WELLESLEY NATURAL RESOURCES COMMISSION

ENVIRONMENTAL EDUCATION AND OUTREACH

SUPPLEMENTAL LESSONS FOR GRADES K-12

2019-2020

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Environmental Education and Outreach Supplemental lessons for Grades K-12

Course Offerings

2019-2020

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NRC

It is the mission of the Natural Resources Commission to provide stewardship of, education about, and advocacy for the Town of Wellesley's parks, conservation, recreation and open space areas so the full value of the Town's natural assets can be passed onto future generations.

The Wellesley Natural Resources Commission Environmental Education and Outreach Coordinator is responsible for supporting environmental education initiatives in the town of Wellesley. The following course description guide represents some of the types of lessons that can be provided at no cost to support Science Education for Wellesley Students in grades K-12. All lessons can be modified to meet the specific needs of the classroom teacher and students. For additional lesson options please contact the Environmental Education and Outreach Coordinator directly to discuss ways to support your science education needs.

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NRC Led Environmental Education Supplemental Lesson Offerings

NRC Organized Field Trips

NRC In-class Lessons

NRC Guided Nature Walks

Grade K

Lesson: In class lesson on Living Vs Non-living (30-45 minutes)

Learning Objectives: All living things need air (respiration), water, food, shelter and room to grow. All living things have the following characteristics in common: Living things **move**, undergo **respiration, sense** changes to their environment and can react to those changes. Living things **grow**, and must **reproduce** to maintain the continuation of a species. Living things **excrete** waste such as urea, CO2, oxygen or indigestible food. All living things must have **nutrition.** (Mrs. Gren) **Autotrophs** create their own food and **heterotrophs** get their food by consuming other living things.

Students will have an opportunity to observe a variety of objects, some living and nonliving. The students will determine if the object is living, once living, or nonliving. Sample things could be plants, animals, and everyday objects. Discuss if the object meets the criteria for life. A non-living object might have one or more of the 7 things needed to be considered alive, but is only alive if it meets all seven criteria. Example: automobile- moves, senses changes, use oxygen and give off CO2, and waste, yet is not living since it does not grow or reproduce. Students can be introduced to the terms **biotic** and **abiotic**.

State standards addressed:

LS1. From Molecules to Organisms: Structures and Processes

K-LS1-1 Observe and communicate that animals (including humans) and plants need food, water, and air to survive. Animals get food from plants or other animals. Plants make their own food and need light to live and grow.

K-LS1-2 Recognize that all plants and animals grow and change over time.

Lesson: Guided Nature Walks (30-60 minutes)

Learning Objectives: Students will practice taking guided nature walks in natural spaces around their school or town and learn to make critical observations like scientists. They will observe and compare patterns of seasonal changes to the environment and the natural world in their own schoolyard or nearby natural space. The Environmental educator will guide the class in making scientific observations using their senses. The students will practice looking for signs of living things and nonliving things in their environment. Students will learn to collect data and use photographs, drawings and simple data collection sheets to compare seasonal changes. Students will look for evidence of how plants and animals can make changes to their environment.

Lesson: In class lesson on "How do plants and animals change an environment over time" (30-45 minutes)

Learning Objectives: Students will observe local samples of plants and animals that make changes to the environment. Students will observe the role of decomposers such as moss, lichens, and fungi as soil producers and nutrient recyclers. Students can observe beaver chews and a beaver skull to learn how

the beaver uses its body parts to make changes to its environment. Comparisons will be made to how humans change their environment.

State standards addressed:

ESS2. Earth's Systems

K-ESS2-2: Construct an argument supported by evidence for how plants and animals (including humans) can change the environment.

Clarification Statement: Examples of plants and animals changing their environment could include a squirrel digging holes in the ground and tree roots that break concrete.

ESS3. Earth and Human Activity

K-ESS3-3. Communicate solutions to reduce the amount of natural resources an individual uses.
Clarification Statement: • Examples of solutions could include reusing paper to reduce the number of trees cut down and recycling cans and bottles to reduce the amount of plastic or metal used.

