Senior 2

Cluster 1: Dynamics of Ecosystems

Overview

In this cluster, students examine the complex relationships present in ecosystems in order to further investigate issues of sustainability. The large-scale cycling of elements in biogeochemical cycles and the bioaccumulation of toxins in food chains are studied. Population dynamics are examined in the context of the carrying capacity and limiting factors of ecosystems. The concepts and implications of species biodiversity are explored as well. With the knowledge they have gained, students investigate how human activities affect an ecosystem and use the decision-making model to propose a course of action to enhance its sustainability.

PRESCRIBED LEARNING OUTCOMES
Students will...
S2-1-01 Illustrate and explain how carbon, nitrogen, and oxygen are cycled through an ecosystem. GLO: D2, D3, D5, E2

SUGGESTIONS FOR INSTRUCTION
(1-1/2 HOURS)

➢ Entry-Level Knowledge

In Grade 7, students were exposed to the idea of cycling in ecosystems, where they studied the cycling of matter in photosynthesis and respiration, energy flow through trophic levels, and examined the role of producers, consumers, scavengers and decomposers. In Grade 8, the concept was further developed with the hydrological cycle.

➢ Notes for Instruction

A brief review of photosynthesis, respiration, trophic levels, and energy flow in ecosystems studied previously in Grade 7 may be a starting point for this unit. A Knowledge Chart could be used (see *Senior Years Science Teachers' Handbook,* Manitoba Education and Training, 1997 [hereinafter referred to as *SYSTH*] 9.25).

Prior knowledge can be activated with a group discussion of the ways in which nutrients are cycled through ecosystems. The following questions may be used to spark discussion: "What happens to the bodies of dead organisms?" "How are the bodies of dead organisms reused and recycled in the environment?" and "What is fertilizer?" Diagrams and flowcharts should be used to illustrate the cycling of matter in an ecosystem.

➢ Student Learning Activities

Visual Display S2-0-2a, 5c

Students or student groups construct visual displays of the three cycles being studied. Displays may include posters, dioramas, bulletin boards, and concept maps. These can be exhibited in the room for future reference.

Laboratory Activity S2-0-4a, 4b, 5b, 5c

Students investigate the cycling of carbon and oxygen in an ecosystem. See Appendix 1.2: Creating a Closed Ecosystem.

Journal Writing S2-0-2a, 8b

Students prepare a glossary of new words for quick reference. A Three-Point Approach could be used (see *SYSTH* 10.22).

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Visual Display S2-0-2a, 5c

Students or student groups prepare visual displays of the three cycles. The displays may include posters, dioramas, bulletin boards, and concept maps. Students should be provided with the rubric in advance of assessment. For review prior to a test or quiz, have students generate questions and answers based on the information contained in their display. The displays, questions, and answers can be shared among different groups.

Laboratory Report S2-0-6a, 6c, 7b, 9c

Students prepare a laboratory report describing their investigation findings (see *SYSTH* 14.12 for a lab report format). Word-processing software and spreadsheets can be used for report writing.

Journal Writing S2-0-2a, 8b

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- draw and label diagrams of the three cycles
- describe what happens when sunlight strikes a wheat field or a forest
- explain how photosynthesis and cellular respiration affect the carbon cycle
- summarize the process of nitrogen fixation
- discuss the importance of the cycling of nutrients in ecosystems
- explain why some farmers alternate legumes (such as alfalfa) with their regular crops
- describe the relationship between the carbon cycle and the oxygen cycle

Suggested Learning Resources

Science 10

2.4 Case Study: The Interaction of Living Things

2.5 The Carbon Cycle

2.6 The Nitrogen Cycle

2.7 Agriculture and Nutrient Cycles

BLM 2.4 Photosynthesis and Respiration Compared

BLM 2.5 The Carbon Cycle

BLM 2.6a The Nitrogen Cycle

Science Power 10

2.2 The Carbon Cycle

Investigation 2-B: The Carbon Cycle and Climate

2.3 The Nitrogen Cycle

Investigation 2-C: Fertilizers and Plant Growth

BLM 2-2 Equation for Respiration

BLM 2-3 Equation for Photosynthesis

BLM 2-6 The Carbon Cycle

BLM 2-10 The Nitrogen Cycle

SYSTH

9.25 Knowledge Chart

10.22 Three-Point Approach

13.21 Journal Evaluation

14.12 Lab Report

Appendices

1.2 Creating a Closed Ecosystem

6.1 Rubric for the Assessment of Class Presentations

6.4 Lab Report Assessment

PRESCRIBED LEARNING OUTCOMES
Students will...
S2-1-02 Discuss factors that may disturb biogeochemical cycles. Include: natural events, human activities GLO: D2, D3, D5, E2

SUGGESTIONS FOR INSTRUCTION
(1-1/2 HOURS)

➢ Entry-Level Knowledge

In Grade 7, students were introduced to the concept of positive and negative human interventions in ecosystems. Fossil fuel formation and human use of it as a source of energy were also discussed. In Grade 8, students examined factors that cause flooding, as well as the management of water resources. The media and other sources will have familiarized students with the enhancement of the greenhouse effect and global warming.

