



Science Standard 8
Ecology
Grade Level Expectations

Science Standard 8 Ecology

Organisms are linked to one another in an ecosystem by the flow of energy and the cycling of materials. Humans are an integral part of the natural system and human activities can alter the stability of ecosystems.

Strand	Grades K-3	Grades 4-5	Grades 6-8	Grades 9-12
<p><u>Interactions within the Environment</u></p> <p>Enduring Understanding: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Essential Question: How can change in one part of an ecosystem affect change in other parts of the ecosystem?</p>	<p>1. An interconnectedness exists among the living and nonliving parts of an environment. This interconnectedness can be observed by the changes made by plants and animals in their environment.</p> <p>2. Plants and animals need enough space and resources to survive. Overcrowding leads to an increased need for resources.</p>	<p>1. People depend on living and nonliving resources to satisfy their need for food, shelter, and fuel.</p> <p>2. All living organisms interact with the living and nonliving parts of their surroundings to meet their needs for survival. These interactions lead to a constant exchange of matter.</p> <p>3. Adaptations in organisms enable them to live and reproduce in certain environments. Those organisms that are best suited for a particular environment have adaptations that allow them to compete for available resources and cope with the physical conditions of their immediate surroundings.</p> <p>4. Changes in an organism's environment may be either beneficial or harmful. Organisms may be affected by other organisms, by various physical factors (e.g., rainfall, temperature), by physical forces (e.g., storms, earthquakes), and by daily, seasonal, and annual cycles.</p>	<p>1. All populations living together (biotic factors) and the physical factors with which they interact (abiotic factors) compose an ecosystem.</p> <p>2. Ecosystems do not have precise boundaries. All ecosystems ultimately exchange materials with one another and all influence one another.</p> <p>3. The Delaware Estuary is a semi-enclosed tidal body of water with a free connection to the ocean. This richly productive system, including the associated marshes, provides a variety of habitats for diverse species. This system is biologically and economically important.</p> <p>4. A population consists of all individuals of a species that occur together at a given place and time. A species is a distinct biological grouping of organisms whose members interbreed in nature and produce fertile offspring.</p>	<p>1. Earth's ecosystems are interconnected by biological, chemical, and physical processes. Changes in one ecosystem may have local and/or global consequences.</p> <p>2. Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate complex ecosystems that are stable over long periods of time and tend to have cyclic fluctuations around an equilibrium.</p> <p>3. Ecosystems undergo major changes as a result of such factors as climate change, introduction of new species, and habitat destruction. These can be the result of natural processes and/or human impact.</p> <p>4. Changes in the physical, chemical, or biological conditions of an ecosystem can alter the diversity of species in the system. Over time, ecosystems change and populations of organisms adapt, move, or become extinct.</p>

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<p><i>Interactions within the Environment</i> continued from previous page.</p>		<p>5. In order to survive, populations within an ecosystem require a balance of resources.</p>	<p>5. The size of populations may change as a result of the interrelationships among organisms. These may include predator/prey ratios, availability of resources, and habitat changes.</p> <p>6. In all environments organisms with similar needs may compete with one another for resources including food, water, air, space and shelter. This competition results in natural population fluctuations.</p> <p>7. Overpopulation can lead to depletion of resources and potential extinction of species.</p> <p>8. Organisms within an ecosystem may interact symbiotically through mutualism, parasitism, and commensalism.</p>	<p>5. The carrying capacity for a specific population in an ecosystem depends on the resources available. Given adequate biotic and abiotic resources and no disease or predators, populations increase at rapid rates. Resources, (limiting factors), predation and climate, limit the growth of populations in specific niches in an ecosystem.</p> <p>6. Populations can increase through exponential growth. Higher populations result in competition for limited resources and increases in environmental pollution.</p>

