Science 1206
Course Outline

Unit 1 Life Science
Sustainability of Ecosystems

This unit extends the concepts gained by analyzing habitats and ecosystems to the issue of sustainability. Students are challenged to think about large-scale ecosystems and the flow of matter and energy within those systems. It is intended that students recognize Earth as essentially a closed system, which means sustainable use of resources becomes a major concern.

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

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

Explain how a paradigm shift can change scientific worldviews in understanding sustainability. Explore and develop a concept of sustainability in relation to a natural resource industry (e.g.: forestry, fishery, agriculture, aquaculture, mining, tourism or others).

- Define sustainability.
- Examine historical attitudes and practices in relation to those of sustainability.
- Define a paradigm and paradigm shift.
- Discuss how attitudes towards pesticides have changed
- Discuss how attitudes towards our forests have changed with respect to commercial usage, residential usage and replanting programs.

Resource: Biology 3201 Forestry Elective, Rachel Carson's Silent Spring

Explain biotic and abiotic factors that keep natural populations in equilibrium and relate this to the resource limits of an ecosystem.

- Define ecology and ecosystem.

- Define abiotic factors (include space, temperature, oxygen, light, water, inorganic and organic soil nutrients).
- Define biotic factors (include decomposing animals, disease, predator/prey, competition, symbiosis, reproductive rates).
- Explain how biotic and abiotic factors affect ecological interactions.
- Define ecotone and explain how this is a situation where abiotic factors influence biotic factors.

Core Lab: Schoolyard Ecosystem OR A Natural Ecosystem OR Construct Your Own Ecosystem

Explore the changes that occur in ecosystems.

- Define succession.
- Describe the factors that contribute to succession.
- Describe what is meant by a climax community.

Explore energy flow in ecosystems.

- Examine the flow of energy in ecosystems using the concept of the pyramid of energy.
- Examine how energy availability affects the total mass of organisms in an ecosystem and summarize this relationship in a pyramid of biomass.

Describe and apply classification systems and nomenclature with respect to trophic levels in ecosystems.

- Define niche and relate it to habitat.
- Classify organisms as producers, consumer, autotroph, heterotroph, herbivore, carnivore, omnivore, saprobe.
- Define competition and explain how competition arises among organisms.
- Differentiate between interspecific competition and intraspecific competition.
- Describe the feeding relationships in terms of competition, food chains and food webs.

Explain how biodiversity of an ecosystem contributes to its sustainability.

- Demonstrate how the many interrelated food chains give a community stability and identify the conditions required for a stable self-sustaining ecosystem.

Describe the mechanisms of bioaccumulation or bioamplification caused by pesticide use, and explain its potential impact on the viability and diversity of consumers at all trophic levels.

- Examine the use of pesticides over the course of human history.
- Describe the impact that DDT usage has had on bird populations.
- Describe how continued DDT usage in developing countries is impacting bird populations.

Illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking carbon, nitrogen and oxygen.

- Diagram the carbon cycle and describe the processes required to cycle from carbon reservoirs to the atmosphere.
- Describe the importance of oxygen to ecosystems.
- Describe the significance of global warming and eutrophication.
- Describe how humans have altered the carbon, oxygen and nitrogen cycles in ecosystems.
- Describe what is being done to negate human impact on these cycles.
- Contrast the flow of energy and the cycling of nutrients.

Describe how ecosystems respond to short-term stress and long-term change differently.

- Students should choose a local topic.

Describe how soil composition and fertility can be altered and how these changes could affect an ecosystem.

- Explain the role that fertilizers and irrigation practices have had on soil quality.
- Describe the potential impact that overuse of fertilizers can have on ecosystems.

Core Lab: Soil Nutrients and Plant Growth OR The Animal Community in Soils

Explain why ecosystems with similar characteristics can exist in different geographical locations.

- Discuss the features of Canada's biomes.
- Relate the distribution of biomes within Canada to the impact of external factors.
- Discuss how abiotic factors affect the distribution of organisms.
- Discuss the reasons for ecosystems that share similar abiotic features also sharing similar animal life. For example the aquaculture industry of Norway vs. Atlantic Canada OR biogeography studies.

Describe how Canadian research projects in environmental science and technology are funded.

- Examine the development of aquaculture projects from which the salmon farming industry grew. Questions to consider include which agency sponsored the project, how it was funded, how the project was managed, when the research changed from pure to applied and at what stage business adopted responsibility for the project.

Compare the risks and benefits to the biosphere of applying new scientific knowledge to industrial processes.

