks are made of

Atmospheric: Relates to things in the air

So why doesn't all the ocean water turn into mountain snow, or all the rocks turn into sediment or all the ***atmospheric*** carbon dioxide turn into sugar? Earth still has oceans, mountains and atmospheric carbon dioxide because they are part of the cycling of matter - the water cycle, the rock cycle and the carbon/oxygen cycle. Water falls from the sky, flows in rivers and back to the oceans where it evaporates once more, to again make clouds; buried sediments reach the surface through volcanoes or erosion (wearing down of rocks), and animals chemically change sugars into carbon dioxide that goes back into the atmosphere. These cycles are the key to change and stability in nature. When things like oxygen and water in our world are used up, they have to be replaced through the recycling of matter. In this way, ecosystems are able to change, yet remain stable. When systems change, yet remain ***balanced***, they are said to be in ***dynamic equilibrium***. Dynamic describes a system as always changing, but equilibrium refers to something remaining constant. To maintain a healthy balance, change in an ecosystem is necessary.

Balanced: This means that things are equal or stable

Dynamic Equilibrium: This means things are changing but staying in balance

Closed System: This is a system that does not receive any new matter or materials

Earth is a recycling planet, a planet in dynamic equilibrium. Everything on Earth has been here since the planet was formed about 6 billion years ago. We do not get new matter and old matter does not go away into space. The same matter keeps getting used over and over again. We can say that Earth is essentially a ***closed system*** with respect to matter.

Since new matter cannot replace old matter, recycling or cycling of materials is very important. There are three important principles necessary for this balance to work:

1. **Matter must cycle**

   Each of the elements that are vital for life exists on Earth in a closed **loop of changes**. This means a constant changing of matter from one thing to another, but, the total amount of matter does not change. This may mean chemically changing some things, for example iron and water creating rust, or physically changing others, like water to ice or steam.

2. **Energy must flow**

   The functioning of our planet depends on a constant input of energy from the sun. This energy leaves Earth in the form of heat flowing to outer space. Earth is an ***open system*** with respect to energy. Energy from the sun enters the environment through the making of food by plants, a process called ***photosynthesis***. From here, animals eat the plants and some of the energy moves from the plants to the animals. And as animals eat animals, energy moves through the ecosystem. Eventually it is lost entirely to the environment.

   > **Open System:** This means that a system can receive new matter or materials
   >
   > **Photosynthesis:** This is the process plants use to make food from CO_2 and sunlight
   >
   > **Network of Systems:** All the living and nonliving systems interacting to create balance

3. **Life is connected**

   A vast and complicated network of relationships connects all Earth's organisms with each other and with the cycles of matter and the flow of energy. Earth is a ***network of systems*** with respect to life. The connection between living organisms and their physical environment is the basis of all ecosystems on Earth.

Knowledge of these three principles can help us understand all environmental issues. When we deal with an environmental issue, we should first explore the roles of matter, energy, and living organisms. Where does the matter (carbon, water, pollutant) come from and where does it go? Does the problem involve changes to our planet's energy flow? How do plants, animals and microorganisms influence it and how are they affected by it? As a result of answering these kinds of questions, we will discover that these three guiding principles provide an organizing framework that makes common sense out of complicated issues.

Analysis

1. What happens to matter on Earth?
2. Why is change necessary in any ecosystem?
3. What does dynamic equilibrium mean in terms of ecosystems?
4. What is a closed system? Give an example.
5. What is an open system? Give an example.
6. Explain how Earth acts as a network of systems.
7. Explain the three principles needed for a balanced ecosystem?

Extension

Visit the following website - http://library.thinkquest.org/11353/indexnorm.htm and read more about alterations of the Earth's cycles by human activity; then try the Eco-Quiz.

References

http://www.nhptv.org/natureworks/nwstmaine.htm

http://www.pz.harvard.edu/ucp/curriculum/ecosystems/s6_background.htm

1-5 Ecosystem Balance

Outcomes:

1. Describe and apply classification systems and nomenclature with respect to trophic levels in ecosystems. (214-1, 318-1)
   - Explain how humans have changed the flow of energy in ecosystems.
   - Explain the nitrogen cycle in terms of nitrogen fixation and denitrification.
2. Debate the use of fertilizers and pesticides in modern society and their effect on the environment. (117-5)
3. Define bioaccumulation. (318-2)
   - Identify what a pesticide is by describing the four categories of pesticides.
4. Describe the potential impact that overuse of fertilizers can have on ecosystems. (331-7)

Introduction

In our world today, nothing symbolizes status in society like a well-groomed lawn. This idea goes back to the days of lords and ladies in England. These well-to-do people showed off their lawns just like people show off cars today. The result, in our communities, is a landscape of perfect lawns and paved driveways. But is this really good for the environment? A well balanced environment is diverse in the amount of living things.

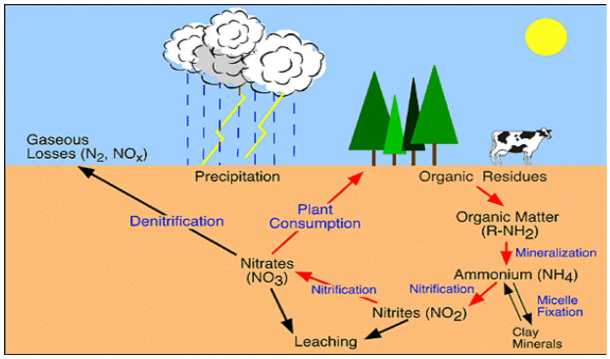
Let's consider the simple lawn, as we know it today. It is generally composed of a single variety of grass suited for our climate (most are produced through ***cross breeding*** varieties of different grasses that have the necessary characteristics for good growth in Newfoundland and Labrador). Unfortunately, single variety lawns are more likely to be harmed due to extreme climatic/environmental conditions, and pests (e.g., chinch bugs). As well, simple grass removes the organic nitrogen from the soil as it grows without replacing it.

Cross Breeding: The practice of mating one type of plant with another

Chemical Fertilizers: These are man made products meant to replace natural fertilizers

Depletion: When something is lost and not replaced

Chemical fertilizers are then added to the soil to make up for the ***depletion*** of soil nutrients like organic nitrogen. Fertilizers generally contain different amounts of nitrogen (chemical symbol N), phosphorus (chemical symbol P), and potassium (chemical symbol K). For example, a lawn fertilizer that is described with the numbers 20-5-10 would have a mixture of 20 parts nitrogen, 5 parts phosphorus, and 10 parts potassium. The numbers are always in the order: nitrogen, phosphorus and potassium. The most important of the three for grass growth is nitrogen. Normally, this exists in soils that have plants like clover and alfalfa grasses. These plants are part of the nitrogen cycle, the natural cycling of nitrogen from the atmosphere to the soil and then to plants and animals. Grasses can not do this. Unfortunately, clover is considered a weed and is not favored in most lawns. In fact, when clover does show up in lawns, the average homeowner will try to rid his/her lawn of clover by using chemical pesticides. This further adds to the disruption in the nitrogen cycle. Destroying plants that add nitrogen to the soil naturally, forces us to artificially add chemical nitrogen to make up for the shortage. Since these chemicals only work for a short period of time, more must be continually added and an artificial semi-cycle begins. This means there is no real balance and matter does not get cycled, as it should.



As mentioned, modern lawn care may also involve the use of **pesticides**. These are man made chemicals designed to rid us of unwanted plants and animals. There are two types of pesticides used:

Herbicides – destroy natural plants that maintain DE. Insect, kill the insects that help pollinate plants and act as decomposers.

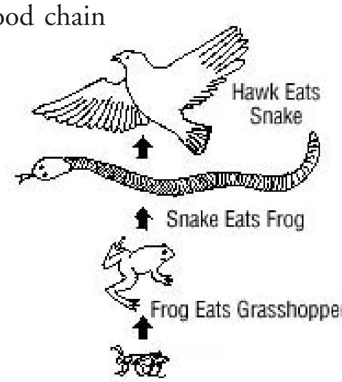
Insecticides – These are designed to destroy **insects or insect-like animals** that are considered pests, like cinch bugs and earwigs.

Imbalance: Means to not be in balance

Food Chain: A path of food getting from one organism to another

Like the fertilizers, these products also cause an ***imbalance*** in the environment. Since all living things are interconnected, the removal of one causes stress to another. The removal of clover causes nitrogen loss in the soil and this affects all plants. As well, pesticides often affect organisms in the environment besides the ones for which they were intended. This often affects ***food chains***. A food chain shows how each living thing gets its food. Some animals eat plants and some animals eat other animals. For example, a simple food chain links the trees & shrubs, the moose (that eat trees & shrubs), and the bears (that eat the moose). Each link in this chain is food for the next link. A food chain always starts with plant life and ends with an animal. Animals that eat only plants are called herbivores. Animals that eat other animals are called carnivores.

A simple food chain



Herbicides destroy plants that maintain a natural dynamic equilibrium. Insecticides kill the insects that help pollinate plants and act as decomposers. When earthworms, for example, take in the pesticides they may then be eaten by robins. Over a summer season, a robin may eat hundreds or thousands of worms. The poison then becomes more concentrated in robins. A second or third level ***consumer,*** like a hawk may eat 10 robins, making the poison even more concentrated in the hawk. This is a process called ***bioaccumulation***. Eventually, these man-made poisons make it to human populations. Exposure to chemical pesticides has even been shown to have negative effects on human health. (See **STSE 1-5 Supplement A and B**)

Consumers: Are organisms that eat other organisms. First level consumers are herbivores while second and third level consumers are usually carnivores

Bioaccumulation: Occurs when pollutants in plants and animals get more concentrated as you move up a food chain

Many of the fertilizers and pesticides applied are washed into storm drains and sewers during rainfalls. From here they eventually reach streams and rivers that represent water supplies for animals and humans.

Fish, birds and wild animals fall victim to chemicals not natural to their systems. Humans, in turn, end up with polluted water supplies.

The question is, "Are the perfect deep green lawns worth the risk to the environment and to us?" Considering all the possible negative consequences, it does not seem likely. You decide.

Analysis

1. What is the nitrogen cycle and how has it been affected by human activity?
2. What is a pesticide and why are they used?
3. Explain bioaccumulation/bioamplification.
4. Identify some ways that human health is negatively affected by pesticide use.
5. What would be the composition of a fertilizer with the following number sequence:
   a) 21-10-10
   b) 7-7-7

Extension

1. Research one of the Earth's cycles and present your finding to the class as a poster, video, or any other format.
2. Research common garden fertilizers to determine their chemical compositions and what they would be used for around a typical garden.
3. Go to the following websites and try the food chain games and projects: http://ecokids.earthday.ca/pub/eco_info/topics/frogs/chain_reaction/index.cfm

   http://www.borealforest.org/school/food_chain.htm
4. Research ways to maintain a proper healthy lawn without using chemical fertilizers and pesticides.