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<p><u>Energy Flow and Material Cycles in the Environment</u></p> <p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the Sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Essential Questions: How do matter and energy link organisms to each other and their environments? Why is sunlight essential to life on Earth?</p>	<p>1. All animals depend on plants. Some animals eat plants for food. Other animals eat animals that have eaten plants.</p>	<p>1. Plants need energy from the Sun, water and nutrients for growth and survival.</p> <p>2. Animals eat plants or other animals that have eaten plants. Animals obtain energy and materials for body repair and growth from food.</p> <p>3. Dead plants and animals are broken down by decomposers.</p>	<p>1. In most ecosystems, energy enters as sunlight and is transformed by producers into a biologically usable form of matter through photosynthesis. That matter and energy then passes from organism to organism through food webs. Some energy is released from the system as heat.</p> <p>2. Over time, matter is transferred repeatedly from one organism to another and between organisms and their physical environment. As in all material systems, the total amount of matter remains constant, even though its form and location change.</p> <p>3. All organisms, including humans, are part of and depend on food webs. Food webs recycle matter continuously as organisms are decomposed after death to return food materials to the environment where it re-enters a food web.</p>	<p>1. The Law of Conservation of Matter applies to ecosystems. Matter needed to sustain life in ecosystems is continually recycled (e.g., carbon cycle, water cycle, nitrogen cycle, mineral cycles) among organisms and between organisms and the environment.</p> <p>2. The Law of Conservation of Energy applies to ecosystems. All energy is conserved as it passes from the Sun through an ecosystem. During energy transformations, some energy is converted to unusable heat. A continual input of energy from the Sun keeps the process going.</p> <p>3. At each level of a food pyramid some energy is stored, but much is dissipated as heat. Consequently the number of trophic levels is finite, and the number of individuals in a population that feed at higher levels is limited.</p>

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<p><i>Energy Flow and Material Cycles in the Environment</i> continued from previous page</p>				<p>4. Biomagnification is an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things any time they are taken up and stored faster than they are broken down (metabolized) or excreted. Biomagnification increases as trophic levels increase.</p> <p>5. Understanding the process of biomagnification is very important in protecting human beings and other organisms from the adverse effects of chemical exposure, and has become a critical consideration in the regulation of chemical use.</p>

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<p><u>Human Impact</u></p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p> <p>Essential Question: How do humans have an impact on the diversity and stability of ecosystems?</p>	<p>1. Many natural resources are limited. The amount available can be made to last longer by decreasing the use of some resources or by reusing or recycling certain materials.</p>	<p>1. Human activities may cause pollution of air, water and soil.</p> <p>2. Different technologies are used to access resources to meet human wants and needs. In many cases the environment is affected and resources become limited. Some activities may include burning of fossil fuels, logging, building of highways, shopping centers, and dams, introduction of one species to control another species, spraying of insects, as well as some aspects of farming.</p>	<p>1. Humans can alter the biotic and abiotic factors within an ecosystem thereby creating changes to the overall system.</p> <p>2. The introduction of competing species, removal of natural habitat, alteration of native landscapes due to urban, industrial and agricultural activities, over-harvesting of species, alteration of waterways and removal of natural predators, etc., are actions that have a lasting impact on ecosystems.</p> <p>3. Individuals and policymakers make decisions regarding the use of resources based on estimated personal and societal benefits and risks. Impacts on environmental systems result from these decisions.</p>	<p>1. Exponential growth of the global human population and the resulting increase in consumption places severe stress on finite resources.</p> <p>2. Human decisions concerning the use of resources can affect the stability and biodiversity of the ecosystems and the natural recycling processes which maintain the quality of air, water, and land.</p> <p>3. Human activities have a major effect on other species. For example, increased land use reduces habitat available to other species, pollution changes the chemical composition of air, soil, and water, and introduction of non-native species disrupts the ecological balance.</p> <p>4. Advances in technology can help mitigate human impact on the environment and increase the carrying capacity of the ecosystem.</p>

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<u><i>Human Impact</i></u> continued from previous page				5. People manage the Earth and its resources by preservation, conservation, appropriate utilization, and restoration. The complexity and interaction of these ecosystems requires individual and collaborative efforts on a local, regional, national, and international scale.

Standard 8: Ecology, Grade Level Expectations Grades K-3

<p>Essential Question: How can change in one part of an ecosystem affect change in other parts of the ecosystem?</p> <p>Essential Questions: How do matter and energy link organisms to each other and their environments? Why is sunlight essential to life on Earth?</p> <p>Essential Question: How do humans have an impact on the diversity and stability of ecosystems?</p>			
<p>Enduring Understanding: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Enduring Understanding: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p>			
<p>All students in Kindergarten will be able to:</p>	<p>Building upon the Kindergarten expectations, all students in Grade 1 will be able to:</p>	<p>Building upon the K-1 expectations, all students in Grade 2 will be able to:</p>	<p>Building upon the K-2 expectations, all students in Grade 3 will be able to:</p>
<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Recognize that humans interact with the environment through the use of their five senses.</p> <p>Identify ways in which living organisms interact with each other and their environment (e.g., birds nest in trees, birds eat worms).</p> <p>Recognize that animals use plants in a variety of ways (e.g., shelter, food and protection).</p>	<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Describe the impact of weather conditions (e.g., sun, fog, rain, snow) on plant and animal activities.</p> <p>Identify and describe the different kinds of living things in an aquatic or terrestrial environment. Recognize that living things coexist in these environments.</p> <p>Describe how aquatic plants and animals interact with each other and their environment (e.g., fish use plants for food and shelter).</p> <p>Describe how terrestrial plants and animals interact with each other and their environment (e.g., millipedes eat decaying bark).</p>	<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Describe the effects that result from plants, insects, and other animals changing the environment in which they live (e.g., worms make tunnels in the earth, crickets eat the grass).</p> <p>Observe the plants and animals living in an environment. Identify ways in which plants and animals benefit from each other (e.g., animals use plants for food and shelter, and plants need insects to spread pollen).</p> <p>Observe and describe the effects of plant and animal overcrowding in a given space (i.e., many guppies in an aquarium, many beetles in a habitat). Recognize that this overcrowding results in an increased need for basic resources.</p>	<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p><i>There are no grade level expectations for this understanding.</i></p>