➢ Notes for Instruction

Take advantage of current and local issues in print and electronic media.

In Cluster 4: Weather Dynamics, students investigate and evaluate evidence that would indicate climate change occurs naturally and could be influenced by human activities. In addition, students discuss the potential consequences of climate change.

➢ Student Learning Activities

Laboratory Activity S2-0-1a, 3a, 3c, 4a

Students investigate the effect(s) of varying amounts of fertilizer on plant growth. They can also suggest additional variables to be tested, and perform these tests as an extension of their learning.

Student Research S2-0-2a, 2d, 8c, 8g

Students or student groups research factors that may disturb the biogeochemical cycles. Topics can include

- overuse of fertilizers or herbicides
- combustion of fossil fuels
- deforestation
- human and animal waste mismanagement
- volcanic activity
- fire

Case studies, newspaper articles, and Internet sources may be used.

Journal Writing S2-0-4e, 6a, 7f

Students create a Chain Concept Map to outline the sequence of events when a biogeochemical cycle is disturbed (see *SYSTH* 11.14).

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Laboratory Report S2-0-5b, 6a, 6b, 7b

Students prepare a lab report based on their findings of the effects of fertilizers on plant growth. If students are encouraged to pursue further avenues of experimentation, their results and analysis can also be included in the assessment (see *SYSTH* 14.12 for a lab report format). Word-processing, graphing, and spreadsheet software can be used for report writing.

Research Report/Presentation S2-0-2a, 2c, 2d, 9c

Students or student groups research factors that disturb biogeochemical cycles and present

- written reports
- oral presentations
- newspaper articles
- multimedia presentations
- posters
- diagrams
- bulletin board displays
- concept maps
- charts

Journal Writing S2-0-4e, 6a, 7f

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- explain how deforestation, fire, and combustion of fossil fuels disrupt the balance between photosynthesis and cellular respiration
- describe how excess fertilizer or herbicide runoff affects bodies of water
- predict how a change in the cycling of carbon may affect the cycling of oxygen
- discuss how human and animal waste mismanagement may affect bodies of water
- predict how the carbon cycle would be disrupted by a reduction in the intensity of sunlight due to smoke and ash from a massive volcanic eruption

Suggested Learning Resources

Science 10

2.5 The Carbon Cycle

2.6 The Nitrogen Cycle

2.7 Agriculture and Nutrient Cycles

2.8 Case Study: Effects of Deforestation on Cycling

3.11 Acid Deposition and Forest Ecosystems

4.2 Sources of Water Pollution

4.3 Investigation: Phosphate Identification

BLM 2.6c Setting the Stage for the Survival of the Fishes

BLM 4.3 That's a Lot of Hamburger

Science Power 10

2.2 The Carbon Cycle

Investigation 2-B: The Carbon Cycle and Climate

2.3 The Nitrogen Cycle

Investigation 2-C: Fertilizers and Plant Growth

BLM 2-5 Charting Carbon Changes

BLM 2-7 The Greenhouse Effect

BLM G-29 Scientific Research Planner

BLM G-30 Research Worksheet

BLM G-31 Internet Research Tips

SYSTH

11.14 Chain Concept Map

13.21 Journal Evaluation

14.12 Lab Report Format

Appendices

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

6.4 Lab Report Assessment

PRESCRIBED LEARNING OUTCOMES
Students will...
S2-1-03 Describe bioaccumulation and explain its potential impact on consumers. *Examples: DDT, lead, dioxin, PCBs, mercury...* GLO: B1, D2

Teacher Background

The fashionable men's hats of the 18th and 19th centuries were made in a process that used mercury to convert Canadian beaver fur into felt. Exposure to high levels of mercury vapour can result in human nervous system damage, including tremors and mood and personality alterations. Because the hat makers (or hatters) exhibited symptoms of mercury poisoning, they came to be known as "mad hatters."

SUGGESTIONS FOR INSTRUCTION

(2 HOURS)

➢ Entry-Level Knowledge

In Grade 7, students examined food chains and food webs, and used the concept of ecological pyramids to analyze the potential for bioaccumulation within an ecosystem.

➢ Notes for Instruction

Activate prior knowledge of food chains and webs, using strategies such as Listen-Draw-Pair-Share or LINK (see *SYSTH* 9.15, 9.18) and note any misconceptions students have. A Sort and Predict activity could be used as a vocabulary warm-up/review (see *SYSTH* 10.13).

Emphasize that bioaccumulation is the result of the non-cycling of matter in ecosystems. Bioaccumulation is also known as biological magnification or bioamplification. It occurs when non-biodegradable substances are concentrated and stored in organisms. There are several instances of bioaccumulation in Manitoba and in Canada; where possible, use local or regional examples (e.g., PCBs in beluga whales, mercury poisoning in the Grassy Narrows First Nations community of northern Ontario, methyl-mercury in northern Manitoba lakes).

➢ Student Learning Activities

Visual Display S2-0-2a, 5c

Students or student groups create diagrams, posters, charts, concept maps, or bulletin boards to illustrate the mechanism of bioaccumulation.