References

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http://www.peterboroughcollective.org/17lawn.htm\

http://www.hc-sc.gc.ca/english/iyh/environment/lawns.html

http://www.chem-tox.com/pesticides/pesticidereport.htm

http://www.magma.ca/~reilly/factsheets/factsheets/useinsecticides.html

http://www.cowac.org/toxic.html

http://www.carleton.ca/ctown/archiv/oct2502/news3.htm

http://www.physicalgeography.net/fundamentals/9s.html

http://www.vtaide.com/png/foodchains.htm

1-6 Sustainable Development

Outcomes:

1. Understand that sustainable development is a shift in the way people view resource development. (114-1)
2. Compare the risks and benefits to the environment of applying new logging technology like clear-cutting. (118-1)
3. Explain why ecosystems with similar characteristics can exist in different geographical regions. (318-3)
4. Describe the potential impact that a large clear-cut logging operation could have on the Newfoundland marten. (318-4)
5. Propose and defend a course of action on the Main River watershed with respect to resource harvesting or conservation. (118-9, 118-5, 215-4)

Introduction

Sustainable development can be defined as development that meets the needs of the people today without reducing the ability of people in the future to meet their needs. This means that people today, who are using the world's resources, must remember that the people yet to come will also need these resources. We cannot, therefore, use up all the world's resources now at their expense.

How does this apply to the concept of ecosystem balance? When we use resources, many of them that are ***renewable*** still need time to replenish. Even the ***nonrenewable*** resources, because of the cycling of matter, can be replaced eventually but it usually takes over millions of years. In either case, the ***natural cycles*** take time and it can sometimes be too long for those who need the resources to live their lives today. Our actions often disrupt the natural cycles that give the environment balance, therefore making it difficult to find resources. To reduce these disruptions, environmentally conscious people practise sustainable development.

Renewable: Resources that can be replaced naturally in a short period of time

Nonrenewable: Resources that can not be replaced naturally in a short period of time

Natural Cycles: Cycles in the environment that cycle energy and physical mater (e.g., Carbon cycle)

In Newfoundland and Labrador, sustainable development has been a goal of the provincial governments since the 1980's. They have generally focused on the natural renewable resources, such as our forests such as trees and wildlife. Within the government's framework there are a number of key principles:

Responsibility – The acknowledgement by government, industry and individuals that we are responsible for the condition of our environment.

Respect for cultural heritage - In our effort to protect the environment we must also remember our strong cultural link to the environment.

Conservation - There has to be a need for conservation for sustainable development to succeed.

Accountability - We must acknowledge our responsibility for our actions and be prepared to demonstrate a willingness to be fully accountable for them.

To ensure everybody, from government to individuals uses these principles to create a sustainable society, integrated resource management can be used.

Integrated resource management refers to the management of natural resources using an integrated or collective approach to resource development. For example, forest management usually means removing trees from the forest for wood or paper. Integrated forest management would consider conservation of animal habitats and water resources, economic factors, and cultural factors. This approach requires much more planning and involvement by the various government agencies, industries, and individuals directly affected.

In Newfoundland and Labrador, the most common method of harvesting the forest is ***clear-cutting***. This involves cutting down all the trees in a selected cutting area. Many people feel this is not the best way to harvest trees because it has negative environmental consequences. These include loss of habitat for animals, increased water run-off on sloped land, disruption of natural ***forest succession***, and loss of natural beauty. Those in favour, say that clear-cutting permits new habitat for different animals and plants, and the results are similar to what a forest fires does. They both create new growth.

> **Integrated Resource Management:** Using a number of approaches to fulfill resource needs without affecting the needs of future generations
>
> **Clear-cutting:** Removing all the trees from a selected area
>
> **Forest Succession:** The natural progression of one plant type to another in a forest, usually from herbs to shrubs to trees

Currently on the island portion of Newfoundland and Labrador, there are two major struggles concerning clear-cutting and its role in integrated forest management. First is the Newfoundland pine marten's struggle to survive in the face of vanishing old growth forests. The second is the struggle to preserve the Main River watershed from clear-cutting.

The Newfoundland Pine Marten

The people on the island of Newfoundland have been seeing marten since 1795. They were probably never abundant due to low food supply. Three major factors contributing to the early decline of marten in Newfoundland are habitat loss (due to logging and fire), over-trapping, and low food supplies. The fur of the marten was highly valued and their keen sense of smell and great curiosity allowed trappers to easily take them. Declining numbers resulted in the permanent closure of the trapping season in 1934. Today, the loss of old growth forest is a real threat to the continued existence of the marten on the Island. In Labrador, the marten populations continue to remain stable and healthy because the factors affecting the Newfoundland marten do not affect them.

In the early 1980's, it was estimated by the Provincial Wildlife Division that there were between 630 and 875 marten in Newfoundland. Recent data indicate that there are now around 300 marten on the island. However, marten are still common in Labrador. Habitat loss due to clear-cutting within their ***home range*** is probably the main reason why recovery of marten on the Island is slow. In addition, the accidental capturing of marten in traps and snares set for other animals, such as rabbits, mink, fox and lynx, may be limiting their spread into other areas.

> **Home Range:** The amount of land a marten requires to find food, shelter and a mate

Habitat damage from logging must be minimized for the marten population to grow. Large areas of undisturbed mature forest need to be preserved as home ranges for marten, or at least managed to ensure that some mature forest is always available.

Preserving some mature coniferous forest for marten may involve a conflict of values: economics versus environmental. Newfoundlanders and Labradorians have a unique opportunity to conserve the remaining old growth forests and the essential character of the land and its wildlife. On the other hand, Newfoundland and Labrador depends on industries such as forestry for its economic base.

Marten prefer to live in undisturbed mature coniferous or mixed forest, with large evergreens and scattered birch and other hardwood trees. Preferring thick shady woods with a dense canopy, they usually avoid large openings or clearings. For ***denning*** and nesting sites, marten use hollow trees, stumps and logs.

> **Denning:** A term referring to building a den and raising young

Marten have been observed crossing large cutovers, but they did not use the logged areas for hunting or as part of their home range. During autumn, cutovers may offer short-term food sources such as raspberries or blueberries for the marten to feed on. However, there are indications that marten avoid previously logged areas until dead woody debris characteristic of older-growth forests is again present on the forest floor.

A Newfoundland Pine Marten Recovery Team was founded in 1990. The team's goal is to develop a plan to increase the marten population on the island portion of the province and to ensure the marten doesn't become yet another extinct species. To help, some marten have been moved to the shelter and protection of Terra Nova National Park where they could be studied and hopefully their population increased.

Integrated forest management has been introduced to address concerns like this and the Western Newfoundland Model Forest has been working on the marten's difficult situation. As a part of their integrated forest management plan for sustainable development, The Western Newfoundland Model Forest created a Pine Marten Working Group. The Working Group is made up of eleven diverse ***stakeholders***.

> **Stakeholders:** All the people or groups of people who have an interest or investment in a particular issue

Department of Forest Resources and Agrifoods

Protected Areas Association

Department of Mines and Energy

Corner Brook Pulp and Paper

Chamber of Mineral Resources

Wilderness and Ecological Reserves Advisory Council

Department of Culture, Tourism and Recreation

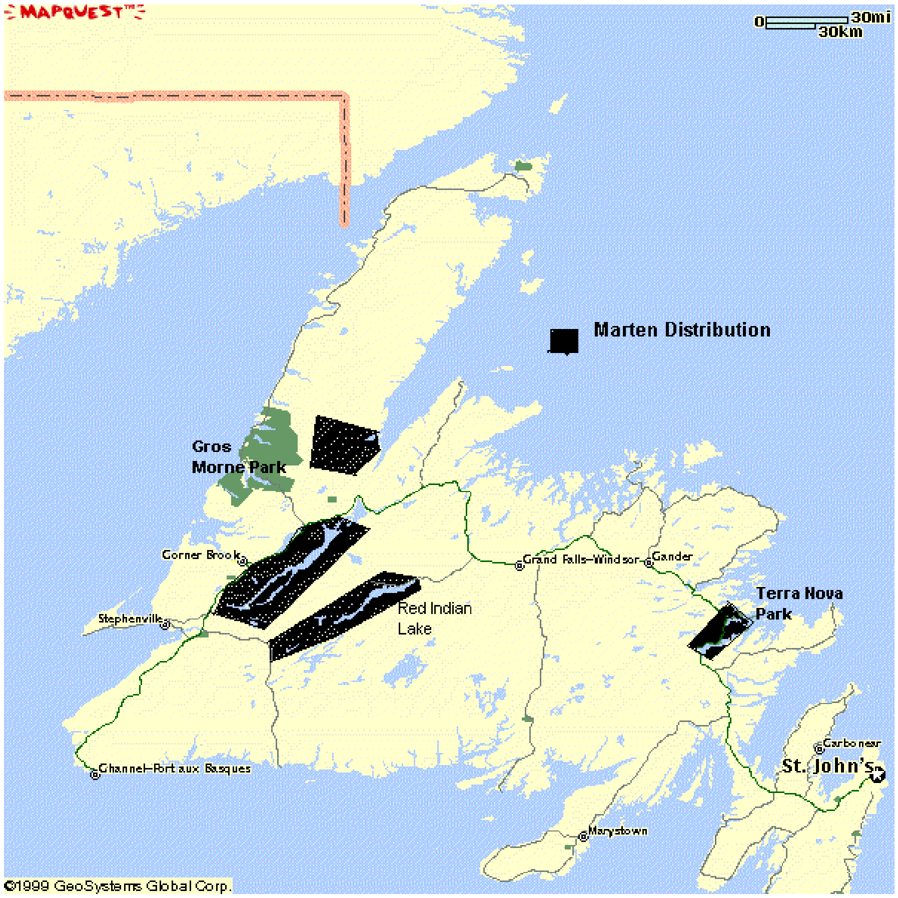
Gros Morne National Park

Natural Resources Canada – Canada Forest Service

Abitibi Consolidated

Newfoundland and Labrador Trappers Association

This working group established a goal to set up a reserve that would protect habitat for the pine marten. After a twenty-four month process, the Pine Marten Working Group agreed on an area that involved an ecological reserve, two wildlife reserves and a crown land reserve. This area has 163,000 ha and meets the objectives of protecting pine marten habitat. On October 15, 1999 the Provincial Government held a press conference to announce the acceptance of the Pine Marten Working Group reserve design. (See **STSE 1-6 Supplement A**)



Logging in Newfoundland and Labrador is usually done by clear-cutting, all that remains in the cutover are scattered birch trees and small stands of spruce and fir that are usually unsuitable for marten. Research in Newfoundland indicates that marten tend to stay away from habitats that have been logged for up to 23 years and as long as 40 years.