- Discuss the benefits of and support for fish farming.
- Discuss the impact of fish farming on the surrounding environment and arguments against use of this technology.

Aquaculture Debate

Unit 2 Physical Science
Chemical Reactions

This unit builds on the previous study of atomic structure and the significance of the periodic table by asking students to observe some chemical reactions. How these reactions are initiated and proceed, and which products result are considered. In preparation for later chemistry courses, these investigations require students to name and write formulas and to begin representing chemical reactions in symbolic form.

By naming and writing common ionic and molecular compounds and by balancing a variety of chemical equation types, students begin to make connections to a variety of chemical examples in everyday life.

This unit also emphasizes the social and environmental contexts of science and technology associated with air and water pollution. Atlantic Canada is particular affected by acid precipitation and other forms of air pollution owing to prevailing winds in North America. These winds carry large amounts of air pollutants from the more populated and industrial regions of the United States and Canada. The problem is further complicated by our own industrial plants and power generation plants. In addition, much of our region has thin soils and granite bedrock, which results in a high sensitivity to acid damage. In this context, students will explore how chemical reactions are associated with technologically produced problems such as acid rain, and look at some steps that can be taken to counter the effects of acid rain.

Provide examples of how science and technology are an integral part of our lives and our community by investigating common examples of combustion.

- Define chemistry and matter.
- Identify examples of chemistry and technology around us in everyday life (include oxidation of iron, combustion of wax, vinegar and baking soda, barbecuing).

Demonstrate knowledge of WHMIS standards by selecting and applying proper techniques for handling and disposing of lab materials.

- Describe the WHMIS information system and its use.
- Identify the eight WHMIS symbols.
- Describe the MSDS sheet and its use.
- Identify the nine categories on a MSDS sheet.

Using problem solving, evaluate and select appropriate methods/tests to investigate the presence of chemicals.

- These tests should include O_2 (glowing splint), H_2 (lit splint), CO_2 (limewater), H_2O (cobalt chloride paper), acid (litmus paper), base (litmus paper) and salts (conductivity apparatus).

Describe the usefulness of IUPAC scientific nomenclature systems to convey chemical information.

- Define molecule, molecular formula, empirical formula, polyatomic ion, simple ion and formula unit.
- Define aqueous solution (aq).
- Define electrolyte and non-electrolyte (electrolytic and non-electrolytic solution).
- Distinguish between physical and chemical property.
- Distinguish between physical and chemical change.
- Differentiate between ionic and molecular compounds based on their composition, bonding and physical properties.

Core Lab: Properties of Ionic and Molecular Compounds

Name and write formulas for common molecular compounds, including the use of prefixes.

- Determine the names of binary molecular compounds, using IUPAC rules, given the molecular formula and vice versa.
- Name several molecular compounds using trivial names.

Name and write formulas for some common ionic compounds (both binary and complex), using the periodic table, a list of ions, and appropriate nomenclature for metal and non-metal ions.

- Given formulas for ionic compounds (including simple ions and polyatomic ions, ions that can form multiple charges, and ionic hydrates), determine the names of ionic compounds using IUPAC rules and vice versa.

Classify simple acids, bases and salts on the basis of their names and formulas.

- Name and write formulas for some common acids and bases, using the periodic table, a list of ions, and rules for naming acids.
- Define acids as molecules that ionize in water to produce hydrogen ions (H^+).
- Identify the physical properties of acids.
- Define bases as ionic compounds that contain the hydroxide ion (OH^-).
- Define salts as ionic compounds.

Classify substances as acids, bases, or salts, on the basis of their characteristic properties.

- Define pH scale in terms of a measure of acidity or alkalinity or neutrality.
- Define acids and bases operationally in terms of their effect on litmus paper, pH, sour and bitter taste, reaction with active metals, and reaction with each other.
- Define salts operationally in terms of the conductivity of their aqueous solution.
- Describe how neutralization involves tempering the effects of an acid with a base and vise versa.
- Simulate neutralizing a lake that has been affected by acid precipitation. React calcium oxide (lime) first with water (thus making the base calcium hydroxide) and subsequently with dilute sulphuric acid. Monitor with a pH meter.

Represent chemical reactions and the conservation of mass, using molecular models and balanced symbolic equations.

- Write and balance reactions that illustrate a variety of reaction types, including combustion, formation, decomposition, single replacement and double replacement.
- Define the Law of conservation of Mass.
- List the four pieces of evidence for a chemical reaction.
- Predict the products of chemical reactions, indicating the phase of all reactants and products (including the use of a solubility table for reactions in solution).
- Define exothermic and endothermic reactions and draw energy diagrams representing each.