Collaborative Teamwork/Student Research
S2-0-2d, 8c, 8g, 9e

Student groups examine case studies, or research and prepare reports describing examples of the bioaccumulation of toxins and their effects on consumers.

A major focus could be that of the long-term implications of bioaccumulation on the environment. Take advantage of current and local issues in print and electronic media.

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Visual Display S2-0-2a, 5c

Students or student groups present

- bulletin board displays
- posters
- diagrams
- charts
- concept maps

Research Report/Presentation S2-0-2c, 3d, 5c, 9c

Students or student groups examine case studies, or research and report examples of the bioaccumulation of toxins and their effects on consumers, and present

- written reports
- oral presentations
- dramatic presentations
- newspaper articles
- multimedia presentations
- pamphlets
- brochures

Pencil-and-Paper Tasks

Students

- describe the mechanism of bioaccumulation
- draw and label a diagram to illustrate how bioaccumulation occurs
- provide examples of environmental pollutants known to have accumulated in food chains, and discuss the consequences of their effects for consumers
- compare and contrast the bioaccumulation of mercury with the cycling of nitrogen
- suggest a reason why the continuing use of DDT in tropical nations is a concern in Canada

Suggested Learning Resources

Science 10

2.2 Case Study: Pesticides

BLM 1.11a Relationships in Ecosystems

BLM 1.11b Constructing Ecological Pyramids

BLM 4.2 Drinking Water: How Safe Is It?

BLM 3.9 Self-Assessment Teamwork Skills

TSM-3 Cooperative Learning

Science Power 10

Investigation 1-C: DDT in a Food Chain

BLM 1-1 You and Food Chains

BLM 1-2 Flowchart of Connecting Links

BLM 1-4 Getting to the Top

BLM 1-10 Chains and Webs

BLM 1-21 Biological Magnification in Nature

SYSTH

9.15 Listen-Draw-Pair-Share

9.18 LINK (List-Inquire-Note-Know)

10.13 Sort and Predict

10.24 Compare and Contrast

Appendices

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

PRESCRIBED LEARNING OUTCOMES
Students will...
S2-1-04 Describe the carrying capacity of an ecosystem. GLO: D2, E2, E3

SUGGESTIONS FOR INSTRUCTION
(1 HOUR)

➢ Entry-Level Knowledge

In Grade 7, students identified abiotic and biotic components of ecosystems that allow particular organisms to survive. They also examined the transfer of energy in ecological pyramids.

➢ Notes for Instruction

A review of the biotic and abiotic components of ecosystems could be used to activate prior knowledge for this outcome. A KWL or Knowledge chart could be used (see *SYSTH* 9.24, 9.25).

Introduce the concept of *carrying capacity* as the optimum number of organisms of a particular species that can be supported by a particular environment. Provide students with the meaning of population in ecology and discuss important properties of a population such as density and age structure. Have students brainstorm to identify the conditions necessary for a population in an ecosystem to be stable and self-sustaining.

➢ Student Learning Activities

Class Discussion S2-0-6a, 7f

Students brainstorm to predict what would happen to the population of a species if abiotic or biotic components changed. For example: Would the population of algae increase or decrease if fertilizer was added to a lake? Would the deer population change if a wolf pack moved into the area? Ask students to explain the rationale for their predictions. Case studies may be used. This discussion can act as a springboard into a further exploration of the concepts of wildlife and habitat conservation, and sustainability (see Appendix 1.3: Carrying Capacity).

Journal Writing S2-0-2c

Students complete a Three-Point Approach frame of words and concepts related to this topic (see *SYSTH* 10.22).

Suggestions for Assessment

Pencil-and-Paper Tasks

Students

- define *population* and discuss properties such as density and age structure
- describe the conditions necessary for a population in an ecosystem to be stable and self-sustaining
- define *carrying capacity* and use it to explain the importance of conservation
- predict the effects of changing biotic and abiotic components on a population (e.g., effects of a cold, snowy winter on the deer population, introduction of toxic waste into a lake)
- explain the relationship between the carrying capacity and the population equilibrium in an ecosystem
- provide examples of how technological advances in agriculture have affected the carrying capacity of humans in many ecosystems

Journal Writing S2-0-2c

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Teacher Background

When a population reaches the carrying capacity of its environment, certain factors prevent the population from increasing any further. At this point, the population has reached the steady state or dynamic equilibrium. While the average growth rate of a population in the steady state is zero, fluctuations in the population size do occur.

Suggested Learning Resources

Science 10

1.12 Roles in Ecosystems

2.10 Limits on Populations

BLM 1.5 Ecological Reach for the Top

ABLM 1.5 Concepts in Ecology

ABLM 2.9a Setting a Moose Licence Quota

Science Power 10

1.3 Populations

4.2 Ecological Footprints

BLM 1-13 Animal Crackers

BLM 4-2 Charting Our World

SYSTH

9.24 KWL Plus

9.25 Knowledge Chart

10.22 Three-Point Approach

13.21 Journal Evaluation

Appendix

1.3 Carrying Capacity

PRESCRIBED LEARNING OUTCOMES
Students will...
S2-1-05 Investigate and discuss various limiting factors that influence population dynamics. Include: density-dependent and density-independent factors GLO: C2, D2, E2, E3

SUGGESTIONS FOR INSTRUCTION
(5 HOURS)

➢ Entry-Level Knowledge

In Grade 7, students identified the biotic and abiotic components of ecosystems that allow organisms to survive, described succession, and identified the signs of succession in a variety of ecosystems.