Standard 8: Ecology, Grade Level Expectations Grades K-3

<p>Essential Question: How can change in one part of an ecosystem affect change in other parts of the ecosystem?</p> <p>Essential Questions: How does matter and energy link organisms to each other and their environments? Why is sunlight essential to life on Earth?</p> <p>Essential Question: How do humans have an impact on the diversity and stability of ecosystems?</p>			
<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p>			
<p>All students in Kindergarten will be able to:</p>	<p>Building upon the Kindergarten expectations, all students in Grade 1 will be able to:</p>	<p>Building upon the K-1 expectations, all students in Grade 2 will be able to:</p>	<p>Building upon the K-2 expectations, all students in Grade 3 will be able to:</p>
<p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Recognize that sunlight is needed by plants for energy.</p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p> <p>Recognize that trees are replanted in an attempt to replace those that are cut down.</p>	<p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Recognize that energy needed by all living things originates from the Sun.</p> <p>Identify and give examples showing that animals eat plants or other animals for energy, and that plants get energy from the Sun.</p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Investigate how natural composting recycles plants and other discarded organic matter. Recognize the importance of this process to the environment.</p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p><i>There are no grade level expectations for this understanding.</i></p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p> <p>Describe the changes to the environment that result from humans obtaining rock and mineral resources (e.g., strip mining).</p>

Standard 8: Ecology, Grade Level Expectations Grades 4-5

<p>Essential Question: How can change in one part of an ecosystem affect change in other parts of the ecosystem?</p> <p>Essential Question: How do matter and energy link organisms to each other and their environments? Why is sunlight essential to life on Earth?</p> <p>Essential Question: How do humans have an impact on the diversity and stability of ecosystems?</p>	
<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p>	
<p>Building upon the K-3 expectations, all students in Grade 4 will be able to:</p>	<p>Building upon the K-4 expectations, all students in Grade 5 will be able to:</p>
<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Predict, investigate and describe how plants can affect water flow, run off and erosion. Relate this knowledge to an ecosystem in Delaware (i.e., planting beach grass to stabilize dunes, planting grass on a slope to decrease soil erosion).</p> <p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Examine a variety of ecosystems such as marsh, pond, field, forest. Compare how the organisms, the habitat, and the food chains are similar and different in these ecosystems.</p> <p>Differentiate between an organism’s “habitat” (where an animal lives) and its “territory” (an area claimed as its own space). Select an organism and describe its habitat and territory.</p> <p>Predict and describe how a dramatic increase or decrease in the population size of a single species within an ecosystem affects the entire ecosystem.</p> <p>Identify environmental factors that affect the growth and reproduction of organisms in an ecosystem (e.g., temperature can affect germination and soil moisture).</p> <p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Conduct investigations to simulate terrestrial and aquatic ecosystems and their interdependence. Demonstrate and describe how alteration of one part of the ecosystem (i.e., change in pH, over fertilization, addition of salt) may cause changes throughout the entire ecosystem.</p> <p>Categorize the organisms within an ecosystem according to the function they serve as producers, consumers, or decomposers. Explain why the organism was categorized this way.</p>