Core Lab: Single Displacement Reactions
Core Lab: Double Displacement Reactions

Independent Study

- Work co-operatively with a team to research and describe the relationship between domestic and industrial technologies and the formation of acid rain (automobile and coal burning emissions).
- Compile and organize data on acid precipitation (pH) in order to interpret patterns and trends in these data, and infer or calculate linear and non-linear relationships among variables such as pH versus time and location.
- Propose alternative solutions to the problem of acid precipitation, assess each, and select one as the basis for a plan of action defending the decision.
- Identify and describe science and technology-based careers related to airborne pollution.
- Compare examples where society has used the presence of airborne pollution to influence decision concerning science and technology (Kyoto Protocol).

Unit 3 Physical Science
Motion

This unit offers the first opportunity for students to observe, measure, and describe motion in a mathematical fashion. Analysis is restricted to one dimension only with uniform (constant) motion and uniformly accelerated motion. As the unit develops, direction becomes important with vector notation being introduced.

The concept of motion allows students to investigate and develop their interest in the sports that are part of their daily lives. Students will not only have opportunities to investigate the principles of kinematics but will also be encouraged to apply its development into areas of individual interest. Snowmobiling or biking can be used to develop the concepts of displacement, velocity and acceleration.

Motion will also be graphically represented. This will provide a visual representation of aspects of velocity and acceleration.

Devise a method of representing the linear motion of two moving people or objects.

- Develop appropriate sampling procedures for determining the speed of an object's linear motion.
- Given measuring tapes and stopwatches, students will work in groups to collect data on the forward motion of a group member. Students should use equal time intervals and collect at least five distance data points (for example the distance traveled by a runner at the end of two-second intervals for a total of ten seconds).

Use instruments such as ticker timers, photogates, or motion sensors effectively and accurately for collecting data.

- Demonstrate the proper use of SI units.
- Describe the role of instruments in experimental physics (thermometers-temperature, microscopes/telescopes-see things very small or very far, stop clocks-measure time, computers-collect, store and analyze data).

Evaluate the relevancy, reliability, and adequacy of data and data collection methods.

- Distinguish between accuracy and precision of data.

Identify and explain sources of errors and uncertainty in measurement, and express results in a form that acknowledges the degree of uncertainty.

- Record measurements using appropriate numbers of significant digits.
- Demonstrate the proper use of significant digits during calculations.
- Express measurements in scientific notation when appropriate.

Describe quantitatively and analyze both graphically and mathematically, the relationship among distance, time, and speed of an object's linear motion.

- Define average speed and calculate it, given information about distance moved and time taken.
- Explain what is meant by uniform motion.
- Explain what is meant by instantaneous speed.
- Carry out an experiment to measure the speed of an object at various points along its path, making use of ticker timers or microcomputer-based laboratories, and analyze the data graphically.
- Given the distance-time data, plot a d/t graph, appropriately labeled with the dependent and independent variables correctly placed.
- Determine the slope of a d/t graph and state the physical significance of the slope.
- For a uniformly moving object, plot a speed-time graph and explain the physical significance of the y-intercept and the area under the graph.
- Determine the speed from a distance-time graph, and determine the distance from a speed-time graph.

Core Lab: Determining an Average Speed

Describe quantitatively, and analyze both graphically and mathematically, the relationship among displacement, time and velocity of an object's uniform motion.

- Predict the time taken for a moving object to complete a course on the basis of initial measurements, estimated values, and an understanding of the displacement, time and velocity relationship.
- Distinguish between scalar and vector quantities, using distance and displacement, and speed and velocity, respectively, as examples.
- Define average velocity and explain why it is a vector quantity.
- Given two (or means of finding two) of average velocity, displacement and elapsed time, calculate the third quantity.
- Determine velocity from a position-time graph, and determine displacement from a velocity-time graph.
- Determine the direction of motion (positive or negative) of a uniformly moving object from its position-time graph, and its velocity-time graph.
- Distinguish between average velocity and instantaneous velocity.

Use instruments for collecting data on uniformly accelerated linear motion effectively and accurately.

- From the data obtained in the core lab, plot a position-time graph.
- Given one of position or time, determine the other from the graph.
- Determine the instantaneous velocity by taking the slope of a tangent drawn to the curve at a selected position or time on the graph and use velocities obtained in this way to plot a velocity-time graph.