➢ Notes for Instruction

Activate prior knowledge, and discuss misconceptions. A Sort and Predict activity could be used as a vocabulary warm-up/review. (See *SYSTH* 10.13.)

Use local examples where possible in the discussion of this topic (e.g., the impact of extremely cold winters on the deer and moose populations, or mange in the coyote populations of southwestern Manitoba). Take advantage of current and local issues in print and electronic media.

Suggestions for reading and writing strategies can be found in *SYSTH* Chapter 12: Reading Scientific Information and Chapter 14: Technical Writing in Science.

➢ Student Learning Activities

Student Research/Collaborative Teamwork/Visual Display
S2-0-2a, 2b, 2c, 5c

Students or student groups research the various ways in which natural populations are kept in dynamic equilibrium. Examples include

- predator-prey relationships
- succession
- resource limits
- competition
- disease
- overcrowding and stress
- drought
- flood
- extreme weather
- fire

Case studies may be used. See Appendix 1.1: Environmental Factors and Population Size.

(continued)

Suggestions for Assessment

Pencil-and-Paper Tasks

Students

- differentiate between density-dependent and density-independent limiting factors (see *SYSTH* 11.21)
- use examples to describe ways in which natural populations are kept in equilibrium
- use the concept of carrying capacity to explain how the growth of predator and prey populations are interrelated
- describe the effect that humans can have on predator-prey relationships
- complete a Word Cycle of terms related to this topic (see *SYSTH* 10.21)
- evaluate the need for using pesticides to control pests such as mosquitoes or forest tent caterpillars
- predict the impact of a major flood on the deer population in the Red River valley
- discuss the effects overcrowding may have on an animal population

Research Report/Presentation/Visual Display
S2-0-2a, 2b, 2c, 5c

Students or student groups present research findings with

- written reports
- oral presentations
- multimedia presentations
- bulletin board displays
- posters
- diagrams
- charts
- concept maps
- dramatic presentations

Teacher Background

Once a population reaches the carrying capacity of its environment, a variety of factors keep the population in equilibrium and prevent it from growing any further. These include limiting factors that depend on the density of the population (density-dependent) and those that operate independent of the population density (density-independent). Examples of density-dependent limiting factors include competition, predation, crowding, and parasitism. Some density-independent limiting factors are fire, flood, drought, and extreme heat or cold.

(continued)

Suggested Learning Resources

Science 10

1.5 Ecology

2.9 Monitoring Changes in Populations

2.10 Limits on Populations

2.11 Explore an Issue: Should We Use Pesticides to Control Pests?

BLM 2.2 Confusing Insects to Prevent Reproduction

BLM 2.11a Assessment Rubric for Debate Participation

BLM 2.11b Decision Sheet for Debate Results

AT-11 Assessment Rubric 6: Research Skills

AT-15 Self-Assessment Checklist 2: Research Skills

Science Power 10

1.3 Populations Managing Resources

1.4 Investigation 4-A: Balancing Populations and the Environment

BLM 1-17 Population Terms

BLM 4-8 Balancing Populations

BLM 4-9 Developing a Wildlife Policy

BLM 4-10 Studying a Deer Population

BLM G-34 Debating Procedures

TSM-9 Debating

(continued)

PRESCRIBED LEARNING OUTCOMES
Students will...
(continued) **S2-1-05** Investigate and discuss various limiting factors that influence population dynamics. Include: density-dependent and density-independent factors GLO: C2, D2, E2, E3

SUGGESTIONS FOR INSTRUCTION
(5 HOURS)

Community Connection S2-0-8e, 8f, 9a

Invite a local conservation/parks officer, elder, trapper, or hunter to share her or his knowledge of this topic with the class. Students could also interview community members in their homes or workplaces.

Class Debate S2-0-1c, 3d, 5d, 7c

Students research and then debate the pros and cons of using pesticides to control forest tent caterpillar, spruce budworm, or mosquito populations.

Journal Writing S2-0-7f

Students pretend they are wise old organisms (e.g., an elm tree or a moose) passing on their knowledge of past hardships and necessary survival skills to a younger generation. A RAFTS format could be used (see *SYSTH* 13.23).

Class Discussion S2-0-7f

Students brainstorm a list of ways in which natural populations are kept in dynamic equilibrium. A Roundtable or Rotational Graffiti format may be used (see *SYSTH* 3.15). See Appendix 1.4: Limiting Factors.

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Journal Writing S2-0-2b, 3d, 7f

Encourage reflection on the debate. The following questions may be posed:

- What surprising points were raised during the debate?
- Do you think there is a right or wrong answer? Explain.
- What valid facts were used to support the arguments?
- Can you summarize the arguments given by each team, including potential environmental effects of pesticide use, insect control program costs, and benefits/risks of long-term use?

