Course Title: Ecology and Environmental Science

Department: Science

Grades: 11-12   **Credits**: 0.5

Course Overview/Description

Ecology and Environmental Science explores the relationships between organisms and their nonliving environment. Emphasis is on exploring the influence of human activity (i.e., pollution, fertilizer run-off, etc.) on local waterways with a discussion of how to make smart environmental decisions. Specific course topics include: General ecology and biomes, nutrient cycles, aquatic ecosystems, water pollution, and environmental ethics. Student evaluation is based on participation in field trips, exams, projects, current event presentations, labs, papers, debates, service projects, and final group research presentations. PLEASE NOTE: SINCE FIELDWORK IS SUCH AN IMPORTANT AND UNIQUE ASPECT OF THIS COURSE, ATTENDANCE ON ALL FIELD TRIPS IS REQUIRED. FURTHERMORE, SOME FIELD TRIPS MAY REQUIRE STUDENTS TO PROVIDE AQUA SHOES OR KNEE-HIGH RUBBER BOOTS FOR THEIR OWN USE. Fall and spring sports participants must consult their instructor before enrolling to discuss potential early release / field trip conflicts.

Course Materials

Binder, Waders

Scope and Sequence

Timeframe	Unit	Instructional Topics
2 weeks	Ecological Impact	• Calculating One's Ecological Footprint • Human Impact on the Environment

4 weeks	Biogeochemical Cycles	• Hydrologic Cycle
		  ○ Water Pollution
		• Carbon Cycle
		  ○ The Greenhouse Effect and Carbon Footprinting
		• Nitrogen Cycle
		  ○ Fertilizers and Human Impact on the Nitrogen Cycle
		• Phosphorus Cycle

3 weeks	Ecology	• Ecological Organization (The Hierarchy of Life on Earth) • Trophic Dynamics • Trophic Cascades • Classifying Terrestrial Biomes • Invasive Species
3 weeks	Water Ecology	• Classifying Aquatic Ecosystems • Principles of Limnology

			● Determining Water Quality and Measuring Water Pollution
2 weeks	Sustainability		● Cradle-to-Grave Economics ● Eco-consumerism ● Materials Recovery / Waste Resource Management

3 weeks	Field Work		● Stream Quality Study
			   ○ Data Collection
			   ○ Data Analysis
			   ○ Results and Discussion
			   ○ Collaboration

Detailed Curriculum Map

Unit 1: Ecological Impact (2 weeks)

- General Description: Introduction to the concept of ecological impact and the role of human activities.
- Student Learning Objective: Understand what an ecological footprint is and how human activities impact the environment.
    - Calculating One's Ecological Footprint
    - Human Impact on the Environment

Unit 2: Biogeochemical Cycles (4 weeks)

- General Description: In-depth study of the various biogeochemical cycles and their importance.
- Student Learning Objective: Understand the major biogeochemical cycles and how they are influenced by human activities.
    - Hydrologic Cycle
    - Water Pollution
    - Carbon Cycle
    - The Greenhouse Effect and Carbon Footprinting
    - Nitrogen Cycle
    - Fertilizers and Human Impact on the Nitrogen Cycle
    - Phosphorus Cycle

Unit 3: Ecology (3 weeks)

- General Description: Comprehensive overview of ecological principles and systems.
- Student Learning Objective: Understand the hierarchical organization of life and the dynamics of biomes and species interactions.
    - Ecological Organization (The Hierarchy of Life on Earth)
    - Trophic Dynamics
    - Trophic Cascades
    - Classifying Terrestrial Biomes

- Invasive Species

Unit 4: Water Ecology (3 weeks)

- General Description: Detailed analysis of aquatic ecosystems and limnology principles.
- Student Learning Objective: Understand the classification of aquatic ecosystems, determine water quality, and measure water pollution.
  - Classifying Aquatic Ecosystems
  - Principles of Limnology
  - Determining Water Quality and Measuring Water Pollution

Unit 5: Sustainability (2 weeks)

- General Description: Examination of sustainability principles and the concept of eco-consumerism.
- Student Learning Objective: Understand cradle-to-grave economics, eco-consumerism, and waste resource management.
  - Cradle-to-Grave Economics
  - Eco-consumerism
  - Materials Recovery / Waste Resource Management

Unit 6: Field Work (3 weeks)

- General Description: Practical application of course concepts through field work.
- Student Learning Objective: Understand how to perform a stream quality study, collect data, analyze results, and collaborate with peers.
  - Stream Quality Study
  - Data Collection
  - Data Analysis
  - Results and Discussion
  - Collaboration

<u>Course Essential Standards</u>

1.1 | Ecological Footprint: "I can measure the impact of my lifestyle on the planet's resources, as well as create a SMART Goal to lessen my impact on the planet."