Core Lab: Speeding Up or Slowing Down

Describe quantitatively, and analyze both graphically and mathematically, the relationship among velocity, time, and acceleration.

- Distinguish between uniform and non-uniform motion.
- Explain what is meant by uniform or constant acceleration and explain why it is a vector quantity.

- Define acceleration as the rate of change of velocity per time unit.
- Use the definition of acceleration to determine acceleration, initial velocity, final velocity, or time, given the other three.
- Relate the slope of a linear velocity-time graph to the acceleration.
- Calculate the area of a velocity-time graph and relate it to the object's displacement.
- Given the velocity-time graph of a uniformly accelerating object, determine its initial velocity and its acceleration.
- Explain how one can tell from the position-time graph whether the magnitude of an object's velocity is increasing, decreasing, or constant.
- Determine, at any time, the instantaneous velocity from a displacement-time graph for an object with zero acceleration or uniform acceleration.

Independent Study

- Distinguish between scientific questions and technological problems related to a motion research topic.
- Describe the historic development of a motion technology.
- Evaluate the design of a motion technology and the way it functions with relation to safety, construction, and cost.
- Evaluate the role of continued testing in the development and improvement of a motion technology.
- Example: What is the effect of the track surface on the performance of a runner's footwear? (scientific question) How can the design of a runner's footwear be modified to take into account the track's surface? (technological problem). Explore design features and function (track event, track surface, indoor/outdoor). Student should evaluate the design of the footwear on the basis of safety (preventing injury), overall construction, reliability, and cost. Students should identify the features of footwear design that would be considered important to develop improvements. They should evaluate the role of continued testing in their development and improvement.

Describe Canadian contributions to science and technology in the area of motion.

- Specific companies or specific topics can be researched. For example Bombardier designs in snowmobiles, trains and airplanes, Canadian contributions in the area of track surface or bicycle design, SPAR Aerospace, Rupert W. Turnbull).
- Relate the research project to studies in other science discipline and interdisciplinary studies. For example, the motion of a runner can be related to studies in kinematics, aerodynamics, and mathematics. Factors that affect the motion of a runner can be related to sports training, computer technology, mechanical engineering and aerodynamics.

Unit 4 Earth and Space Science
Weather Dynamics

This unit is designed to guide the student to understand major concepts associated with atmospheric conditions that produce our weather. Students may construct weather data collection instruments and collect, analyze, and interpret their data, as well as those from a variety of other sources. The influence of matter and energy exchanges on weather system development is central to the unit. Students are also encouraged to attempt weather forecasting and consider how weather affects our society.

Global climate and local weather patterns are affected by many factors and have many consequences. This unit asks students to consider such questions 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 Canada in a variety of ways.

Relate personal activities and technology used with meteorology in the design of a weather station.

- Identify and explain the function of instruments used in a weather station. Instruments include: thermometer, hydrometer, aneroid barometer, anemometer and rain gauge.

Use weather instruments effectively and accurately for collecting local weather data.

- Identify questions to investigate that arise from the operation and findings of the weather station.
- Distinguish between weather and climate.

Use print and electronic sources to collect weather data from regional and national weather observational networks.

- Prepare a report in which local weather data is collected for a period of five days.
- Record data on a standard meteorological map.
- Recognize and explain weather symbols seen on weather maps.
- Predict future weather conditions, using appropriate technologies and methodologies.

Identify questions to investigate that arise from considering the energy transferred within the water cycle.

- Identify solar energy (sun) as the driving force behind the water cycle.
- Illustrate the distribution of incoming solar radiation.
- Identify that the amount of heat energy absorbed by any material depends on the albedo of the material.
- Provide a brief explanation of the water cycle.
- Define and explain evaporation, condensation and precipitation.
- Identify and define the three main categories of clouds: convective, frontal and orographic.
- Classify clouds into their separate types.
- Investigate some of the following: How does the water cycle influence the seasonal high/low temperatures for inland and coastal communities? Why is the arrival of a snowstorm normally linked to a rise in air temperature? How and why do clouds form? Why does it snow or rain? What mutual interactions occur between atmospheric and large bodies of water such as ocean or lakes?

Using scientific theory, illustrate and explain heat energy transfers that occur in the water cycle.

- Briefly review kinetic molecular theory.
- Describe and explain how heat energy is transferred by radiation, conduction, convection and advection.
- Define the conditions necessary to form fog.