Grade 1

Lesson: In class lesson about the parts of a plant and their functions. Build a forest lesson. (45-60 min)

Learning Objectives: Students will learn about the parts of a plant and their function. Each student will become a plant part, (roots, stems, leaves, fruits) and the class will "grow a forest" in their classroom by using, leaf hats, apron stems and pipe cleaner roots. Students will then look at actual plant parts, (roots, stems, leaves, seeds, fruits) gathered in nature and make observations of similarities and differences. The lesson culminates in the "Tree parts" song to reinforce plant parts and functions.

Lesson: Animal adaptations for survival (45-60 min)

Learning Objectives: In this lesson students will observe a variety of animal parts and models and compare how different animals use their parts to survive in their habitat. Samples of organisms from different local habitats will be observed. Insect life cycle model, sample insects, skulls (herbivore, carnivore, omnivore), pelts, bird parts, nests, etc. will be brought in for students to observe.

Lesson: Guided nature walk (45-60 min)

Learning objectives: Students will take a guided nature walk around their campus or other green space. They will make observations about how the different plants and animals observed are adapted to survive in their environment

State standards addressed:

LS1. From Molecules to Organisms: Structures and Processes

1-LS1-1. Use evidence to explain that (a) different animals use their body parts and senses in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air, and (b) plants have roots, stems, leaves, flowers, and fruits that are used to take in water, air, and other nutrients, and produce food for the plant. Clarification Statement: • Descriptions are not expected to include mechanisms such as the process of photosynthesis.

1-LS1-2. Obtain information to compare ways in which the behavior of different animal parents and their offspring help the offspring to survive. Clarification Statement: • Examples of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).

Lesson: In class lesson: Similarities and differences (45-60 min)

Learning objective: Students will observe a variety of leaves, for example oak, maple, and sassafras. Students will make observations of similarities and differences between different types of leaves as well as similarities and differences among leaves of the same type. The concept of variation will be introduced.

Lesson: Guided nature walk (45-60 min)

Learning objectives: Students will take a guided nature walk. The naturalist will bring the students around the natural spaces in and around their school building. The students will observe similarities and differences between organisms in different habitats.

State standards addressed:

LS3. Heredity: Inheritance and Variation of Traits

1-LS3-1. Use information from observations (first-hand and from media) to identify similarities and differences among individual plants or animals of the same kind. Clarification Statements: • Examples of observations could include that leaves from the same kind of plant are the same shape but can differ in size. • Inheritance, animals that undergo metamorphosis, or hybrids are not expected

Grade 2

Lesson: Guided nature walk (45-60 min)

Learning objectives: Students will take a guided nature walk. The naturalist will bring the students around the natural spaces in and around their school building. Students will make observations of areas that show erosion and deposition. Students will identify the agents of erosion and can develop plans for mitigating areas of erosion.

State standards addressed:

ESS2. Earth's Systems

2-ESS2-1. Investigate and compare the effectiveness of multiple solutions designed to slow or prevent wind or water from changing the shape of the land. * Clarification Statements: • Solutions to be compared could include different designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land. • Solutions can be generated or provided.

2-ESS2-2. Map the shapes and types of landforms and bodies of water in an area. Clarification Statements: • Examples of types of landforms can include hills, valleys, river banks, and dunes. • Examples of water bodies can include streams, ponds, bays, and rivers. • Quantitative scaling in models or contour mapping is not expected.

Lesson: Guided nature walk (45-60 min)

Learning objectives: Students will take a guided nature walk. Students can visit the North 40 vernal pool and/or Morses pond or other nearby water body, to learn about the different types of bodies of water and why these water bodies are important for the town. Morses pond has several sites where erosion and deposition have changed the area. Students can make observations and create models to show how they might mitigate the erosion and deposition problems seen at the pond. Comparisons between ponds and vernal pool ecosystems can be studied. Visit https://wellesleyma.gov/455/Morses-Pond to learn about the Morses Pond erosion study and recommendations for abatement.