Within the Pine Marten Study Area of western Newfoundland, where marten are protected from snaring, there remain 41000 ***hectares*** of mature and older forest (aged 60+ years). Of that, 2-10% is dead as a result of a 1987 insect infestation. An additional 37500 hectares have been harvested over the past 60 years, with 79% of that in the past 20 years. There is little forest in the age class of 20-60 years. This makes the forest type similar to areas formerly occupied by marten in Newfoundland, particularly on the west coast. However, the future plans for present forests indicates there will be habitat for only 100 marten within the west coast balsam fir ongoing in the Lloyd's River/Battle Pond areas, south of Little Grand Lake, also known to be used by marten.

Hectares: An area of land that measure 10,000 square meters. One square kilometer equals 100 hectares

Both pulp and paper companies (Abitibi Consolidated and Corner Brook Pulp and Paper Limited) have plans to continue logging within the distribution area of marten in western Newfoundland. No cutting has been permitted in the Little Grand Lake area since 1988.

Depending on the commitments made by forest harvesters and the conditions imposed by the Minister of the Newfoundland and Labrador Department of Environment, harvesting may continue. As well, there has been no solution to the conflict between timber goals and habitat needs for marten. Timber harvesting by the Abitibi Consolidated is ongoing in the Lloyd's River/ Battle Pond areas, south of Little Grand Lake, also known to be used by marten.

Whether the efforts to save forest for marten survival are successful, remains to be seen. Current logging practices do not favour its survival. The fight to cut the old growth forests in the Main River area of White Bay on the island portion of the province is only making the marten's future more dim.

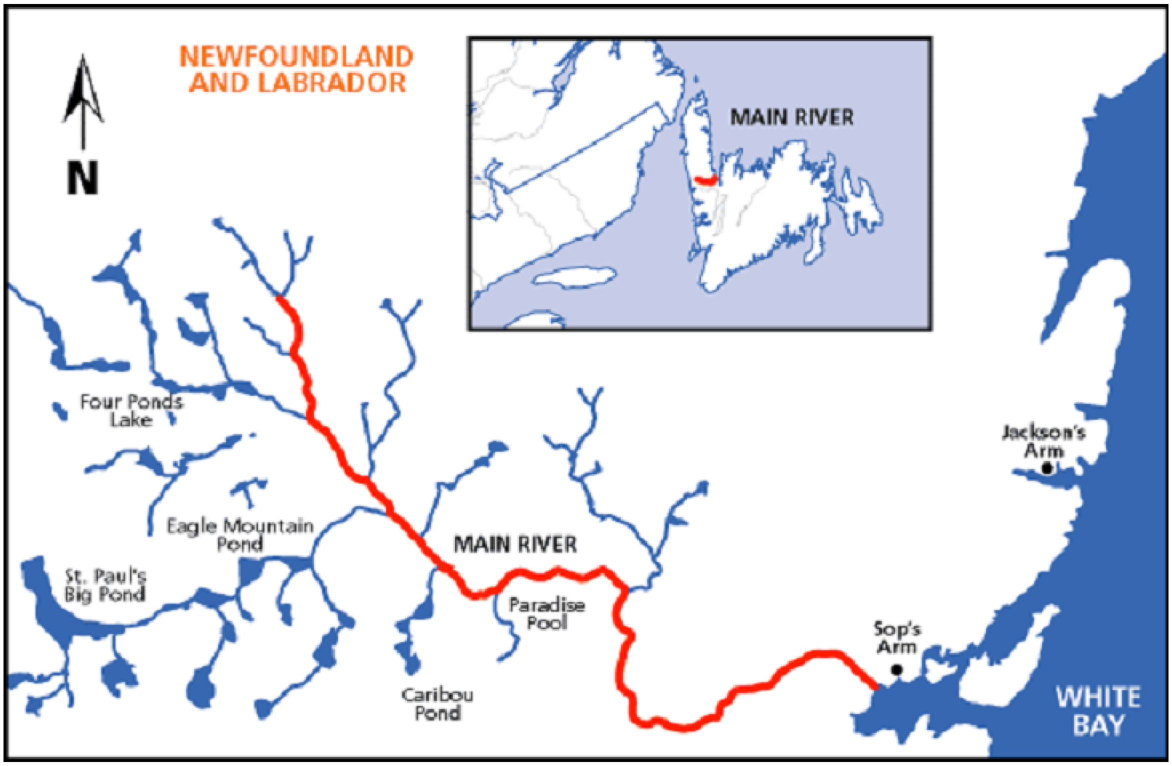
Analysis

1. What factors have led to the reduction in marten numbers on the island of Newfoundland? Do these affect the marten in Labrador?
2. What is the preferred habitat of the marten? Why is it disappearing?
3. Identify where the marten still live on the island of Newfoundland.
4. What is the goal of the Pine Marten Working Group? When was this group officially recognized by the Newfoundland and Labrador government?
5. How do cut over areas affect the marten?
6. Where is the Pine Marten study area located?

Extension

1. Visit the following website, http://www.newfoundlandmarten.com, view the marten video, and then write a physical description of the marten. What other animals does the marten bring to mind?

The Main River – Last of the Old Growth Forests



In the fall of 2001, the Main River became the first river in Newfoundland to be designated as part of the Canadian Heritage Rivers System. The management of the Main entails a delicate balance between logging and keeping undisturbed habitat sufficient to maintain the natural values and recreational values for which the river was nominated to the system. A large area has been set aside as a provincial waterway park, providing legislative protection for the river corridor. Areas outside the proposed provincial park that fall within the view of people canoeing on the river (the "viewshed"), will be designated as zones where special logging techniques will be used to ensure that the effects of logging will not be visible from the river. Areas that are key or sensitive habitats for wildlife will be exempt from logging, and a ***buffer*** of 100m will be left along all major ***tributaries*** to ensure that aquatic habitat is not impaired.

> **Buffer:** A buffer zone is an area that serves as a protective barrier. During logging buffer zones are left around ponds and streams
>
> **Tributaries:** Smaller streams and brooks that feed into a larger river. Tributaries are part of a river system

When Main River was nominated in 1991, it was one of the few truly wild rivers on the Island of Newfoundland.

The Main River has its ***headwaters*** in the heart of the Long Range Mountains on the Great Northern Peninsula. It flows southeast from tundra-like barrens to the Atlantic Ocean where it empties into White Bay at Sop's Arm. The river passes through an area of approximately 105 km^2.

> **Headwaters:** This refers to the source of a river or stream; where it begins

The Main River is one of the last wild and scenic areas of the island of Newfoundland. It provides habitat for a variety of animals and plants. Farther down the Main, the forests are predominantly balsam fir and black spruce. The Newfoundland marten, native to the island and classified in 1986 as threatened, has been re-introduced to the area. The river also contains one of the healthiest populations of Atlantic salmon in the province, with the gravel-cobble river bed and upper ponds excellent for salmon spawning.

As one of the last pieces of old growth Boreal forest in Newfoundland and Labrador to have remained untouched, the Main River has caught the attention of both logging companies and environmentalists alike. The Main River area at the base of the Great Northern Peninsula on the Island's west coast is part of the northern ***boreal forest biome***, as is most of the province of Newfoundland and Labrador. Labrador also has ***tundra biome*** as part of its physical make-up. A biome is a large geographical area that has similar climate, soil, animals and plants. The main plants in the boreal forest are coniferous trees like Balsam fir, spruce and pine.

> **Boreal Forest Biome:** The boreal forest is large forest system that stretches around the planet in the north that has coniferous trees as its main plant
>
> **Tundra Biome:** Another large area north of the boreal forest that has virtually no trees and is characterized by permanently frozen ground called permafrost

Balsam fir and spruce are also the main trees harvested for the pulp and paper industry in our province. These trees, in particular the spruce, are excellent for making newsprint because of their strong fiber. Unfortunately due to declining wood supplies on the island of Newfoundland, areas like Main River are now the target of the paper companies. The Corner Brook Pulp and Paper Company (CBPP) has the timber rights to the Main River ***watershed***. Their plan is to cut the trees to make paper.

CBPP first proposed to start harvesting in the Main River area back in 1986 at which time they were required to prepare an ***Environmental Impact Statement (EIS)***. For various reasons no cutting has taken place in this area to date, even though a number of roads have been built by the company to access wood from this area.

> **Watershed:** The total land area that drains into a river system
>
> **Environmental Impact Statement (EIS):** A study prepared to show all possible environmental impacts a project could have and all the possible courses of action the group or company will take to reduce or eliminate those risks
>
> **Eco-tourism:** Ecological tourism is the practice of touring natural habitats in a manner meant to minimize ecological impact

As of 2002, CBPP has issued a new Environmental Preview Report for the Main River that spans the years 2002 – 2006. In this plan, the company outlines its approach to wood harvesting in the Main River watershed. CBPP has adopted a policy of no clear-cutting in the entire Main River watershed. They do however intend to cut down trees.

The negative effects to cutting down trees are significant for this area. For example, there is a loss of potential ***eco-tourism***, which is short for ecological tourism. This type of tourism depends on untouched wilderness that tourists find appealing. Tourists enjoy hiking, camping, canoeing and other outdoor activities that leave no lasting impact on the environment. These tourists tend to spend considerable sums of money while visiting nearby communities and this can be a significant boost to local economies. With the declaration of Main River as a Canadian Heritage river, its tourism potential will likely increase in the near future.

Outside its tourism potential, Main River is also an important Atlantic salmon river where thousands of these fish return yearly to reproduce. Logging potentially decreases the effectiveness of stream beds as spawning grounds for fish. This is due to increased silt run off from the ground when trees are removed from a rivers watershed. The silt tends to interfere with the fertilization and development of the fish eggs. This of course results in fewer salmon being produced. With the already low numbers of salmon returning yearly, still fewer being produced will not be a favourable outcome for the salmon populations.