Standard 8: Ecology, Grade Level Expectations Grades 4-5

<p>Essential Question: How can change in one part of an ecosystem affect change in other parts of the ecosystem?</p> <p>Essential Question: How does matter and energy link organisms to each other and their environments? Why is sunlight essential to life on Earth?</p> <p>Essential Question: How do humans have an impact on the diversity and stability of ecosystems?</p>	
<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p>	
<p>Building upon the K-3 expectations, all students in Grade 4 will be able to:</p>	<p>Building upon the K-4 expectations, all students in Grade 5 will be able to:</p>
<p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Identify the Sun as a source of energy that drives an ecosystem. Describe the path of energy from the Sun to the producers then to the consumer in the food chain. Recognize that an organism has dependent and independent relationships in an ecosystem.</p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p> <p>Identify natural (i.e., wildfire, flood, drought) and man-made changes (forest clear cutting, input of pollutants, filling in of marshland) to an ecosystem. Discuss how these changes affect the balance of an ecosystem.</p> <p>Explain why moving organisms from their ecosystem to a new ecosystem may upset the balance of the new ecosystem, for example, by introduction of diseases or depletion of resources.</p>

Standard 8: Ecology, Grade Level Expectations Grades 6-8

<p>Essential Question: How can change in one part of an ecosystem affect change in other parts of the ecosystem?</p> <p>Essential Questions: How does matter and energy link organisms to each other and their environments? Why is sunlight essential to life on Earth?</p> <p>Essential Question: How do humans have an impact on the diversity and stability of ecosystems?</p>		
<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p>		
<p>Building upon the K-5 expectations, all students in Grade 6 will be able to:</p>	<p>Building upon the K-6 expectations, all students in Grade 7 will be able to:</p>	<p>Building upon the K-7 expectations, all students in Grade 8 will be able to:</p>
<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Survey the diversity of organisms in a local or model ecosystem. Recognizing that a population consists of all individuals of a species that occur together at a given place and time, describe how to estimate and then calculate the size of a large population of a variety of organisms. Chart the diversity of the organisms in the ecosystem.</p> <p>Categorize populations of organisms according to the roles (producers, consumers, and decomposers) they play in an ecosystem.</p> <p>Describe and explain how factors (i.e., space, food, water, disease) limit the number of organisms an ecosystem can support.</p> <p>Construct a data table or line graph to show population changes of a selected species over time. Describe the population changes portrayed by the graph.</p> <p>Observe graphs or data tables showing both the population growth of a species and the consequences of resource depletion on the population. Analyze the data and explain the effect that may occur from exponential growth of a population (given finite resources).</p>

Standard 8: Ecology, Grade Level Expectations Grades 6-8

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<p>Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.</p> <p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p>		
<p>Building upon the K-5 expectations, all students in Grade 6 will be able to:</p>	<p>Building upon the K-6 expectations, all students in Grade 7 will be able to:</p>	<p>Building upon the K-7 expectations, all students in Grade 8 will be able to:</p>
<p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Investigate and discuss how short-term physiological changes of an organism (e.g., skin tanning, muscle development, formation of calluses) differ from long-term evolutionary adaptations (e.g., white coloration of polar bears, seed formation in plants) that occur in a group of organisms over generations.</p> <p>Investigate local areas, disturbed and undisturbed, that are undergoing succession (i.e., abandoned gardens, ditch banks, and the edge of a forest). Predict how plant communities that grow in the area may change over time and how their presence determines what kinds of animals may move into and out of the areas.</p> <p>Enduring Understandings: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.</p> <p>Construct food webs and identify the relationships among producers, consumers, and decomposers.</p> <p>Design food webs and trace the flow of matter and energy (beginning with the Sun) through the food web.</p>

Standard 8: Ecology, Grade Level Expectations Grades 6-8

<p>Essential Question: How can change in one part of an ecosystem affect change in other parts of the ecosystem?</p> <p>Essential Questions: How does matter and energy link organisms to each other and their environments? Why is sunlight essential to life on Earth?</p> <p>Essential Question: How do humans have an impact on the diversity and stability of ecosystems?</p>		
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<p>Building upon the K-5 expectations, all students in Grade 6 will be able to:</p>	<p>Building upon the K-6 expectations, all students in Grade 7 will be able to:</p>	<p>Building upon the K-7 expectations, all students in Grade 8 will be able to:</p>
<p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p> <p>Explain how sanitation measures such as sewers, landfills, and water treatment are important in controlling the spread of organisms that contaminate water and cause disease.</p>	<p>Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.</p> <p>Research and analyze data on human population changes that have occurred in a specific Delaware ecosystem. Discuss reasons for changes in human population and explain how these changes have affected the biodiversity of local organisms and availability of natural resources in the given ecosystem (e.g., habitat loss, water quality, preservation/conservation efforts).</p> <p>Identify ways in which invasive species can disrupt the balance of Delaware as well as other ecosystems (i.e., competition for resources including habitat and/or food). Research and report on an invasive species, indicating how this species has altered the ecosystem.</p>

Standard 8: Ecology, Grade Level Expectations Grades 9-12

Essential Questions: How can change in one part of an ecosystem affect change in other parts of the ecosystem?