State standards addressed:

ESS2. Earth's Systems

2-ESS2-3. Use examples obtained from informational sources to explain that water is found in the ocean, rivers and streams, lakes and ponds, and may be solid or liquid.

2-ESS2-4(MA). Observe how blowing wind and flowing water can move Earth materials from one place to another and change the shape of a landform. Clarification Statement: • Examples of types of landforms can include hills, valleys, river banks, and dunes.

LS2. Ecosystems: Interactions, Energy, and Dynamics

2-LS2-3(MA). Develop and use models to compare how plants and animals depend on their surroundings and other living things to meet their needs in the places they live. Clarification Statement: • Animals

need food, water, air, shelter, and favorable temperature; plants need sufficient light, water, minerals, favorable temperature, and animals or other mechanisms to disperse seeds.

LS4. Biological Evolution: Unity and Diversity

2-LS4-1. Use texts, media, or local environments to observe and compare (a) different kinds of living things in an area, and (b) differences in the kinds of living things living in different types of areas. Clarification Statements: • Examples of areas to compare can include temperate forest, desert, tropical rain forest, grassland, arctic, and aquatic. • Specific animal and plant names in specific areas are not expected.

Grade 3

Lesson: In class lesson on design solutions to counter act weather related damage (45-60 min)

Learning objectives: Students will observe changes to sea level as caused by climate change. They will use a model to simulate this and design solutions to mitigating the impact of such an event. Flooding mitigation, wind breaks, and better material use are some factors which could be discussed.

State standards addressed:

ESS3. Earth and Human Activity

3-ESS3-1. Evaluate the merit of a design solution that reduces the damage caused by weather. * Clarification Statement: • Examples of design solutions to reduce weather-related damage could include a barrier to prevent flooding, a wind-resistant roof, and a lightning rod.

Lesson: In class lesson on lifecycles (45-60 min)

Learning Objectives: Students will learn to identify the stages of the life cycle that all living things share: birth, growth, reproduction and death. They will observe, compare, and contrast, various plant and animal lifecycle models and living samples.

Lesson: Guided nature walk (45-60 min): students will participate in a guided nature walk in the green spaces around their school yard. The naturalist will point out examples and evidence of plants and animal life cycles as observed in nature. Spring and early fall provide the best opportunities for viewing lifecycle examples in nature.

State standards addressed:

LS1. From Molecules to Organisms: Structures and Processes

3-LS1-1. Use simple graphical representations to show that different types of organisms have unique and diverse life cycles. Describe that all organisms have birth, growth, reproduction, and death in common but there are a variety of ways in which these happen.

Clarification Statements: • Examples can include different ways plants and animals begin (e.g., sprout from a seed, born from an egg), grow (e.g., increase in size and weight, produce a new part), reproduce (e.g., develop seeds, root runners, mate and lay eggs that hatch), and die (e.g., length of life). • Plant life cycles should focus on those of flowering plants. • Describing variation in organism life cycles should focus on comparisons of the general stages of each, not specifics. State Assessment Boundary: • Detailed descriptions of any one organism's cycle, the differences of "complete metamorphosis" and "incomplete metamorphosis," or details of human reproduction are not expected in state assessment.

Lesson: In class lesson on heredity and inheritance of traits (60 min)

Learning objectives: Students will participate in a lesson about the Galapagos Islands and Darwin's finches. Using an interactive model, students will be "birds", using different tools that represent bird beaks. The students will feed on different "islands" where different "food" sources are available. They

will learn how beak adaptations impact survival and impact which traits are passed on to future generations.

State standards addressed:

LS3. Heredity: Inheritance and Variation of Traits

3-LS3-1. Provide evidence, including through the analysis of data, that plants and animals have traits inherited from parents and that variation of these traits exist in a group of similar organisms. Clarification Statements: • Examples of inherited traits that vary can include the color of fur, shape of leaves, length of legs, and size of flowers. • Focus should be on non-human examples. State Assessment Boundary: • Genetic mechanisms of inheritance or prediction of traits are not expected in state assessment.