Scale Score	Description
1	I can define and measure my ecological footprint by using an online calculator to input my specific environmental impact data.
2	Additionally, I can evaluate my ecological footprint by coming up with solutions to reduce my environmental impact in each of the 5 main areas: city, energy, food, population and planet.

	Additionally, I can create a SMART Goal that will help me to increase pro-environmental, stewardship behaviors. All 5 elements of a SMART goal (specific, measurable, attainable, relevant, and time-bound) are evident.
3	

2.1 | Biogeochemical Cycles: "I can model how water, carbon, nitrogen and phosphorus cycle throughout the planet."

Scale Score	Description
1	I can explain similarities and differences amongst the 4 different nutrient cycles: water, carbon, nitrogen and phosphorus.
2	Additionally, I can diagram or illustrate the processes of nutrient recycling for each of the 4 nutrient cycles, labeling important steps with key vocabulary.
3	Additionally, I can provide ecological context for the greater importance of each nutrient as it moves around the planet in both living and nonliving things.

2.2 | Human Influences on the Carbon Cycle: "I can provide specific evidence as to how humans are influencing the carbon cycle, such as with climate change."

Scale Score	Description
1	I can explain and illustrate the process of the "Greenhouse Effect."
2	Additionally, I can detail the specific ways that humans are contributing to global climate change, as I measure my very own carbon footprint.
3	Additionally, I can articulate solutions to combat rising carbon emissions, whether that be through outright carbon reductions or carbon offsets.

2.3 | Human Influences on the Nitrogen Cycle: "I can provide specific evidence as to how humans are influencing the nitrogen cycle."

Scale Score	Description
1	I can define the process "eutrophication."
2	Additionally, I can detail the specific contributions that scientists like Fritz Haber have had on the nitrogen cycle.
3	Additionally, I can propose solutions to mitigating the human impact on the nitrogen cycle.

3.1 | Ecological Organization: "I can illustrate the hierarchy of life on planet earth."

Scale Score	Description
1	I can identify the different levels of ecological organization, from an individual to the biosphere.
2	Additionally, I can explain the interdependent relationship between abiotic and biotic factors in an ecosystem.
3	Additionally, I can predict the impact of predator-prey, top-down (trophic cascades), or bottom-up impacts on an ecosystem when the populations of different players of a trophic pyramid are affected.

3.2 | Trophic Dynamics: "I can distinguish between different trophic levels and establish where an organism is positioned in an ecosystem."

Scale Score	Description
1	I can identify the trophic level or ecological position of an organism based on where and/or how it gets its energy.
2	Additionally, I can demonstrate how energy is passed from one trophic level to the next, as well as calculate an organism's energy efficiency.
3	Additionally, I can describe "Lindeman's Rule" and explain how this rule explains the distribution of life on planet earth.

3.3 | Trophic Cascade: "I can model the impact that the removal of an apex predator has on the rest of an ecosystem."

Scale Score	Description
1	I can define a trophic cascade.
2	Additionally, I can illustrate a trophic cascade, indicating the impact on each trophic level in a particular ecosystem.
3	Additionally, I can provide a specific historical example of a trophic cascade actually occurring in nature, as well as describe the impact that it had on the entire ecosystem.

3.4 | Terrestrial Biomes: "I can distinguish amongst the various terrestrial biomes on the planet based on geographic distribution, climate, and indicator flora and fauna."

Scale Score	Description

Scale Score	Description
1	I can identify a terrestrial biome based on its geographic location.
2	Additionally, I can distinguish between different climatic conditions for each biome.
3	Additionally, I can list key indicator fauna (animal) and flora (plant) species that occupy each terrestrial biome.