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Suggested Learning Resources

SYSTH

3.15 Rotational Cooperative Graffiti

10.13 Sort and Predict

10.21 Word Cycle

11.21 Concept Relationship Frame

13.21 Journal Evaluation

13.23 RAFTS

Appendices

1.1 Environmental Factors and Population Size

1.4 Limiting Factors

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

PRESCRIBED LEARNING OUTCOMES
Students will...
S2-1-06 Construct and interpret graphs of population dynamics. GLO: C6, D2, E2

SUGGESTIONS FOR INSTRUCTION
(3 HOURS)

➢ Notes for Instruction

Have students analyze different tables, charts, and graphs of growing, stable, and declining populations. Students should be able to interpret growth curves and histograms and predict if the population is growing, declining, or stable. Students should also be able to account for changes in the shape of growth curves and histograms.

➢ Student Learning Activities

Collaborative Teamwork S2-0-3a, 5c, 6a

Students work in groups and construct population histograms, given sample data. Provide the groups with histograms of growing, stable, and declining populations. Ask students to analyze the shape of the histograms in order to predict future changes in populations. For example, the age distribution of Canadians indicates our population will begin to decline in the absence of immigration.

Students work in groups and construct growth curves of the relationship between populations of predator and prey (e.g., the lynx and snowshoe hare). Ask students what they can infer from the growth curves of each organism. Case studies may be used. See Appendix 1.5: Predator-Prey Interactions.

Laboratory Activity S2-0-4b, 5c, 6a, 7a

Students culture a yeast, bacterial, or paramecium population and calculate the size and growth rate over time. Spreadsheet software can be used to tabulate and graph data.

Students can use interactive population ecology software programs. These programs allow the user to manipulate variables affecting population size, and predict subsequent changes in the population.

Students can play a predator-prey simulation or game.

Journal Writing S2-0-2a

Students prepare a glossary of new words for quick reference. A Three-Point Approach could be used (see *SYSTH* 10.22).

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Laboratory Report S2-0-3b, 4a, 5a, 7a

Students graph the results, interpret the growth patterns of their yeast, bacterial, or paramecium culture, and prepare a report of their findings.

Students prepare reports based on their use of interactive population ecology software programs or predator-prey simulations or games (see *SYSTH* 14.12 for a lab report format). Word-processing, graphing, and spreadsheet software can be used for report writing.

Journal Writing S2-0-2a

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

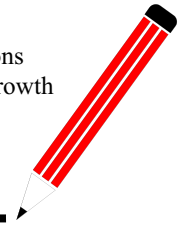
Pencil-and-Paper Tasks

Students

- construct a histogram, given population data
- analyze the histogram to determine if the population is growing, stable, or in decline
- use the histogram to predict future changes in the size of the population
- construct a growth curve, given population data
- analyze the phases of the growth curve to determine where the population is growing, stable, or declining
- account for changes in the shape of the growth curve over time
- interpret growth curves that represent the relationship between populations of predators and their prey

Teacher Background

Histograms (bar graphs) are used to illustrate age distributions within a population. Line graphs are used to represent the growth curve of a population.



Suggested Learning Resources

Science 10

2.9 Monitoring Changes in Populations

2.10 Limits on Populations

BLM 1 Assessment Template for the Microscope

BLM 1.9 Studying Decay Using Artificial Logs

BLM 2.9a Yeast Population Study

BLM 2.9b Case Study: Yeast Population

BLM 2.9c Population Graphs

ABLM 2.9 Understanding Exponential Population Growth

Science Power 10

Investigation 1-B: Regulating Population Size

BLM 1-15 Growing Bacteria

BLM 1-16 Predator-Prey Patterns

BLM 1-19 Geometric Population Growth

BLM 1-20 Population Growth Curves

SYSTH

10.22 Three-Point Approach for Words and Concepts

13.21 Journal Evaluation

14.12 Lab Report Format

Appendices

1.5 Predator-Prey Interactions

6.4 Lab Report Assessment

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION (2 HOURS)
Students will... **S2-1-07** Discuss the potential consequences of introducing new species and of species extinction to an ecosystem. GLO: E1, E2	➢ **Entry-Level Knowledge** In Grade 6, students gained familiarity with the diversity of living things (five kingdoms). In Grade 7, they analyzed food webs and ecological pyramids, and identified and described positive and negative examples of human interventions that affect ecological succession, or the makeup of ecosystems. ➢ **Notes for Instruction** Activate student knowledge by reviewing the diversity of living things, food webs, and ecological pyramids. A KWL frame or Anticipation Guide could be used (see *SYSTH* 9.24, 9.26). Students must first comprehend the concepts of ecological niche and competition in order to understand why the introduction of a new species or species extinction can effect devastating results on an ecosystem. ➢ **Student Learning Activities** **Class Discussion S2-0-7f** Examine a food chain in an ecosystem. Students brainstorm to predict the consequences of removing one species from the chain. Expand the discussion to the effects of species extinction on a food web. **Student Research S2-0-2a, 2c, 2d, 9e** Students or student groups research one example of how the introduction of a new species has affected an ecosystem. Some examples may include • zebra mussels in the Great Lakes • purple loosestrife in Manitoba waterways • lampreys in the Great Lakes • carp in Manitoba lakes and rivers **Journal Writing S2-0-7f** Students speculate on reasons why large carnivores (such as bears and eagles) are in greater danger of extinction than small herbivores (such as mice and rabbits). **Collaborative Teamwork S2-0-2a, 2c, 2d, 4f** Various student groups investigate one example of the effect of introducing a new species or of species extinction into an ecosystem, and then share their findings with their classmates in a Jigsaw format (see *SYSTH* 3.20).