With logging also comes a loss of biodiversity. When habitats are destroyed, animals have to find new homes or they die. Also, there comes a loss of native plant species specific to the conditions that exist prior to cutting. Many years will have to pass for these types of plants to return if at all.

Still other people from the Main River area will argue that the potential jobs for the local loggers are badly needed. Since the closure of the cod fishery, many people have had to leave the area, while others struggle to find employment. For those who have stayed, logging provides valuable income to meet the financial needs.

With so many groups adding their needs and wants to the Main River controversy, it seems its future is rather uncertain. Hopefully a balance of needs by all concerned can be reached such that the river ecosystem can be maintained without a high level of permanent disturbance. Conserving ancient boreal forest should be a priority for everyone involved, especially the organisms that call the Main River watershed home.

Analysis

1. Why was Main River named as a Canadian Heritage River?
2. What paper company has logging rights in the Main River watershed?
3. How is wood typically harvested in Newfoundland and Labrador? What are the logging plans for Main River?
4. Identify three negative effects that logging could have on this area. Identify a reason that favours logging in this area.
5. How will logging affect the Newfoundland marten's struggle to survive?

Extension

1. Research what a river a heritage river is at the following website: http://www.chrs.ca/Main_e.htm.

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http://www.wnmf.com/PDF%20Reports/Non%20Tech%20Dist3.pdf

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2-1 Weather Lore

Outcomes:

1. Discuss the relative accuracy of weather forecasting by folklore and scientific methods. (115-2)
2. Compare the ways older generations forecasted weather (folklore) with the scientific methods used today. (115-6)
3. Identify examples where scientific understanding was enhanced or revised as a result of the invention of a technology. (116-1)
4. Identify questions to investigate that arise from practical problems and issues (e.g., develop questions related to the effect of heat energy transfer within the hydrosphere). (212-1)
5. Analyze the interactions between the atmosphere and human activities. (330-4)

Introduction

The current atmospheric conditions outside is what we call ***weather***. For example, how strong the wind blows, if it is cloudy or clear, rain fall and temperature are used to describe the weather. ***Climate*** is the average of the measures used to describe weather over a longer time period, usually years.

Weather: The condition of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness

Climate: The average condition of the weather at a place usually over a period of years as exhibited by temperature, wind speed, and precipitation

To get an accurate weather forecast in our modern world, all you need to is do switch on the radio, television, or even the internet. With the use of satellite and radar images, electronic atmospheric measuring devices and computer programs, weather forecasting has become a fairly accurate science. It is even possible for forecasters to predict weather a week in advance and even a season in advance!

This was not possible even 50 years ago. How did the people in the past predict weather? Careful observations of their surroundings were the key to knowing in advance the arrival of good and bad weather. People watched the cloud patterns in the sky, the behavior of animals, and growth of plants to predict weather. They were also aware of seasonal changes as marked by certain events occurring on certain dates. For example, spring and fall were marked by observing that there were two days each year that have equal amounts of daylight and darkness. These are the equinoxes when the amount of daylight equals night. This is the beginning of Autumn and Spring (roughly September 20 and March 20 each year).

Weather Lore in Newfoundland and Labrador

In Newfoundland and Labrador, the development of weather forecasting in the past was a matter of life or death. Historically, our people depended heavily on the land and sea to survive. The land and sea provided food, materials to build, fuel for heating, travel, and employment. Knowing when conditions were most favourable to pursue any of these necessities was extremely important. Depending on the season, getting caught in a storm could have meant disaster. This was particularly true for fishermen.

Also, predicting the weather could mean knowing when and where to fish and hunt. Animals also respond to changes in the atmosphere and are somehow sensitive to these changes more so than people. For fishermen, observing the movements of fish and birds was, and still is, important for successful hunting and keeping track of weather changes. Even the average person who trout fishes knows that wind from the northeast usually means poor fishing.

From the centuries of observations in Newfoundland and Labrador arose what is known as ***weather lore***. This ability to predict weather has been gained through careful observations and has been passed on from generation to generation. The passing of weather knowledge has traditionaly been done through sayings and rhymes. These sayings have been made after many years of noticing events prior to a change in the weather. After witnessing the same result over and over, the observations become a predictor of weather change. Some sayings predict ***short term*** changes, from one day to another. Other sayings are for ***long term*** or seasonal changes.

> **Weather lore:** traditional knowledge of weather based on observations made by people over a number of years
>
> **Short Term:** Involving a relatively short period of time, usually days
>
> **Long Term:** Involving a relatively long period of time, usually weeks, months or year

Perhaps the most commonly known of these rhymes would be:

"Red sky at night, a sailor's greatest delight; Red sky in the morning, sailors take warning."

This saying has its roots in the observation that when a sky is red at sunset, it is an indicator of fair weather the next day (short term). However, if the sky is red at sunrise, it is a sign of poor weather to come that day. How does this work? We see the sun setting in our western sky. Changes in the weather usually come from the west. When there is lots of moisture in the air, the red rays of the sun won't shine through. So when you see a red sunset, it means there is no moisture gathering. You'll have a nice day ahead. "A red sky in the morning" means that good weather is moving out. But, watch out, there might be rain within 24 hours.

Another traditional sign of poor weather to come is:

"If the sun has a halo around it, poor weather is sure to follow."

According to folklore, a ring around the sun means rain is coming. In fact, high icy cirrus clouds that produce haloes often, but not always, come before stormy weather. This again uses observations of atmospheric conditions to predict that a change in weather conditions is on the way.

Still another sign of poor weather is:

"When the wind comes from the east, 'Tis neither good for man nor beast."

In this case, the direction of the wind is the sign to indicate poor weather. Generally speaking, in Newfoundland and Labrador, the ***prevailing wind*** is westerly. Fair weather is associated with these types of winds. Easterly winds tend to be associated with poor weather because they bring cooler weather conditions in from the ocean.

> **Prevailing Winds:** Winds most often experienced that generally come from one direction

This saying uses animal behavior to predict the weather:

"Sea birds keeping near the land, Tell a storm is near at hand. But flying seaward out of sight, you may stay and fish all night."

The behavior of sea birds, as with other animals, can tell if the weather to come is fair or poor. As with people, animals rely heavily on weather conditions for feeding and survival. If we carefully observe them, their actions can help us with weather watching.

Many of the sayings and rhymes have a high percentage of accuracy because the observations have been repeatedly made over many years by many people. This is an important part of doing good science. Although the observations were not likely recorded using specific dates and locations, they were preserved through folklore. The older generations devised sayings and rhymes to remember their observations and pass them on to the younger generations and so on.

Some of the traditional sayings are not as accurate as others. These usually deal with expected weather related to observations made on specific dates. The best example of this, due to its popularity, would be

the annual February 2nd event known as Groundhog Day. As tradition goes, should the appointed groundhog see his or her shadow on this particular day, there is expected to be six more weeks of hard winter (long term). On the other hand, should the shadow not be observed, the worst of winter is over and an early spring can be expected. The history of Groundhog Day is directly linked to the European celebration of Candlemas. When German settlers arrived in Pennsylvania, they brought with them the celebration of Candlemas. This is a Christian extension of an old tradition that marked the midpoint between the date of the ***winter solstice*** and the ***spring equinox***. The tradition went, the weather on that day would predict the extent of winter's hold. A sunny day would mean 6 more weeks of winter weather. A dull day indicated a lessening on the length of winter. Germans used a badger emerging from hibernation as the animal whose shadow would be the weather predictor. In Pennsylvania it became the groundhog. Punxsutawney Phil was the name he was given and his accuracy after 118 years of forecasting was 39%. That means that the predictions made are only correct 4 times for every 10 made. Obviously the degree of accuracy is low and not really to be trusted. The Canadian cousin to Phil is Wiarton Willie from Wiarton, Ontario.

Winter Solstice: The time when winter begins, also the least amount of dayligth hours. December 21 or 22

Spring Equinox: The time when day and night are everywhere of equal length, March 20 or 21

Another Candlemas related saying in Newfoundland and Labrador is:

> "If the wind's in the east on Candlemas Day,
> There it will stick till the first of May"

Like the groundhog and his shadow, this one uses wind direction to predict a longer winter. In Newfoundland and Labrador, we have another date related weather prediction - Sheila's Brush. It is usually a storm with heavy snowfall that arrives around the 18th of March. Sheila's Brush is the last of winter usually arriving just after St. Patrick's Day. Legend has it that Sheila was a relative or acquaintance of St. Patrick and the snow is a result of Sheila's sweeping away the last of winter. Sometimes a storm before "Paddy's" Day is called Patrick and Sheila. Newfoundland sailors always counted on a storm around St. Patrick's Day and once the brush blew through it signaled that spring was just around the corner.

Newfoundlanders and Labradorians have also paid close attention to the changes in plants. As one saying goes:

> "A lot of dogberries on the trees in the fall means a hard winter ahead."

Although difficult to determine the origins and accuracy of this saying, many older people feel it is true. Why the amount of dogberries on a tree would be an indicator of a hard winter is unknown.

In today's world, the forecasting of weather has advanced significantly since the days when people relied on observations of the natural world. There are even television stations dedicated to providing current and upcoming weather conditions across Canada.

Weather is an important part of our lives. It determines our daily activities, travel plans, where we choose to live, and our recreational activities. Therefore, predicting the weather is, and has always been, important.

Analysis

1. What is weather? How is it related to climate?
2. What is weather lore?
3. Why is (was) weather forecasting so important to people?
4. Identify three observations in nature used to predict weather.
5. What is a short term forecast? What is a long term forecast?
6. Are forecasts made using weather lore accurate? Explain.
7. When does the winter solstice occur and what does it signify?
8. When does the spring equinox occur and what does it signify?

Extension

1. Suggest what these weather related sayings might mean (internet research may be necessary):

   "A fine Christmas, A fat churchyard"

   "April showers bring forth may flowers"

   "March came in like a lamb and goes out like a lion"

   "If Candlemas Day be fair and fine Half the Winter is left behind"

   "If the wind's in the east on Candlemas Day, There it will stick till the first of May"

   "Winter thunder means summer's hunger"

   "A year of snow, a year of plenty"

   "A peck of March dust is worth a king's ransom"

   "When the winds of October won't make the leaves go; then a frosty Winter and banks of snow"

   "A warm Christmas, a cold Easter"

   "Evening red and morning grey; double signs of one fine day"

   "A red sun got water in his eye"

   "The moon with a circle got water in her beak"

   "Clear moon, frost soon"

   "When the rain comes from the south, it blows the bait into the fishes mouth"

   "When the wind veers against the sun, trust it not, for back 'twill run"

   "Rain before seven, Lift before eleven"

   "After a storm come a calm"

   "Quick thaw, long frost"

   "If the goats come home in file, get your fish in covered piles"

2. Go to http://www.ec.gc.ca/EnviroZine/english/issues/39/feature2_e.cfm, What are the criteria used to determine the top ten weather events for a calendar year? (**See STSE 2-1 Supplement A** for The Top Ten Of 2000)

3. Read **STSE 2-1 Supplement B** "Seasonal forecasting". How is seasonal forecasting different today than in the past? How accurate is it?