Describe examples that illustrate the atmosphere and hydrosphere are heat sinks in the water cycle.

- Define the term heat sink and heat source.
- Recognize that the hydrosphere and atmosphere are the Earth's main heat sinks.
- Recognize the significant heat storage by water caused by its high value of specific heat and how this energy is transferred between the hydrosphere and the atmosphere.
- Rank air, water and soil as good or poor heat sinks.
- Demonstrate that the energy stored in the hydrosphere influences other systems.

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.

- Estimate the specific heat of air, water, sand and soil by heat absorption techniques.

Discuss the design of experiments that compare the magnitude of the specific heat for water with that of its latent heat of fusion and vaporization.

- Define latent heat of fusion and latent heat of vaporization.
- Compare latent heat and specific heat.

Core Lab: Energy Changes During Melting and Evaporation

Identify and explain the uncertainties in measurement and express them in a form that acknowledges the degree of uncertainty.

- Investigate factors such as type of container for test materials (shape, color, material), mass, surface area, closed container, open container, air conditions surrounding the container (still or moving).

Core Lab: Heat Absorption and Radiation

Explain how scientific knowledge evolves about changing weather patterns with new evidence about changes in ocean temperature.

- Identify how oceans are important in weather dynamics.
- Study ocean layers close to coastal regions and the edges of continental shelves to assist in interpreting flow patterns that influence weather patterns.
- Identify factors that are responsible for causing ocean currents.
- Compile and display data, using this to support conclusions from experiments which investigate heat energy storage by and heat energy exchange between water and air masses.

Use weather data to describe and explain heat transfers in the hydrosphere and atmosphere showing how these affect air and water currents.

- Identify the different prevailing winds around the Earth.
- Recognize that high heat transfer between the oceans and the air above creates convection currents within the atmosphere.
- Explain the importance of convection and the Earth's rotation in causing prevailing winds.

Select and integrate information about weather from a variety of sources. Compile and display this information to illustrate a particular hypothesis about weather in Atlantic Canada.

- Search from various sources (anecdotal, print, electronic) to explore specific examples of notable weather events.
- Relate historical accounts with the concept of energy exchanges within the systems.
- Explore intense or consistent weather events that have had human and societal impact (example: habitation patterns in a region, weather patterns impacting economy of a region, the role of weather on Newfoundland and Labrador settlement patterns).

Illustrate how science attempts to explain seasonal changes, and variations in weather patterns for a given location.

- Explore how latitude of a location and incline of the Earth's axis (in terms of incident solar radiation) play a major role in seasonal change.
- Explore a flashlight and globe model to explain seasonal change.
- Investigate localized air movement (thermals, sea breezes and land breezes) and its effect on regional weather.

Using scientific theory, describe and explain heat transfer and its consequences in both the atmosphere and hydrosphere, relating this science to natural phenomena.

- Identify and describe the principal characteristics of layers found in the atmosphere.
- Identify the distribution of common atmospheric gases (oxygen, nitrogen, water vapor, carbon dioxide).
- Investigate the relationship between altitude, temperature and atmospheric pressure.

Describe and explain the effects of heat transfer on the development, severity and movement of weather systems.

- Define a weather system.
- Identify air masses (tropical, polar, maritime, continental) and compare their movements across North America.
- Identify weather conditions associated with maritime polar, maritime tropical, continental polar and continental tropical air masses.
- Identify and explain the formation of low pressure (cyclone) and high pressure (anti-cyclone) systems.
- Define front and distinguish between four types of fronts formed along pressure systems.
- Determine that low pressure systems at low latitudes have potential to develop into severe weather systems (hurricanes, typhoons, tropical cyclones).

Describe weather satellite imaging, its benefits to society and Canada's contribution to this technology.

- Identify how imaging technology has improved decision making about projects in which weather systems can have significant economic impact.

Identify examples where improved data gathering technology has resulted in better understanding of weather systems and of forecasting.

- Explore the following technologies: Doppler Radar, infra red and visible imaging from satellites, fog detectors, precipitation detectors, remote sensing and transmission data stations.
- Describe the impact of Canadian contributions to the field of meteorology.

Describe the limitations of scientific knowledge and technology in making predictions related to weather.

- Appreciate the limits of accuracy caused by our location on the North American continent. Atlantic Canada is at a junction of flowing systems.

Relate both personal activities and scientific/technological processes to weather and climate research and the application of the research.

- How are you personally influenced by and respond to various weather conditions.

Identify the impact of severe weather systems on economic, social and environmental conditions.