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Research Report/Presentation S2-0-2a, 2c, 2d, 9e

Students or student groups present research findings with

- written reports
- oral presentations
- multimedia presentations
- bulletin board displays
- dramatic presentations
- posters
- debates
- newspaper articles

Journal Writing S2-0-7f

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- complete a Compare and Contrast or Concept Relationship frame comparing species extinction with species introduction (see *SYSTH* 10.24, 11.35)
- draw a food web diagram of 10 organisms in a local ecosystem, including at least one producer, one primary consumer, one secondary consumer, one tertiary consumer, and one decomposer
- use the diagram to predict how the introduction of a new species or the extinction of one of the 10 organisms would affect the food web
- describe, with the use of examples, the problems created when a new species is introduced into an ecosystem

Teacher Background

The introduction of rabbits in Australia and New Zealand is a well-documented example of how a new species can have an impact upon an ecosystem. Originally imported for hunting, the wild rabbits multiplied at an incredible rate in the absence of any predators. They have been one of the main causes of habitat destruction, native plant and animal extinction, land degradation, and crop damage. A variety of methods to control the rabbit population has been attempted, including chemical and biological means.

Suggested Learning Resources

Science 10

1.1 The Silence of the Frogs

1.2 Canada's Endangered Species

1.3 Extinction in the Modern World

1.4 Explore an Issue: What is the Value of Wolves?

1.12 Roles in Ecosystems

BLM 1.4 Pleistocene Park?

AT-5 Assessment Rubric 2: Communication

Science Power 10

BLM G-10 Group Roles

BLM G-11 Say It with Style!

SYSTH

3.20 Jigsaw

9.24 KWL Plus

9.26 Anticipation Guide

10.24 Compare and Contrast

11.35 Concept Relationship Frame

13.21 Journal Evaluation

Appendices

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION (3 HOURS)
Students will...	
S2-1-08 Observe and document a range of organisms that illustrate the biodiversity within a local or regional ecosystem. GLO: D2, E1	

➢ Entry-Level Knowledge

In Grade 6, students studied the five kingdom classification system, identified organisms with classification keys, and observed and described the diversity of living things within a local environment. In Grade 7, students studied the role of producers, consumers, and decomposers, and analyzed food webs.

➢ Notes for Instruction

A field trip is a necessity for this learning outcome; however, the outing need not be to a distant location. A class in an urban school may visit a local park, while a class in a rural or northern school may be close to a wilderness area, such as a marsh or swamp.

➢ Student Learning Activities

Community Connection S2-0-2c, 4b, 5a, 8e

Visit a local park or wilderness area. Students observe and document the range of organisms present.

Students collect water samples and later examine them in the lab for the presence of freshwater invertebrates. Simple biological keys or field guides can be used to identify tree and shrub species, or leaf collections can be taken back to the lab for analysis. Invite a local birdwatcher to accompany the class and assist in the identification of bird species. Students can make sketches of plant, animal, and fungi species.

Laboratory Activity S2-0-2c, 5a, 5c, 6a

Students examine the water samples collected on the field trip and identify the freshwater invertebrates present in the samples. Students can examine their leaf collections in the lab in order to identify the tree and shrub species present in the area. Classification keys or field guides can be used for identifications of plants, animals, and fungi.

Collaborative Teamwork/Student Research S2-0-4f, 4g

Student groups prepare illustrated field guides or walking tours for the local or regional ecosystem visited on the field trip. The guides/tours should demonstrate the biodiversity of the area and include both animal and plant species, and possibly fungi and protists as well. The guides/tours can take the form of brochures, pamphlets, maps, or booklets.

(continued)

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Laboratory Report S2-0-2c, 5a, 5c, 9c

Students sketch and identify the freshwater invertebrates present in their water samples. Using their pressed leaves, students identify the tree and shrub species in the area. Classification keys or field guides could also be used for the identification of plants, animals, and fungi (see *SYSTH* 14.12 for a lab report format). Word-processing software and spreadsheets can be used for report writing.