3.5 | Invasive Species: "I can identify an invasive species and explain the impact that it has on native organisms."

Scale Score	Description
1	I can identify an invasive species, either a plant or animal, describing where it is invasive to and where it is originally from.
2	Additionally, I can explain the ecological impact of a particular invasive species on native flora and/or fauna.
3	Additionally, I can propose solutions to mitigating the impact of the invasive species, or at least, preventing its further spread.

4.1 | Aquatic Ecosystems: "I can distinguish amongst the various aquatic ecosystems on the planet based on indicator flora and fauna, among other characteristics."

Scale Score	Description
1	I can identify different aquatic ecosystems.
2	Additionally, I can define each aquatic ecosystem, as well as differentiate amongst them, especially when they share characteristics (such as a "swamp" and "marsh.")
3	Additionally, I can identify indicator flora and fauna that live in each aquatic ecosystem.

4.2 | Principles of Limnology: "I can model the various characteristics of a water column."

Scale Score	Description
1	I can identify lakes based on the net flow of water, nutrients, as well as how they were originally formed.
2	Additionally, I can identify or label the major components of a lake (such as, light zones, productive zones, and lake stratification layers.)

3	Additionally, I can describe the different ways that lakes may be stratified (thermally, with gasses, dissolved solutes, etc.) as well as explain the impact that this stratification may have on lake mixing.

4.3 | Water Pollution: "I can compare and contrast point and non-point water pollution, as well as differentiate amongst the 7 different types of anthropogenic pollution in bodies of water."

Scale Score	Description
1	I can identify water pollution as either point or non-point pollution, depending on the source.
2	Additionally, I can differentiate amongst the different types of water pollution by providing, listing or identifying examples of each.
3	Additionally, I can explain how humans are contributing to each type of water pollution, as well as offer solutions to mitigate the impact humans are having.

5.1 | Sustainability: "I can identify and propose solutions to sustainability issues through concepts like "cradle-to-grave" vs. "cradle-to-cradle" economics."

Scale Score	Description
1	I can identify sustainability concerns of a given product, indicating ways in which the product is treated as a disposable good, perpetuating a "cradle-to-grave" philosophy in the lifecycle of the product.
2	Additionally, I can offer potential solutions to keeping a given product out of landfills, whether it be by recycling, upcycling, or repurposing materials.
3	Additionally, I can propose a broader solution of systemic change that encourages "cradle-to-cradle" economics on a much larger scale, leading to less waste and fewer landfills.

5.2 | Eco-Consumerism: "I can explain the environmental impact of consumerism and materialism."

Scale Score	Description
1	I can explain the environmental impact of the harvesting of raw materials needed to create a product of my choosing, which may include land degradation, habitat modification, etc.
2	Additionally, I can detail the hidden environmental costs of transportation when producing this product, whether that be transporting the raw materials to make the product in the first place, or how far the product travels to be ultimately marketed and sold to consumers.
3	Additionally, I can explain how long the product typically lasts before it is discarded, recycled or upcycled.

Field_Work.1 | Data Collection: "I can properly collect water quality data (chemical and macroinvertebrates) while working in the field."

Scale Score	Description
1	I can collect study area (GPS, altitude, substrate, etc.) and chemical data for each stream being studied.
2	Additionally, I can properly collect chemical data (nitrates, nitrites, phosphates, alkalinity, and pH) for each stream being studied.
3	Additionally, I can properly collect 20 samples of macroinvertebrates.

Field_Work.2 | Data Analysis: "I can analyze the data collected in the field to decipher the significance of the data as it pertains to water quality."

Scale Score	Description
1	I can correctly identify macroinvertebrate species that were collected in the field.
2	Additionally, I can assign abundance codes to each species based on the total number of individuals collected per stream.
3	Additionally, I can correctly calculate a PTI score for each stream following the formulas provided by the Environmental Protection Agency.

Field_Work.3 | Results and Discussion: "I can present the results of my findings and draw reasonable conclusions based on the evidence collected."

Scale Score	Description
1	I can create graphs and figures to illustrate the data collected in the field.
2	Additionally, I can explain potential types and sources of water pollution that may have led to less than ideal water quality scores, based on the surrounding environment, current events, and more.
3	Additionally, I can propose solutions to curb or mitigate sources of pollution for the various streams being studied.