3-LS3-2. Distinguish between inherited characteristics and those characteristics that result from a direct interaction with the environment. Give examples of characteristics of living organisms that are influenced by both inheritance and the environment. Clarification Statements: • Examples of the environment affecting a characteristic could include normally tall plants stunted because they were grown with insufficient water or light, a lizard missing a tail due to a predator, and a pet dog becoming overweight because it is given too much food and little exercise. • Focus should be on non-human examples.

LS4. Biological Evolution: Unity and Diversity

3-LS4-1. Use fossils to describe types of organisms and their environments that existed long ago and compare those to living organisms and their environments. Recognize that most kinds of plants and animals that once lived on Earth are no longer found anywhere. Clarification Statement: • Comparisons should focus on physical or observable features. 2016 Massachusetts Science and Technology/Engineering Curriculum Framework 39 State Assessment Boundary: • Identification of specific fossils or specific present-day plants and animals, dynamic processes, or genetics are not expected in state assessment.

3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals within the same species may provide advantages to these individuals in their survival and reproduction. Clarification Statements: • Examples can include rose bushes of the same species, one with slightly longer thorns than the other which may prevent its predation by deer, and color variation within a species that may provide advantages so one organism may be more likely to survive and therefore more likely to produce offspring. • Examples of evidence could include needs and characteristics of the organisms and habitats involved.

3-LS4-3. Construct an argument with evidence that in a particular environment some organisms can survive well, some survive less well, and some cannot survive. Clarification Statement: • Examples of evidence could include needs and characteristics of the different organisms (species) and habitats involved.

3-LS4-4. Analyze and interpret given data about changes in a habitat and describe how the changes may affect the ability of organisms that live in that habitat to survive and reproduce. Clarification Statements: • Changes should include changes to landforms, distribution of water, climate, and availability of

resources. • Changes in the habitat could range in time from a season to a decade. • While it is understood that ecological changes are complex, the focus should be on a single change to the habitat.

3-LS4-5(MA). Provide evidence to support a claim that the survival of a population is dependent upon reproduction. State Assessment Boundary: • Details of reproduction are not expected in state assessment.

Grade 4

Lesson: Guided nature walk/ field trip (45-60 min)

Learning objectives: Students can visit local areas in town that show geological land formations such as kettle lakes, exposed volcanic plugs, glacial erratic's, moraines, etc. Evidence of weathering, erosion and deposition will also be observed. The naturalist will lead the walk and point out various landforms and how they came to be.

Lesson: In class lesson on basic geology (45-60 min)

Learning objectives: Students will observe fossils, minerals, rocks, and models that represent glacial action, erosion, deposition and weathering to gain an understanding of how these actions change an environment and create specific land formations.

State standards addressed:

ESS1. Earth's Place in the Universe

4-ESS1-1. Use evidence from a given landscape that includes simple landforms and rock layers to support a claim about the role of erosion or deposition in the formation of the landscape over long periods of time. Clarification Statements: • Examples of evidence and claims could include rock layers with shell fossils above rock layers with plant fossils and no shells, indicating a change from deposition on land to deposition in water over time; and a canyon with rock layers in the walls and a river in the bottom, indicating that a river eroded the rock over time. • Examples of simple landforms can include valleys, hills, mountains, plains, and canyons. • Focus should be on relative time. State Assessment Boundary: • Specific details of the mechanisms of rock formation or specific rock formations and layers are not expected in state assessment.

SS2. Earth's Systems

4-ESS2-1. Make observations and collect data to provide evidence that rocks, soils, and sediments are broken into smaller pieces through mechanical weathering and moved around through erosion. Clarification Statements: • Mechanical weathering processes can include frost wedging, abrasion, and tree root wedging. • Erosion can include movement by blowing wind, flowing water, and moving ice. State Assessment Boundary: • Chemical processes are not expected in state assessment.

4-ESS2-2. Analyze and interpret maps of Earth's mountain ranges, deep ocean trenches, volcanoes, and earthquake epicenters to describe patterns of these features and their locations relative to boundaries between continents and oceans

Lesson: In class lesson on renewable and nonrenewable resources (45-60 min)

Learning objectives: Students will gain an understanding of the difference between renewable and nonrenewable resources and the impact their use has on the environment. Students will discuss the positive and negative impacts that using different energy sources create. Students will evaluate the risks of and design solutions for preventing different natural disasters impacts on the local region.