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http://ona.cabe.k12.wv.us/groundhog.html

http://www.ec.gc.ca/press/00-12-27_b_e.htm

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http://www.bishops.k12.nf.ca/science/escience/weather.htm

http://www.ec.gc.ca/EnviroZine/english/issues/21/feature2_e.cfm

http://www.greenscreen.org/newsletter/articles/Clouds.html

http://www.merriam-webster.com

2-2 Weather Forecasting

Outcomes:

1. Define the terms related to weather forecasting. (114-6, 212-1, 330-6)
2. Describe some of the methods of weather forecasting. (331-5)
3. Describe the dominant factors that produce seasonal weather phenomena. (330-6)
4. Apply the effects of ocean currents, air currents and latitude on the climate of Newloundland and Labrador. (115-2, 331-4)
5. Explain how scientific knowledge evolves as new evidence comes to light. (115-6)

Atmospheric Terminology

To understand weather forecasting, you must first have an understanding of the terms used to describe the atmosphere.

1. Air Mass- a large, horizontal body of air with a uniform distribution of moisture and temperature throughout. An air mass may be colder or warmer in comparison to another air mass close by. ***Air pressure*** describes the force exerted by the weight of the atmosphere on the surface of Earth. Air pressure or atmospheric pressure may increase or decrease as air masses are replaced by other air masses. ***High pressure*** refers to an area of high atmospheric pressure with a clockwise movement of air, while ***low pressure*** refers to an area of low atmospheric pressure with a counterclockwise circulation of air. A ***ridge*** is a line of high pressure extending outward from the centre of a high pressure region. A ***trough*** is a line of low pressure extending outward from the centre of a region of low pressure.

Air Pressure: Is the force exerted by the weight of the atmosphere

High Pressure: In the Northern Hemisphere, an area of high atmospheric pressure with a clockwise movement of air, also known as a cyclone

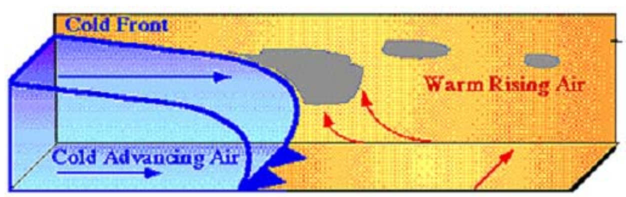
Low Pressure: An area of low atmospheric pressure that has a counter-clockwise circulation in the Northern Hemisphere, also known as a cyclone

Ridge: An area of relatively high pressure extending from the centre of a high pressure region; the opposite of a trough

Trough: An area of relatively low pressure extending from the centre of a low pressure region; the opposite of a ridge

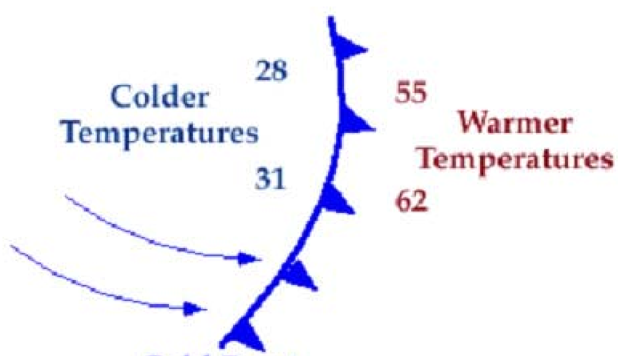
2. Fronts - areas where air masses meet

   A front is defined as the area between warm air and cold air that can extend both vertically and horizontally. Therefore, when a reference is made to a frontal surface (or frontal zone), it refers to both the horizontal and vertical components of the front.



A **cold front** is a transition zone from warm air to cold air, where a cold air mass is replacing a warmer air mass. The air behind a cold front is noticeably colder and drier than the air ahead of it. When a cold front passes through, temperatures can drop more than 15 degrees within the first hour.

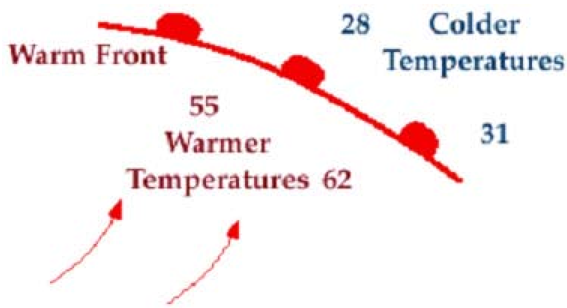
Cold Front: The leading edge of an advancing cold air mass



A ***warm front*** is a transition zone from cold air to warm air, where a warm air mass is replacing a cold air mass. The air behind a warm front is warmer and moister than the air ahead of it. When a warm front passes through, the air becomes noticeably warmer and more humid than it was before. ***Humidity*** is a measure of the amount of moisture (or water) in the air.

Warm Front: The leading edge of an advancing warm air mass

Humidity: A measure of the water vapour content of the air



3. ***Relative humidity*** is the amount of water (in gas form) in the air at a given temperature compared to the maximum amount of water that could exist at that temperature. As the air temperature rises, this increases the amount of moisture it can hold while cold air loses ability to hold water. On hot summer days, the air can feel sticky and uncomfortable. This is because the air does not evaporate sweat easily from a person due to the high relative humidity. The ***humidex*** is the scale describing how hot, humid weather feels to the average person. The humidex combines the temperature and humidity into one number to reflect the perceived temperature. For example, the air temperature on a humid summer day may be 28 °C while the humidex may be 36 °C. We use the humidex to make people aware of the effect the humidity has a air temperature.

Relative Humidity: The amount of water vapour in the air at a certain temperature compared to the maximum amount which the air could hold at that temperature. It is usually expressed as a percentage

Humidex: IIs a way of reporting how hot the air feels as a result of the moisture (humidity) in the air

Pervailing Wind: rThe wind direction most frequently observed during a given period

4. Wind - the horizontal movement of air relative to Earth's surface caused by variations in temperature and pressure. As warm air rises up, cool air, which drops, rushes in to takes its place. The result is wind. Another way to say this is: the air moves over Earth as temperature and pressure changes from place to place. ***Prevailing winds*** are the winds most frequently observed coming from the same direction. Wind direction refers to the direction the wind comes from, for example, north winds blow from the north to the south.

5. ***Chinook*** is a warm down-slope wind in the Rocky Mountains that may occur after an intense cold spell. The temperature could rise by 20°F to 40°F in a matter of minutes when warm air passes over the mountains from the warmer coastal regions of British Columbia. These winds are called snoweaters since they melt snow when they arrive.

Chinook: The relatively warm, dry gusty winds that occasionally occur to the leeward side of mountain ranges

Analysis

1. What are air masses and how are they related to air pressure?
2. What are fronts? What are the differences between cold and warm fronts?
3. What is relative humidity? How is it related to the humidex?
4. What are prevailing winds?

Extension

1. Check the latest forecast for your region using newspapers, television or internet. Determine if there are any current fronts approaching or if there are stationary fronts. Record; air pressure, humidity, and wind direction.

Weather Forecasting

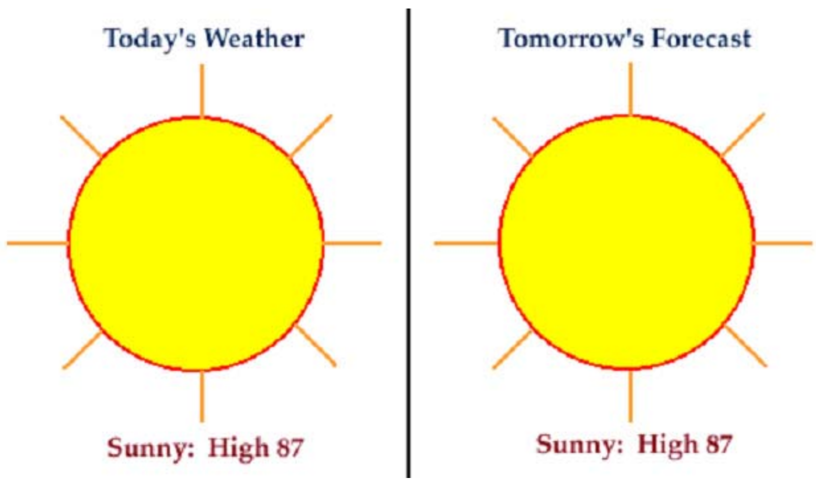
There are several different methods that can be used to create a forecast. The method used depends upon the experience of the forecaster, the amount of information available, atmospheric conditions, and the degree of accuracy or confidence needed in the forecast.

Persistence

The first of these methods is the Persistence Method. It is the simplest way of producing a forecast. The persistence method assumes that the conditions at the time of the forecast will not change. For example, if it is sunny and 27 degrees today, the persistence method predicts that it will be sunny and 27 degrees tomorrow. If 20 millimeters of rain fell today, the persistence method would predict 20 millimeters of rain for tomorrow.

It may appear that the persistence method would work only for short term forecasts (e.g. a forecast for a day or two), but one of the most useful roles of the persistence forecast is predicting long range weather conditions or making ***climate forecasts***. For example, it is often the case that one hot and dry month will be followed by another hot and dry month. So, making persistence forecasts for monthly and seasonal weather conditions requires a lot of skill. Some of the other forecasting methods, such as numerical weather prediction, lose all their skill for forecasts longer than 10 days. This makes persistence a "hard to beat" method for forecasting longer time periods.

Climate Forecasts: Forecasting climate conditions over a long period of time, usually years



The persistence method works well when weather patterns change very little and features on the weather maps move very slowly. It also works well in places like central Australia, where summer time weather conditions vary little from day to day. However, if weather conditions change significantly from day to day, the persistence method is usually not the best forecasting method to use.