Visual Display/Research Report/Presentation S2-0-2c, 4f, 5c, 9b

Students or student groups present research findings of their field trip observations, field guides, or walking tours with

- bulletin board displays
- posters
- diagrams
- charts
- multimedia presentations
- brochures
- pamphlets
- booklets
- maps

Journal Writing S2-0-7b, 7f

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- define the term *biodiversity*
- identify organisms using a simple biological key
- provide examples of plant, animal, and fungi species found in their local/regional ecosystem
- identify organisms observed on the field trip as producers, consumers, or decomposers
- draw and label a food chain or web, based on the organisms observed on the field trip

Suggested Learning Resources

Science 10

3.6 Investigation: The Animal Community in Soils

BLM 4.6a Indicator Organisms

BLM 4.6b Collecting Stream Organisms for the Lab

ABLM 3.9 Self-Assessment Teamwork Skills

ABLM 4.6a Aquatic Insect Larvae and Invertebrates

Science Power 10

Investigation 1-A: Seeing Patterns in Nature

SYSTH

13.21 Journal Evaluation

14.12 Lab Report Format

Appendices

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

6.4 Lab Report Assessment

PRESCRIBED LEARNING OUTCOMES
Students will...
(continued) **S2-1-08** Observe and document a range of organisms that illustrate the biodiversity within a local or regional ecosystem. GLO: D2, E1

SUGGESTIONS FOR INSTRUCTION
(3 HOURS)

Visual Display S2-0-2c, 5c

Students draw diagrams or prepare posters, bulletin board displays, charts, or multimedia presentations illustrating the range of organisms observed on their field trip.

Journal Entry S2-0-7b, 7f, 9e

Students reflect on their field trip observations and respond to the following questions:

- How has your understanding of biodiversity changed?
- What new questions do you have about biodiversity?

Suggestions for Assessment

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES
Students will...
S2-1-09 Explain how the biodiversity of an ecosystem contributes to its sustainability. GLO: B5, E1

SUGGESTIONS FOR INSTRUCTION
(1 HOUR)

➢ Entry-Level Knowledge

In Grade 6, students gained familiarity with the diversity of living things, and in Grade 7, they analyzed food webs and ecological pyramids.

➢ Notes for Instruction

Activate prior knowledge by reviewing diversity of living things, food webs, and ecological pyramids. A KWL frame or Anticipation Guide could be used (see *SYSTH* 9.24, 9.26). An examination of the classification system for at-risk species in Canada or Manitoba can be used to introduce the topic. Some local examples of at-risk species include the burrowing owl and the small, white lady's slipper orchid.

The Manitoba Conservation Wildlife Branch website at <www.gov.mb.ca/conservation/wildlife/index> can provide additional information about *The Endangered Species Act,* biodiversity conservation, hunting and trapping guides, and problem wildlife.

➢ Student Learning Activities

Class Discussion S2-0-8g

Guide the students through a discussion of the possible effects of introducing a new species or of species extinction to an ecosystem, by first examining a food chain and then a food web. Relate this discussion to how biodiversity contributes to the sustainability of an ecosystem. A case study could be used.

Journal Writing S2-0-7f, 9e

Students reflect on the sustainability of a monoculture ecosystem such as a canola field or a lawn and compare it to a natural grassland ecosystem.

Suggestions for Assessment

Pencil-and-Paper Tasks

Students

- complete a Word Cycle of the following terms: *ecosystem, population, biodiversity, extinction, species, predation, equilibrium, sustainability, competition* (see *SYSTH* 10.21)
- differentiate among extinct, endangered, extirpated, threatened, and vulnerable species
- list some examples of Canadian at-risk species
- suggest ways in which at-risk species could be protected
- discuss possible causes of species extinction
- with the use of examples, explain how the biodiversity of an ecosystem contributes to its sustainability

Journal Writing S2-0-7f, 9e

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Teacher Background

Examples of **endangered** Manitoba species include the whooping crane, peregrine falcon, piping plover, and western prairie fringed orchid.

Threatened Manitoba species include the ferruginous hawk, western silvery aster, and western spiderwort.

Extirpated Manitoba species include the swift fox, musk ox, pronghorn antelope, and trumpeter swan.

Suggested Learning Resources

Science 10

1.1 The Silence of the Frogs

1.2 Canada's Endangered Species

1.3 Extinction in the Modern World

1.4 Explore an Issue: What Is the Value of Wolves?

3.7 Agriculture and Food Production

3.9 Explore an Issue: How Many Potatoes are Enough?

BLM 1.2 Classification System for At-Risk Species

BLM 1.8 Whose Neighborhood Is It?

ABLM 1.8 Looking at a Meadow and a Park

SYSTH

9.24 KWL Plus

9.26 Anticipation Guide

10.21 Word Cycle

13.21 Journal Evaluation

PRESCRIBED LEARNING OUTCOMES
Students will...
S2-1-10 Investigate how human activities affect an ecosystem and use the decision-making model to propose a course of action to enhance its sustainability. Include: impact on biogeochemical cycling, population dynamics, and biodiversity GLO: B5, C4, C5, C8

SUGGESTIONS FOR INSTRUCTION
(5 HOURS)

➢ Entry-Level Knowledge

In Grade 7, students identified environmental, social, and economic factors that should be considered in the management and preservation of ecosystems. They also proposed a course of action to protect the habitat of a particular organism in an ecosystem. In Senior 1, the formal decision-making model was introduced.

➢ Notes for Instruction

Guide students through the steps of the Decision-Making Model (see *Senior 2 Science: Manitoba Curriculum Framework of Outcomes* and Manitoba Foundations for Scientific Literacy section at the front of this document). Model the process, guide students, and provide opportunities for practice. Other Senior 2 clusters will provide more opportunities for decision making. See Appendix 1.6: Educating for Sustainability: Decision-Making Skills. Suggestions for reading and writing can be found in *SYSTH* Chapter 12: Reading Scientific Information and Chapter 14: Technical Writing in Science. Environment Canada's Science and the Environment Bulletin <www.ec.gc.ca/science/splash.htm> and Envirozine <www.ec.gc.ca/envirozine/english/home_e.cfm> contain up-to-date information.