State standards addressed:

SS3. Earth and Human Activity

4-ESS3-1. Obtain information to describe that energy and fuels humans use are derived from natural resources and that some energy and fuel sources are renewable and some are not. Clarification Statements: • Examples of renewable energy resources could include wind energy, water behind dams, tides, and sunlight. • Non-renewable energy resources are fossil fuels and nuclear materials.

4-ESS3-2. Evaluate different solutions to reduce the impacts of a natural event such as an earthquake, blizzard, or flood on humans. * Clarification Statement: • Examples of solutions could include an earthquake-resistant building or a constructed wetland to mitigate flooding.

Lesson: In class lesson on form and function, plant and animal adaptations for survival (45-60 min)

Learning objectives: Students will observe specimens and artifacts of plants and animals from different local habitats. The students will explore how the plant and animal parts help them to survive in their specific habitat. Woodland, marsh, pond, vernal pool, meadow and ocean habitats can be explored.

Lesson: Guided nature walk (45-60 min.)

Learning objectives: Students can be led on a guided nature walk around the green spaces near their school or at one of the many trails in town. The naturalist will lead the students around and assist them to make observations of the living things found and how they are adapted to survive in their specific habitat.

LS1. From Molecules to Organisms: Structures and Processes

4-LS1-1. Construct an argument that animals and plants have internal and external structures that support their survival, growth, behavior, and reproduction. Clarification Statements: • Animal structures can include legs, wings, fins, feathers, trunks, claws, horns, antennae, eyes, ears, nose, heart, stomach, lung, brain, and skin. • Plant structures can include leaves, roots, stems, bark, branches, flowers, fruit, and seeds. State Assessment Boundary: • State assessment will be limited to macroscopic structures.

Grade 5

Lesson: In class lesson on the cycling of water through a watershed (45-60 min)

Learning objectives: The students will participate in a watershed model demonstration. They will learn how water gets cycled through a watershed and how pollution can enter a watershed. The students will learn about point source and nonpoint source pollution and devise ways to prevent these pollution sources from entering the watershed.

Lesson: Guided nature walk/fieldtrip (1-3 hours)

Learning objectives: The students will take a field trip to explore Morses pond, the wells that feed it and the water treatment facility in town. Students can learn how the town gets its water supply from Morses pond and the nearby wells and how human activities can impact our local water supply.

State standards addressed:

ESS2. Earth's Systems

5-ESS2-1. Use a model to describe the cycling of water through a watershed through evaporation, precipitation, absorption, surface runoff, and condensation. State Assessment Boundary: • Transpiration or explanations of mechanisms that drive the cycle are not expected in state assessment.

5-ESS2-2. Describe and graph the relative amounts of salt water in the ocean; fresh water in lakes, rivers, and groundwater; and fresh water frozen in glaciers and polar ice caps to provide evidence about the availability of fresh water in Earth's biosphere. State Assessment Boundary: • Inclusion of the atmosphere is not expected in state assessment.

ESS3. Earth and Human Activity

5-ESS3-1. Obtain and combine information about ways communities reduce human impact on the Earth's resources and environment by changing an agricultural, industrial, or community practice or process. Clarification Statement: • Examples of changed practices or processes include treating sewage, reducing the amounts of materials used, capturing polluting emissions from factories or power plants, and preventing runoff from agricultural activities. State Assessment Boundary: • Climate change or social science aspects of practices such as regulation or policy are not expected in state assessment. 5-

ESS3-2(MA). Test a simple system designed to filter particulates out of water and propose one change to the design to improve it.

Lesson: Guided nature walk (45-60 min)

Learning objectives: Students will participate in a guided nature walk around the green spaces of their school. Evidence of plant life will be explored. Plant parts and their functions will be reviewed. Students will look for evidence of photosynthesis and the formation of fruits, seeds, and sap.