Trends

The Trends Method involves determining the speed and direction of movement for fronts, high and low pressure centers, and areas of clouds and precipitation. Using this information, the forecaster can predict where he or she expects those features to be at some future time. For example, if a storm system is 1000 kilometers west of your location and moving to the east at 250 kilometers per day, using the trends method you would predict it to arrive in your area in 4 days.

Mathematically, this is how this works out:

$$1000 \text{ km} \div 250 \text{ km per day} = 4 \text{ days}$$

Using the trends method to forecast only a few hours into the future is known as "Nowcasting" and this method is frequently used to forecast precipitation. For example, if a line of thunderstorms is located 60 kilometers to the northwest and moving southeast at 30 kilometers per hour, you would predict the storms to arrive in your area in 2 hours. Below is an example of using the trends method to forecast the movement of a cold front. Initially, the cold front moved 600 kilometers during the first 24 hours, from the central Quebec to the Gulf of St. Lawrence. Using the trends method, you would predict this weather system to move another 600 kilometers in the next 24 hours, reaching the east coast of Newfoundland and Labrador. The trends method works well when systems continue to move at the same speed in the same direction for a long period of time. If they slow down, speed up, change intensity, or change direction, the trends forecast will probably not work as well.

Climatology

The Climatology Method is another simple way of producing a forecast. This method involves averaging weather statistics accumulated over many years to make the forecast. For example, if you were using the climatology method to predict the weather for St. John's on July 1st, you would go through all the weather data that has been recorded for every July 1st and take an average. If you were making a forecast for temperature and precipitation, then you would use this recorded weather data to compute the averages for temperature and precipitation.

If these averages were 22 degrees with 3 mm of rain, then the weather forecast for St. John's on July 1st, using the climatology method, would call for a high temperature of 22 degrees with 3 mm of rain. The climatology method only works well when the weather pattern is similar to that expected for the chosen time of year. If the pattern is quite unusual for the given time of year, the climatology method will often fail.

Analog

The Analog Method is a slightly more complicated method of producing a forecast. It involves examining today's forecast pattern and remembering a day in the past when the weather pattern looked very similar. This would produce an event similar to current conditions for comparing later. The forecaster would predict that the weather in this forecast will behave the same as it did during the earlier event.

For example, suppose today is very warm, but a cold front is approaching your area. You remember similar weather conditions last week, also a warm day with cold front approaching. You may also remember how heavy thunderstorms developed in the afternoon as the cold front pushed through the area. Therefore, using the analog method, you would predict that this cold front will also produce thunderstorms in the afternoon.

The analog method is difficult to use because it is virtually impossible to find a perfect analog. Weather events are rarely experienced in the same locations as they were in the past. Even small differences between the current time and the previous event can lead to very different results. However, as time passes and more weather data is collected and stored, the chances of finding a "good match" event for the current weather situation should improve, and so should analog forecasts.

Numerial Weather Prediction

Numerical Weather Prediction (NWP) uses the power of computers to make a forecast. Complex computer programs, also known as forecast models, run on supercomputers and provide predictions on many atmospheric ***variables*** such as temperature, pressure, wind, and rainfall. A meterologist examines how the features predicted by the computer will interact to produce the day's weather.

Variables: Are the things or conditions that have the capacity to change

The NWP method is flawed in that the equations used by the models to simulate the atmosphere are not perfect. This leads to some error in the predictions. In addition, since there are many gaps in the initial data this causes problems. For example, we do not receive many weather observations from areas in the mountains or over the oceans. If the initial conditions are not completely known, the computer's prediction of how those conditions will develop may not be entirely correct.

Despite these flaws, the NWP method is probably the best of the five discussed here at forecasting the day-to-day weather changes. Very few people, however, have access to the computer data. In addition, the beginning meteorologist does not have the knowledge to interpret the computer forecast, so the simpler forecasting methods, such as the trends or analogue method, are recommended for the beginner.

Analysis

1. What are the five methods of weather forecasting?
2. Which method requires the least amount of training and technology?
3. Which method uses past weather patterns to predict current weather?
4. Why is the numerical weather prediction method flawed?
5. Which method provides the best forecasting of day to day weather? Why?

Extension

1. Ask students to go to http://weatheroffice.ec.gc.ca/satellite/index_e.html, and then choose one of the current satellite images for Eastern Canada. Based on the image, make a precipitation forecast for the next 24 hours for their region of the province.

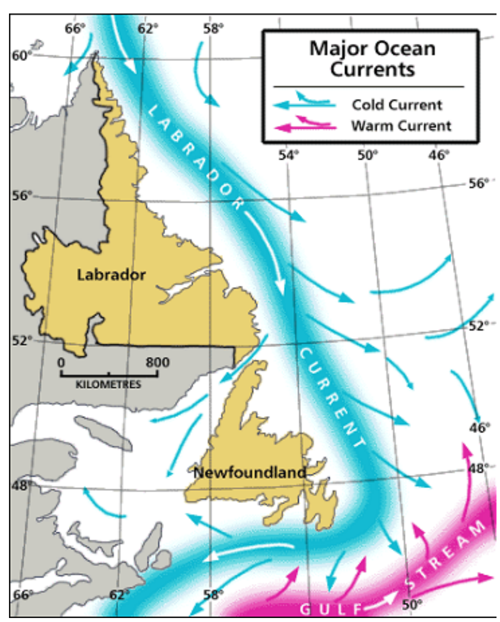
Newfoundland and Labrador Climate

Newfoundland and Labrador has some of the most variable climate and weather conditions in Canada and the world. As one favorite saying goes "If you don't like the weather, wait 10 minutes and it'll change". The physical geography, closeness to the Atlantic Ocean, air movements, and global location help explain many of the unique features of our province's climate and weather.

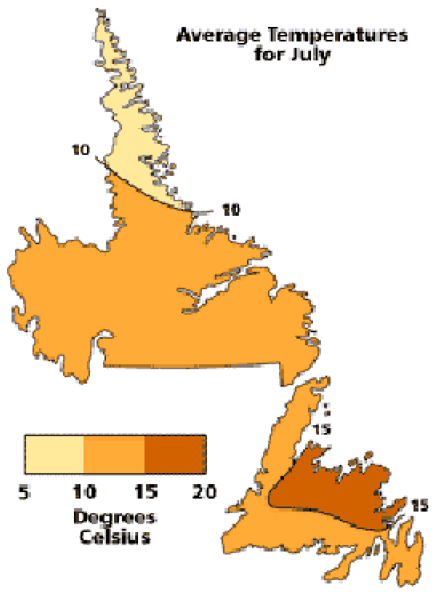
Geography

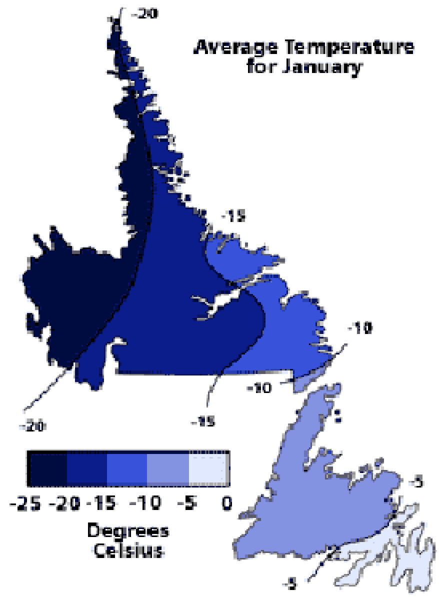
The island portion covers 5 1/2 degrees of latitude, about the same as the Great Lakes. Labrador covers about 9 degrees of latitude. The southern extremity lies close to the forty-seventh parallel, approximately the same latitude as Seattle and Paris. The northern extremity lies close to the sixty-first parallel, about the same as Yellowknife. The island covers an area of 111 390 km^2, while Labrador has 294 330 km^2, with elevations ranging from sea level to above 1600 m. This geographical spread contributes to the variability in climate and weather from one region to another. For example, Labrador winters tend to be drier and colder than the island. Central and western regions of the island tend to be snowier in the winter and hotter in the summer than Eastern regions.

Ocean Influence



It is said the people here live on, by, and from the sea. On the island, no place is more than 100 km from the ocean, and therefore every part of the island is subject to the year-round influences of the cold and air movements from it. A marine climate generally causes more changeable weather, lots of precipitation in a variety of forms (sometimes all at





waters surrounding the island and down the Labrador coast. Many of the communities of Labrador are on the coast or close to it. Surface water temperatures on the eastern side of the island range from summer highs of 11 °C to 13 °C inshore and 8 °C to 11 °C offshore with winter lows of -1 °C inshore and +2 °C offshore. Sea temperatures on the western side are warmer than the eastern side by 1 °C to 3 °C. The open sea keeps winter air temperatures a little warmer and summer air temperatures slightly cooler along the coast than inland. This is due to the two major ocean currents that pass by our province. From the north, bringing cold Arctic water, is the Labrador Current. This current helps keep our province slightly cooler in the summer than other parts of Canada. From the south, bringing warm tropical water, is the Gulf Stream. This current helps keep some areas of the island slightly warmer in the winter than others parts of Canada.

Because of the effect of the ocean on our climate, the island of Newfoundland experiences a maritime climate where there are generally milder winters and cooler summers. Labrador's climate has more Arctic influences due to the larger land mass once), higher humidity, lower visibility, more cloud, less sunshine, and stronger winds than a continental climate.

Air temperatures on the island are directly affected by the presence of the Atlantic Ocean. Winter temperatures on the island of Newfoundland show the day-to-day variability that is characteristic of a stormy maritime climate. Movements of moist, mild Atlantic air of the ocean are frequent. There is also a noticeable difference between inland and coastal temperatures. In the interior, winter temperatures average between -6 °C and -10 °C, whereas on the southeast coast, where the moderating influence of the ocean is greatest, the winter average is between -2 °C and -4 °C. The lowest Newfoundland temperature on record is -41.1 °C, set at Wooddale (Central Newfoundland) on February 4, 1975.

Prevailing Winds

There are few physical barriers to protect the island of Newfoundland from weather systems sweeping across it. Its situation on the eastern side of North America favours strong seasonal changes in the visiting air masses. Due to prevailing westerly winds that move air from across North America and up from the equator, there are plenty of low clouds, heavy precipitation, and strong winds over the island of Newfoundland. This is evident by the number of storms that pass over and near the island on an annual basis. Indeed, many of the storms that cross North America during the year from west to east, or develop and intensify off the East Coast of the United States, pass near the island while they move out to the North Atlantic. The result is that Newfoundland and Labrador has a deserved reputation as one of the stormiest parts of the continent. It also has some of the most changeable weather anywhere. At all times of the year Newfoundland is near one of the principal ***storm tracks***. The severity and frequency of storms is greatest between November and March, although they may occur at any time of the year. In fact, some of the most severe storms ever recorded, have been observed off our coasts. The movie "The Perfect Storm" is a good example of how strong storms develop off Newfoundland and Labrador.