➢ Student Learning Activities

Student Research/Collaborative Teamwork
S2-0-1d, 2b, 3e, 6d

Students hold mock public hearings on the use of land and resources in provincial parks. The class first identifies the various stakeholders and their proposals. Next, students break into groups that represent the various stakeholders, and research the issue from their (stakeholders') perspective. Each group then prepares a brief summary outlining their proposal for land and resource use, and presents it publicly. Class discussions are held after all the stakeholders' briefs have been presented, and recommendations for a course of action are developed using the decision-making model. Case studies, newspaper articles, and Internet sources can be used.

(continued)

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Research Report/Presentation S2-0-5d, 7c, 7e, 9c

Students present their research findings with

- written reports
- oral presentations
- multimedia presentations
- bulletin board displays
- dramatic presentations
- newspaper articles
- public hearings

Visual Display S2-0-9c, 9e, 9f

Student groups present visual displays that depict ways human activities affect an ecosystem. Displays may take the form of

- posters
- bulletin board presentations
- charts
- cartoons
- dioramas

Teacher Background

See *SYSTH,* Chapter 5: Science and Sustainable Development for principles, fundamental guidelines, and approaches for teaching about sustainable development.

See *Education for a Sustainable Future* for additional information and instructional strategies (Manitoba Education and Training, 2000).

(continued)

Suggested Learning Resources

Science 10

3.10 Logging Forests

4.5 Case Study: The Great Lakes

4.9 Case Study: Managing Fish Populations

4.10 Explore an Issue: Can We Create a Sustainable Fishery?

Unit 1 Challenge: Assessing the Environmental Effects of Human Communities

BLM 2.3a When Is a Farm Not a Farm?

BLM 3.7 What's the Alternative?

BLM 3.10 The Forests of the Temagami Region

Science Power 10

Investigation 3-C: Modeling an Environmental Impact Assessment

4.1 Managing Resources

Investigation 4-B: Alternatives to Growth

4.3 Sustainable Future

Unit 1 Issues Analysis: Clear-cutting Versus Selective Cutting of Forests

BLM 3-10 Urban Use of Rural Lands

BLM 4-11 Sustainable Metaphors

BLM 4-12 Conserving Resources

BLM G-33 Procedure for a Public Hearing

BLM G-37 Decision-Making Organizer

(continued)

PRESCRIBED LEARNING OUTCOMES
Students will...
(continued) **S2-1-10** Investigate how human activities affect an ecosystem and use the decision-making model to propose a course of action to enhance its sustainability. Include: impact on biogeochemical cycling, population dynamics, and biodiversity GLO: B5, C4, C5, C8

SUGGESTIONS FOR INSTRUCTION
(5 HOURS)

Visual Display S2-0-1c, 3f, 7c, 7d

Students or student groups create visual displays illustrating how human activities affect an ecosystem and propose a course of action to enhance its sustainability. Some examples can include

- regulating the water levels in Lake Winnipeg and Lake Manitoba
- building a shopping mall/housing development on prime agricultural land
- draining wetlands for agriculture/housing developments

Case studies, newspaper articles, and Internet sources can be used.

Class Debate S2-0-2d, 3e, 3f, 5d

Students research and debate the pros and cons of local/regional issues such as

- building a new hydro dam on the Nelson River
- clear-cutting versus selective cutting of forests
- allowing the expansion of hog barn operations
- changing the creel limits for recreational fishers
- permitting hunting in provincial/national parks

Student Research S2-0-2d, 9b, 9f

Students complete a fact- or issue-based article analysis of a current newspaper, Internet, or magazine article related to these learning outcomes (see *SYSTH* 11.40, 11.41).

Suggestions for Assessment

Journal Writing S2-0-2b, 3d, 7e, 9e

Encourage reflection on the debate. The following may be posed:

- What surprising points were raised during the debate?
- Do you think there is a right or wrong answer? Explain.
- What valid facts were used to support the arguments?
- Summarize the arguments given by each team according to agreed-upon criteria negotiated prior to the debate.

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- identify local/regional STSE issues
- summarize the arguments of the stakeholders in an issue related to this learning outcome
- evaluate the stakeholders' arguments
- formulate their own opinion on the issue
- defend their opinion
- complete a fact- or issue-based article analysis of a current newspaper or magazine article related to the topic (see *SYSTH* 11.40, 11.41)
- suggest ways in which they can be personally involved and proactive with respect to STSE issues

Suggested Learning Resources

SYSTH

Chapter 5: Science and Sustainable Development

Chapter 12: Reading Scientific Information

Chapter 14: Technical Writing in Science

11.40 Issue-Based Article Analysis

11.41 Fact-Based Article Analysis

13.21 Journal Evaluation

Appendices

1.6 Educating for Sustainability: Decision-Making Skills

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

6.3 Rubric for the Assessment of a Decision-Making Process Activity

NOTES