Field_Work.4 | Collaboration: "I can work cooperatively with field group members to collect and analyze data, as well as share the results in a symposium-like style."

Scale Score	Description

1	I can work collaboratively with my group to collect data in the field.
2	Additionally, I can collaborate with my group members to analyze data in the lab.
3	Additionally, I can collaborate with my group members to create and present the research presentation, doing so with pride, poise and professionalism.

Cross-Cutting Concept / Skill Standards:

STEM.Skill.1 | Research: "I can identify sources of information that are credible, using a variety of criteria to determine the legitimacy of the information I am consuming."

Scale Score	Description
1	I can identify credible and reliable sources of information.
2	Additionally, I can summarize the specific criteria that legitimize the sources I have chosen to rely on for information, focusing on accuracy, authority, objectivity, currency and coverage.
3	Additionally, I can properly cite the sources I've relied on for my research in APA format, both in-text and within a bibliography, if necessary.

STEM.Skill.2 | CERCA: "I can think critically about a scientific topic or phenomenon, by identifying claims, summarizing evidence, proposing counter arguments, and providing sound reasoning to support a conclusion."

Scale Score	Description
1	I can provide or identify claims about a particular phenomenon.
2	Additionally, I can identify or provide multiple pieces of evidence that support the claim being made.
3	Additionally, I can think critically about the evidence at hand, identifying potential counter-arguments, and ultimately coming to a reasoned conclusion as to whether or not the claim is sufficiently substantiated.

STEM.Skill.3 | Writing: "I can express my mastery of science content or skills in written form, while being detailed yet concise, using appropriate grammar."

Scale Score	Description

1	I can write coherently about a scientific topic.
2	Additionally, my writing is well organized, structured in a logical manner. Sentences flow nicely and ideas are concise but not redundant.
3	Additionally, I can write with proper conventions, demonstrating very minor grammatical errors, such as spelling mishaps or incorrect punctuation.

Scale Score	Description
1	I can create a presentation that is rich with visuals or other multimedia, which help convey a particular scientific topic or phenomenon.
2	Additionally, I can share my presentation with the class in a way where it is evident that I am knowledgeable about the topic and that I've prepared.
3	Additionally, I can communicate with pride, poise and professionalism, since I am the expert on this topic. This includes answering any questions that my peers or instructor may have on the given topic.

STEM.Skill.5 | Dissection: "I can demonstrate understanding of anatomical structures and functions through hands-on dissections."

Scale Score	Description
1	I can follow safety procedures while in the laboratory setting, limiting risk to myself and/or my dissection partners.
2	Additionally, I can rely on my dissection specimen to correctly identify anatomical structures.
3	Additionally, I can demonstrate physiological understanding of anatomical structures in a dissection setting.

STEM.Skill.6 | Practicum: "I can apply content learned in a laboratory setting."

Scale Score	Description
1	I can show beginning levels of understanding of the content being learned in a laboratory setting.
2	Additionally, I can show emerging levels of understanding of the content being learned in a laboratory setting.

Scale Score	Description
3	Additionally, I can show proficient or advanced levels of understanding of the content being learned in a laboratory setting.

ACT.1 | Data Representation: "I can manipulate and analyze scientific data presented in tables, graphs, and diagrams."

Scale Score	Description
1	I can identify a passage that illustrates data representation.
2	Additionally, manipulate and analyze scientific data presented in tables, graphs, and diagrams.
3	Additionally, I can achieve the level 2 scale at 80% proficiency or greater.

ACT.2 | Research Summaries: "I can understand experimental tools, procedures, and design."

Scale Score	Description
1	I can identify a passage that illustrates research summaries.
2	Additionally, I can understand experimental tools, procedures, and design.
3	Additionally, I can achieve the level 2 scale at 80% proficiency or greater.

ACT.3 | Conflicting Viewpoints: "I can judge the validity of scientific information and formulate conclusions and predictions based on that information."

Scale Score	Description
1	I can identify a passage that demonstrates conflicting viewpoints.
2	Additionally, I can judge the validity of scientific information and formulate conclusions and predictions based on that information.
3	Additionally, I can achieve the level 2 scale at 80% proficiency or greater.