> **Storm Tracks:** Are the paths that storms take as they move from one region to another
>
> **Cyclones:** In the Northern Hemisphere, a closed counter-clockwise movement of air

Winter ***cyclones*** are fast-moving storms (up to 80 km/h) that bring abundant and varied precipitation in the form of snow, sleet, freezing rain or rain. They pose a serious threat to fishermen, commercial shipping, and offshore oil and gas exploration activities. Winds often mount to gale and sometimes hurricane force. Hardly a winter goes by without at least three or four East Coast gales. Blizzards occur frequently in Newfoundland and Labrador. A common part of winter public forecasts include weather warnings and blizzard warnings. (See **STSE 2-2 Supplement A)** The official Environment Canada definition states a blizzard, in general, is a winter storm lasting for at least three hours with winds exceeding 40 km/h and visibility reduced to under a kilometer by falling or blowing snow. Typically air temperatures of -7 ^{o}C are required, however falling snow is not. Many blizzards result from already fallen snow blowing around. The application of the term blizzard differs from region to region across Canada.

Occasionally, throughout the year, large rotating storm centers are prevented from moving out of the region by an upper atmosphere air mass. The resulting cool, cloudy, and rainy weather associated with the system may persist for a week or more.

During the summer and early fall, Newfoundland weather is typically less stormy. However, in the fall, there are tropical storms that begin near the equator and develop in the Caribbean. These may bring windy, wet weather while they pass by the island. They eventually die or gain new strength in the North Atlantic. Over the past thirty-five years, an average of one tropical storm per year has passed within 300 km of Newfoundland and Labrador. One of the most notorious of these was the "Independence Hurricane" that struck eastern Newfoundland on September 9, 1775. About 4000 sailors, mostly from the British Isles, were reported to have been drowned. On September 5, 1978, another violent storm, Hurricane Ella, passed south of Cape Race. Her winds exceeded 220 km/h. At St. John's, 45 mm of rain fell and winds reached 115 km/h.

Analysis

1. Identify four things that influence the climate of Newfoundland and Labrador.
2. What ocean currents directly affect the climate of Newfoundland and Labrador?
3. Are climate conditions the same throughout this province? Explain.
4. How do wind patterns affect our climate?
5. What is a storm track?
6. What is a blizzard?

Extension

1. Ask students to go to http://www.pnr-rpn.ec.gc.ca/air/wintersevere/quiz.en.asp and take the weather quiz. There are many interesting facts to learn here.

Resources

Resource page: http://www.pnr-rpn.ec.gc.ca/air/wintersevere/weatherwords.en.html

World Meteorological Organization

http://www.wmo.ch/index-en.html

WW 2010 – The Weather World 2010 Project, University of Illinois

http://ww2010.atmos.uiuc.edu/

Environment Canada – Understanding Your Forecast

http://www.msc-smc.ec.gc.ca/cd/brochures/forecast_e.cfm#3

Environment Canada – The Climate of Newfoundland

http://www.ns.ec.gc.ca/climate/nfld.html

Envirozine – Canada's Online Weather Magazine

http://www.ec.gc.ca/EnviroZine/english/issues/04/print_version_e.cfm?page=feature1

Winter Warning Criteria

http://www.pnr-rpn.ec.gc.ca/air/wintersevere/warning.en.html

2-3 Severe Weather

Outcomes:

1. Analyze a possible cause for extreme weather and describe some of the effects. (214-11, 214-17, 330-4, 331-4)
2. Describe the causes and effects of seasonal weather events such as the Badger flood of 2003. (212-1, 330-6)
3. Integrate global climate change to local weather patterns. (213-7)

Introduction

The Ice Storm of 1998 was a natural disaster like no other. It affected millions of Canadians and left everyone wondering just how easily society is affected by the forces of nature.

Starting late on January 4, 1998 and continuing for the next six days until January 10, freezing rain fell on eastern Ontario, southwestern Quebec, and southern New Brunswick and Nova Scotia. These areas were pelted with 80 millimetres or more of freezing rain. The storm doubled the amount of precipitation experienced in any prior ice storm. The result was a catastrophe that produced the largest estimated insured loss ($1.44 billion Cdn.) in the history of Canada. The combined Canadian and United States insured loss stands in excess of $1.2 billion U.S. or $1.75 billion Cdn as of October 1, 1998. The same storm slashed across northern and parts of the United States but the damage in the United States paled in contrast to the damage in Canada.

In Canada, 28 deaths were attributed to the storm, while in the United States, 17 people lost their lives. According to Emergency Preparedness Canada, electric outages in the affected areas of Canada deprived 4.7 million people, or 16 percent of the Canadian population, of power.

Crumpled Steel Towers

People look at a series of Hydro-Quebec high voltage towers near St-Bruno, Que., south of Montreal, Saturday, that collapsed after a severe ice storm hit southwest Quebec. The storm left over one million households out of electricity.

Many Canadians living in large cities, expect that their homes and businesses will be protected from nature's greatest forces. In rural areas, farmers have become more dependent on technology for their work. Their feelings of security were broken in January, 1998 when this ice storm moved into the region.

The freezing rain fell for four days without stopping and thousands of power poles and towers came crashing down under tons of ice. As a result, in most of Quebec and eastern Ontario the power did not come back on for weeks. This meant that Quebec and Ontario had no power for lighting or heat. This was especially difficult with winter conditions becoming worse.

Rebuilding the power network and cleaning up downed lines, fallen trees and crumpled metal hydro towers were huge tasks. So large in fact, the Canadian Armed Forces were called in to help. It was the largest peacetime deployment of troops in Canadian history. Work crews came from Atlantic Canada, the US, and as far away as British Columbia to help restore electricity.

Because the warm air from the Gulf of Mexico was unable to push out the denser, cold air near the ground, the southerly (i.e. from the south) stream of moist air rose up above the cold air that was near the ground setting the scene for the start of freezing rain. The weather map (See figure 1) shows warm, moist air from the United States flowing into Ontario and Quebec. At first, snow fell into the mass of warm air

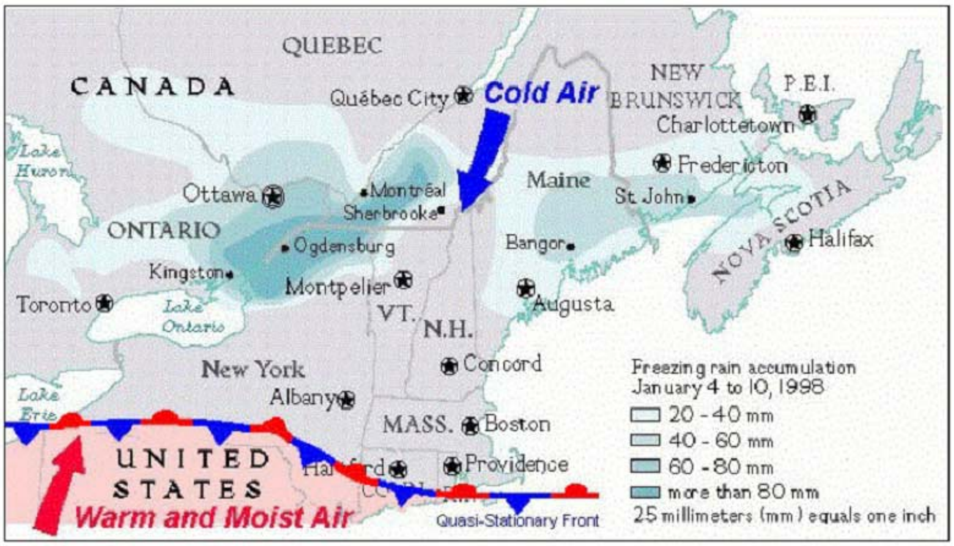


Figure 1

As people waited for power they tried to keep warm with fireplaces or propane heaters. Several died in fires or from carbon monoxide poisoning. Tens of thousands of people were forced into emergency shelters all over southern Quebec where many would stay for weeks. The cost and effects of the storm were still being felt a year later.

The Cause

Scientists called the four consecutive days of freezing rain an event never seen before in the history of Canada. The rains began the night of Jan. 5 during an unusually mild winter. A low-pressure weather system over northern Texas had put moist, warm air from the Gulf of Mexico into southern Ontario and Quebec at the higher altitudes (cloud levels). By January 5, a large Arctic high pressure area had established itself over central Quebec with its circulation putting very cold air into Southwestern Quebec, Western Ontario and the Maritimes.

and melted to fall as rain. The rain then met the mass of cold air lying close to the ground and quickly changed to freezing rain. Freezing rain results when super-cooled rain hits cold objects on the ground and freezes on contact. This resulted in the biggest ice storm to hit central Canada. It stretched from Kingston in Ontario, to Quebec City.

Typically at this time of year the region would be getting hit with huge winter snowstorms, but all across Canada the effects of the warming system **El Niño** had been noticed. British Columbia had a dry, pleasant winter. The prairies had hardly any snow, and warm temperatures produced unusual winter brush fires. So the ice storm was a surprise, but it didn't sneak up quietly. In the first day ice coated everything from trees to cars to hydro wires. Although silvery and beautiful, the ice coatings

> **El Nino** is a weather-related event in the Pacific ocean caused by warmer than average ocean water

were dangerous and disruptive. Trees fell, cars remained shielded in ice casings, hydro wires sagged and poles dropped. Within 24 hours, more than 750,000 homes were blacked out. Soon one-quarter of all Hydro Quebec's customers were without power. The power utility sent out 2,000 hydro workers to repair lines and restore electricity, but they couldn't keep up as more freezing rain fell.

The Results

Three days later on Jan. 7 the massive ice storm had Eastern Canada shut down. People were beginning to realize the already dangerous situation could get worse. Some houses caught fire after people continually burned wood in fireplaces whose chimneys were not built or maintained for constant use. Some people ended up poisoned by carbon monoxide fumes while using propane heaters or barbecues to stay warm. After three days in the cold and dark, many people gave up and sought refuge in shelters. But even the shelters had problems with blackouts.

