Ecology

Curriculum/Content Area: Science	**Course Length:** 1 Term
Course Title: Ecology	**Date last reviewed:** 2018
Prerequisites: Grade 10-12	**Board approval date:** May 2018
Primary Resource: *tbd*	

Desired Results

Course Description: Students investigate living and nonliving aspects of the environment and how they impact one another. Current environmental issues are discussed throughout the term, and topics such as endangered species and natural resources management are explored. Web-based instruction, reading, discussions, audiovisual presentations, fieldwork and lecture are teaching and learning strategies used to help students gain mastery of ecological concepts.

Enduring Understandings:	**Essential Questions**:
1. **Patterns:** Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. 2. **Cause and Effect:** Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. 3. **Scale, Proportion, and Quantity:** In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change. 4. **Systems and System Models:** A system is an organized group of	1. How can the scientific method be used to investigate questions, and how can findings be communicated? 2. How can organisms and environmental conditions within ecosystems affect each other? 3. What contributes to changes in populations of species? 4. How do nutrients and energy move through environments? 5. How are organisms' adaptations influenced by the environment? 6. How do species adapt to environmental changes? 7. How have human activities impacted ecosystems?

related objects or components; models can be used for understanding and predicting the behavior of systems. 5. **Energy and Matter:** Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. 6. **Structure and Function:** The way an object is shaped or structured determines many of its properties and functions. 7. **Stability and Change:** For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.	8. How can we conserve and protect the global environment?

Unit 1: Principles of Ecology
Topics of Study: 1. Scientific Methods 2. Relationships Among Organisms 3. Energy and Nutrient Flow in the Ecosystem 4. Evolution and Adaptations of Species 5. Biomes, Aquatic Life Zones & Succession 6. Carrying Capacity & Population Dynamics
Standards:
<u>**Cross Cutting Concepts**</u> 1. **Stability and Change** ○ Much of science deals with constructing explanations of how things change and how they remain stable. 2. **Scale, Proportion, and Quantity** ○ Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. 3. **Energy and Matter** ○ Energy cannot be created or destroyed; it only moves between one place and

another place, between objects and/or fields, or between systems.

4. **Cause and Effect**
    - Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Science and Engineering Practices

1. **Constructing Explanations and Designing Solutions -** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
    a. Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
2. **Using Mathematics and Computational Thinking**
    a. Mathematical and Computational Thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
        i. Use mathematical representations of phenomena or design solutions to support and revise explanations.

Disciplinary Core Ideas

ETS1.B: Developing Possible Solutions

- When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.

LS4.C: Adaptation

- Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
- Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a

food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.

LS2.A: Interdependent Relationships in Ecosystems

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

Learning Targets:

1. I can use the scientific method to design an experiment to answer a question and/or propose a solution to problem. (HS-LS2-7) (Constructing Explanations and Designing Solutions, ETS1.B, Stability and Change)
2. I can identify abiotic and biotic factors in ecosystems and explain how they affect the distribution of life on Earth. (HS-LS2-2) (Using Mathematics and Computational Thinking, LS2.A, Scale, Proportion, and Quantity)
3. I can describe and model how energy and nutrients flow through ecosystems. (HS-LS2-4) (Using Mathematical and Computational Thinking, LS2.B, Energy and Matter)
4. I can explain how organisms cooperate and compete in ecosystems and the interrelationships that exist. (HS-LS2-1) (Using Mathematical and Computational Thinking, LS2.A, Scale, Proportion, and Quantity)
5. I can describe how natural selection has led to the evolution of organisms. HS-LS4-4 (Constructing Explanations and Designing Solutions, LS4.C, Cause and Effect)
6. I can describe factors that influence population dynamics and determine carrying capacity. (HS-LS2-1) (Using Mathematical and Computational Thinking, LS2.A, Scale, Proportion, and Quantity)

Assessment Evidence:

Performance Assessment Options *May include, but are not limited to the following:* **HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.**	**Other assessment options** *May include, but are not limited to the following:*

[Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.] **HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.** [Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).] [*Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth's surface.*] **HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.] **HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.] **HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.** [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]	
Digital Tools & Supplementary Resources	

Unit 2: Natural Resources Management and Environmental Issues
Topics of Study: 1. Value of healthy ecosystems to humans. 2. Wildlife Management Goals & Techniques 3. Human Caused Environmental Issues 4. Conservation and Sustainability
Standards:

<u>Cross Cutting Concepts</u>

1. **Scale, Proportion, and Quantity**
    - The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.
2. **Stability and Change**
    - Much of science deals with constructing explanations of how things change and how they remain stable.
3. **Cause and Effect**
    - Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
4. **Influence of Engineering, Technology, and Science on Society and the Natural World**
    - New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.
5. **Systems and System Models**
    - When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

<u>Science and Engineering Practices</u>

1. **Constructing Explanations and Designing Solutions -** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
    a. Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
2. **Using Mathematics and Computational Thinking**
    a. Mathematical and Computational Thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and

used based on mathematical models of basic assumptions.

i. Use mathematical representations of phenomena or design solutions to support and revise explanations.

3. **Engaging in Argument from Evidence -** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.
    a. Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

<u>Disciplinary Core Ideas</u>

1. **ESS3.C: Human Impacts on Earth Systems**
    a. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
2. **LS2.A: Interdependent Relationships in Ecosystems**
    a. Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.
3. **LS2.C: Ecosystem Dynamics, Functioning, and Resilience**
    a. Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.
4. **LS4.C: Adaptation**
    a. Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species.
5. **LS4.D: Biodiversity and Humans**
    a. Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
    b. Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
6. **ETS1.B: Developing Possible Solutions**

a. When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.
b. Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.

7. **ESS2.D: Weather and Climate**
   a. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
8. **ESS3.C: Human Impacts on Earth Systems**
   a. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
   b. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
9. **ESS3.D: Global Climate Change**
   a. Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.

Learning Targets:

1. I can describe how populations change over time based on human activities (HS-LS2-1), (HS-LS2-7), (HS-LS4-6), (HS-LS4-5), (HS-ESS3-4) (Using Mathematics and Computational Thinking, Constructing Explanations and Designing Solutions, Using Mathematics and Computational Thinking, Engaging in Argument from Evidence,LS2.A, LS2.C, LS4.D, LS4.C, ESS3.C, ETS1.B, Scale, Proportion and Quantity, Stability and Change, Cause and Effect, Influence of Science, Engineering, and Technology on Society and the Natural World). I can describe human caused threats to ecosystems worldwide. (HS-ESS3-6) (Using Mathematics and Computational Thinking, ESS2.D, ESS3.D, Systems and System Models)
2. I can propose and evaluate potential solutions to current environmental issues. (HS-ESS3-3), (HS-ESS3-4) (Using Mathematics and Computational Thinking, Constructing Explanations and Designing Solutions, ESS3.C, ETS1.B, Influence of Science, Engineering, and Technology on Society and the Natural World)

Assessment Evidence:

Performance Assessment Options *May include, but are not limited to the following:* **HS-LS2-1. Use mathematical and/or computational representations**	**Other assessment options** *May include, but are not limited to the following:*

to support explanations of factors that affect carrying capacity of ecosystems at different scales. **HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*** [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.] **HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*** [Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.] **HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.** [Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.] **HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*** [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).] **HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.** [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.] **HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies.	

Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]	
Digital Tools & Supplementary Resources: *Tools and resources that can augment the learning experience for students*	