Essential Question: How does matter and energy link organisms to each other and their environments? Why is sunlight essential to life on Earth?

Essential Questions: How do humans have an impact on the diversity and stability of ecosystems?

Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.

Enduring Understanding: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.

Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.

Building upon the K-11 expectations, all students in **Grade 12** will be able to:

Enduring Understanding: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.

Identify and measure biological, chemical and physical indicators within a given ecosystem (pH, dissolved oxygen, macroinvertebrate and other indicator species, salinity).

Using models, computer simulations, or graphic representations, demonstrate how, changes in these indicators may affect interactions within ecosystems. Evaluate the current health of the ecosystem and suggest possible interventions for mitigation.

Explain how feedback loops keep an ecosystem (at the local and global level) in a state of dynamic equilibrium (e.g., positive and negative feedback loops associated with global climate).

Explain how niches help to increase the diversity within an ecosystem and maximize the number of populations that can live in the same habitat.

Using graphs of population data of a predator and its prey, describe the patterns observed. Explain how the interactions of predator and prey generate these patterns, and predict possible future trends in these populations.

Analyze and explain the short-term impact of a natural disaster on the biological, chemical, and physical components of the affected ecosystem and their associated interrelationships, including geochemical cycles and food webs.

Based on knowledge of populations and interactions in an ecosystem, predict the possible long-term outcomes (e.g., extinction, adaptation, succession) of a natural disaster on populations in the ecosystem.

Explain the significance of the introduction of non-native and invasive species to a stable ecosystem and describe the consequent harm to the native species and the environment (e.g., zebra mussels, purple loosestrife, phragmites, Japanese Beetles).

Describe how the biotic and abiotic factors can act as selective pressures on a population and can alter the diversity of the ecosystem over time.

Identify limiting factors in an ecosystem and explain why these factors prevent populations from reaching biotic potential. Predict the effects on a population if these limiting factors were removed. Explain why a population reaching unlimited biotic potential can be detrimental to the ecosystem.

Determine the carrying capacity for a population in an ecosystem using graphical representations of population data.

Describe how birth rate, death rate, emigration, and immigration contribute to a population's growth rate.

Standard 8: Ecology, Grade Level Expectations Grades 9-12

Essential Questions: How can change in one part of an ecosystem affect change in other parts of the ecosystem?

Essential Question: How does matter and energy link organisms to each other and their environments? Why is sunlight essential to life on Earth?

Essential Questions: How do humans have an impact on the diversity and stability of ecosystems?

Enduring Understandings: Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.

Enduring Understanding: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.

Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.

Building upon the K-11 expectations, all students in **Grade 12** will be able to:

Enduring Understanding: Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it.

Illustrate how elements on Earth cycle among the biotic and abiotic components of the biosphere.

Recognize that the amount of matter in a closed ecosystem will remain constant.

Relate an ecosystem's requirement for the continual input of energy to the inefficiency of energy transfer.

Explain how ecosystems that do not rely on radiant energy obtain energy to maintain life.

Explain how the inefficiency of energy transfer determines the number of trophic levels and affects the relative number of organisms at each trophic level in an ecosystem.

Relate a chemical's properties to its accumulation within organisms, such as PCBs in the fatty tissues of fish.

Relate the accumulation of a chemical in an organism to the organism's trophic level. Explain why bioaccumulation is a greater problem for organisms at higher trophic levels.

Explain how biomagnification has led to unsafe food supplies, such as mercury accumulation in tuna.

Analyze how an understanding of biomagnification has led to the regulation of chemical use and disposal.

Enduring Understanding: Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.

Examine and describe how social and biological factors influence the exponential growth of the human population (e.g., economic, cultural, age at reproduction, fertility rate, birth/death rate, and environmental factors).

Examine and describe how the exponential growth of the human population has affected the consumption of renewable and non-renewable resources.

Evaluate decisions about the use of resources in one country and how these decisions can impact the diversity and stability of ecosystems globally.

Analyze ways in which human activity (i.e., producing food, transporting materials, generating energy, disposing of waste, obtaining fresh water, or extracting natural resources) can affect ecosystems and the organisms within.

Research and discuss ways in which humans use technology to reduce the negative impact of human activity on the environment. (e.g., phytoremediation, smokestack scrubbers).

Describe how advances in technology can increase the carrying capacity of an ecosystem (i.e., advances in agricultural technology have led to increases in crop yields per acre).