Five days later on Jan. 9, the worst day of the storm was felt. Fallen power lines blocked access to roads and made traveling on highways unsafe. The city of Montreal became completely blocked off as bridges were closed due to risk of falling ice. The few areas that still had power lost it and for the first time in its history all four lines of Montreal's subway, the Metro, were closed.

By late afternoon 3 million people were without electricity and clean water was becoming hard to find. The power crisis shut down water filtration plants and with no back-up generators there was only a two-hour supply of fresh water left. People were warned to boil water from their taps before drinking it.

The rain stopped on Jan. 10 but the effects of the storm carried on. At least 80 km of transmission lines, 23,000 poles and hundreds of transformers had to be repaired and replaced on Quebec's south shore alone.

This area, dubbed the "Triangle of darkness" because of the length of time it spent in a power blackout, was the most devastated section.

In all, 120,000 km of transmission and distribution lines, which took more than half a century to create, came down in a week. Hydro crews came from across the country to work at rebuilding the network and Hydro Quebec had to foot the bill for the hundreds of hours of reconstruction: about $500 million. Ontario Hydro had some rebuilding of its own to do at a cost of about $120 million.

Army troops also played a big role in the clean-up effort. Nearly 16,000 soldiers cleared debris from roads, delivered generators and supplies and assisted hydro crews in their work. After 10 days many of the troops headed back home but some stayed into February until all power was restored and the emergency shelters were empty. Some rural areas had gone without power for a month.

Other provinces sent relief and volunteer crews. Money poured in to the Red Cross relief fund from many sources including $500,000 from the National Hockey League. In isolated areas south of Kingston, Ontario volunteers visited individual homes to make sure people were safe and sheltered.

Deaths - Ice Storm '98 caused the deaths of 28 persons from the following causes:

Cause of Death	No. of Deaths
Trauma	9
Carbon monoxide poisoning	7
Fire	5
Hypothermia	4
Hazardous activities, i.e. removal of snow and ice from roofs	3
Total	**28**

Economic losses

- agricultural losses of $25 million
- hydro electric towers and transmission lines $1 billion.
- dairy production losses $8 million
- insurance claims of $1.44 billion
- use of military personnel $60 million

Added to this were the cost of clean-up, cost of sheltering and feeding thousands of individuals, loss of large hardwood forests, and the cost of emergency and overtime police, fire and medical services.

As an extreme weather event, the Ice Storm of 98 ranks as one of the most significant both in terms of its effects on the economy and the general lives of Canadians. (See **STSE 2-3 Supplement A**)

Analysis

1. Draw a diagram of the layers of air that caused the Ice Storm of 98. Remember, a layer of warm air was wedged between two layers of cold air.
2. Why was the winter of 98 so unusually warm in Eastern Canada?
3. How many people were without electricity in Canada and the USA? What was the longest duration?
4. Estimate the total Canadian economic losses.
5. How many deaths in Canada were directly related to the storm?

Extension

1. Research ice storms in Newfoundland and Labrador to compare the effects on this province to the Ice Storm of 98's effect on Eastern Canada.

The Badger Flood 2003

Introduction

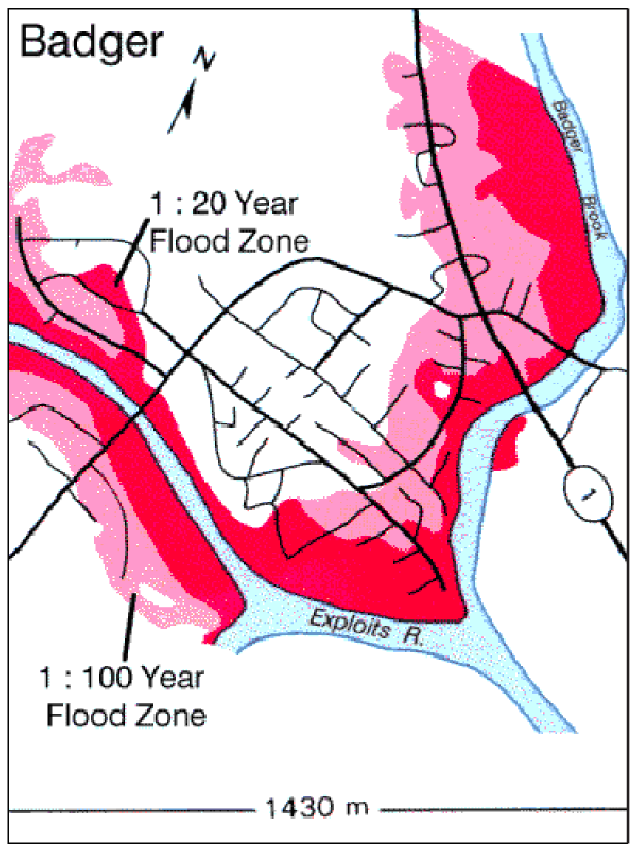
On the morning of Saturday February 15, 2003, the residents of Badger, a central Newfoundland community, awoke to find water rushing into their homes as the three rivers which join near the community (the Exploits, Red Indian, and Badger) backed up with ice jams. At 11:35 a.m. That day Mayor Gerald Hurley declared a State of Emergency. Initially, a partial evacuation was begun but by late evening, the partial evacuation order had been expanded to include the entire community of about 900.

The sewer system had failed, the water supply was thought to be contaminated, and more flooding was feared. People spent the night with friends and relatives in neighbouring communities or at the Beaumont Hamel Armouries in nearby Grand Falls-Windsor, where the Canadian Red Cross had beds, food, and other necessities set up. Firefighters and other volunteers stayed behind to monitor water levels and to heat homes not hit by the flood. The flood had occurred without warning as water swept down the Exploits.

The Cause

Winter floods are not uncommon to Badger. The town is located in the central region of the province of Newfoundland and Labrador, west of Grand Falls-Windsor. It is situated at the meeting point of three rivers, the largest of which is the Exploits River (See flood zone map). Badger's long recorded history of flooding dates back to 1916. They were hit by major floods in 1978, 1982, and 1985. As is often the case, ice jams, formed during a period of high winds, blowing snow and extremely cold temperatures, caused the Badger, Exploits and Red Indian Rivers to spill their banks, washing away riverside structures and encasing the entire town in ice.

The Exploits River, in particular, has a history of ice jams. These can occur when ice floes encounter ice dams that blocks the movement of ice upstream. Ice jam flooding occurs in two ways. One way this occurs is when river water backs up behind ice jams, thereby flooding low-lying areas. Another way is when ice floes break away, allowing water to spill down stream, an occurance similar to opening the gates of dam. This is what appears to have happened on February 15.



Ice jams form most frequently in the following areas:

- around islands in rivers
- at bends in rivers
- at points where rivers meet or come together
- near bridges and other obstructions.

Freeze-up jams occur when ice is forming in early to mid winter. Break up jams occur when ice is melting and breaking up. The ice moves down stream in late winter and early spring.

The Result

During the flooding and subsequent evacuations, people had to be rescued from many homes using a front-end tractor because the water flooded Badger so quickly. Reports indicated that the water rose 2.5 meters in the first hour of the flood. As the water filled the town, both the sewage treatment and water treatment plants failed. Later Saturday night and early Sunday morning, air temperatures dropped to -20^{o} C, quickly freezing the water that had filled the homes, offices, businesses and recreational facilities of Badger.

A closer look at the homes revealed many were shifted off their foundations as the ice struck them. Others were suffering water damage as well as damage due to swelling ice as it formed inside the homes. Some homes had half filled oil tanks tipped over, adding to the environmental concerns of the failed treatment systems.

The residents that were struck first by the flood also had no time to remove their vehicles and as a result many were caught in the water and later froze in ice as temperatures dropped.

As the flood waters slowly retreated over the next week, some residents could return to their homes because they had little damage due to the flood. Many others would be out of their homes for months. The impact of this flood created large financial costs. Some were covered by donations from people and organizations like the Royal Canadian Legion and the Canadian Red Cross. The personal costs, however, would be much higher for some people and too high for others who would choose not to return to their homes (See **STSE 2-3 Supplement B**).

The Badger Flood of 2003 was significant enough to make the list of the top ten weather events of 2003 (See http://www.msc.ec.gc.ca/media/top10/2003_e.html).

Analysis

1. What is an ice jam? How can it occur?
2. How quickly did the Badger flood of 2003 occur?
3. Why is Badger prone to flooding? How many times has flooding occurred?
4. Describe some of the damage suffered by residents and the town.
5. What were some environmental concerns?
6. What made the flooding event significantly worst?
7. Where did people go during the full evacuation? How long did it last?

Extension

1. Research the Newfoundland and Labrador governments' contribution to the Badger relief effort. What conditions, if any, did they place on the town of Badger?
2. Although nothing indicates the involvement of the Abitibi-Consolidated paper mill. The company has denied any responsibility for the flood. Research why they would have to make such a claim.

Resources

CBC Newsworld Online

http://www.newsworld.cbc.ca/flashback/1998/ice3.html

CBC St. John's Online

http://stjohns.cbc.ca/regional/servlet/View?filename=nf_badger3_20030218

The Ottawa Sun

http://boating.ncf.ca/icestorm.html

ICE STORM '98 by Eugene L. Lecomte with Alan W. Pang and James W. Russell

http://collection.nlc-bnc.ca/100/200/300/institute_for_catastrophic/iclr_research_paper-ef/no01-e/Research_Paper_No_1.pdf

THE BADGER FLOOD Author: Robert Hunter Published on: March 8, 2003

http://www.suite101.com/article.cfm/canadian_tourism/98976

Badger Water Level Information-Government of Newfoundland and Labrador

http://www.gov.nf.ca/wrmd/Badger/default.asp

Great Canadian Rivers – Exploits River Focus on Flooding

http://www.greatcanadianrivers.com/rivers/explo_n/flood.htm

APPENDIX B: Resources

Resources

Gibb, T., LeDrew, B., Osborne, D., Patterson, J., Poole, M., Roberts, J., Toor, I. & White-McMahon, M.(2002). *Science 10 Concepts and Connections.* Toronto, ON: Nelson Thomson Learning.

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Government of Newfoundland and Labrador. (1993). *Forestry Module*. Department of Education, Division of Program Development. Prepared for the Department by Susan J. Meades.

Government of Newfoundland and Labrador. (1993). *Fishery Module,Teacher's Manual*. Department of Education, Division of Program Development. Prepared for the Department by Vernon Pepper and Barbara Pepper.

Government of Newfoundland and Labrador. (1993). *Forestry Module, Teacher's Manual*. Department of Education, Division of Program Development. Prepared for the Department by Susan J. Meades.