State standards addressed:

LS1. From Molecules to Organisms: Structures and Processes

5-LS1-1. Ask testable questions about the process by which plants use air, water, and energy from sunlight to produce sugars and plant materials needed for growth and reproduction. State Assessment Boundary: • The chemical formula or molecular details about the process of photosynthesis are not expected in state assessment.

Lesson: In class lesson on energy flow through an ecosystem (45-60 min)

Learning objectives: Students will explore samples of producers, consumers and decomposers from a local habitat. Food chains and food webs will be constructed to show how energy flows through the ecosystem.

Lesson: Guided nature walk (45-60 min)

Learning objectives: Students will participate in a guided nature walk in green spaces around their school. Evidence of food chains and food webs will be observed and ways energy travels through the food chain will be discussed.

State standards addressed:

LS2. Ecosystems: Interactions, Energy, and Dynamics

5-LS2-1. Develop a model to describe the movement of matter among producers, consumers, decomposers, and the air, water, and soil in the environment to (a) show that plants produce sugars and plant materials, (b) show that animals can eat plants and/or other animals for food, and (c) show that some organisms, including fungi and bacteria, break down dead organisms and recycle some materials back to the air and soil. Clarification Statement: • Emphasis is on matter moving throughout the ecosystem. State Assessment Boundary: • Molecular explanations, or distinctions among primary, secondary, and tertiary consumers, are not expected in state assessment.

Lesson: In class lesson on composting (45-60 min)

Learning objectives: The students will learn about the function of a composter, what is needed for successful composting, the unique food web of organisms found in the compost pile and design ways to create a functional classroom or school composter.

State standards addressed:

LS2. Ecosystems: Interactions, Energy, and Dynamics

5-LS2-2(MA). Compare at least two designs for a composter to determine which is most likely to encourage decomposition of materials. * Clarification Statement: • Measures or evidence of decomposition should be on qualitative descriptions or comparisons.

Grade 6

Lesson: In class lesson on the geology of Wellesley (45-60 min)

Learning objectives: The students will learn about the geologic processes that formed Wellesley and the surrounding area. Glaciation, the rock cycle, weathering, erosion, deposition and the geologic time scale will be discussed. Local geologic points of interest will be discussed.

Lesson: Guided nature walk (45-60 min)

Learning objectives: Students will participate in a guided nature walk around the green spaces of their school or local trail. Evidence of weathering, erosion, deposition, glaciation and other geologic processes will be observed and discussed.

State standards addressed:

ESS1. Earth's Place in the Universe

6.MS-ESS1-4. Analyze and interpret rock layers and index fossils to determine the relative ages of rock formations that result from processes occurring over long periods of time. Clarification Statements: • Analysis includes laws of superposition and crosscutting relationships limited to minor displacement faults that offset layers. • Processes that occur over long periods of time include changes in rock types through weathering, erosion, heat, and pressure. State Assessment Boundary: • Strata sequences that have been reordered or overturned, names of specific periods or epochs and events within them, or the identification and naming of minerals or rock types are not expected in state assessment.

Grade 7

Lesson: In class lesson on form and function. How animals and plants are adapted for reproduction (45-60 min)

Learning objectives: The students will learn how form and function are related and how plant and animal adaptations help ensure successful reproduction. Examples of materials used in the lesson could include plant parts, flowers, seeds, pollen and the role of pollinators that help plants to reproduce and animal parts and behaviors that help ensure successful reproduction.

Lesson: Guided nature walk (45-60 min)

Learning objectives: The students will participate in a guided nature walk around the green spaces near their school. Evidence of animal behaviors such as courtship rituals, nest building, food collection, and mating rituals will be observed. Plants specialized structures that help promote successful reproduction will be observed, such as bright colors, odors, seed formation and distribution, and animal/plant relationships will be explored.

State standards addressed:

LS1. From Molecules to Organisms: Structures and Processes

7.MS-LS1-4. Construct an explanation based on evidence for how characteristic animal behaviors and specialized plant structures increase the probability of successful reproduction of animals and plants. Clarification Statements: • Examples of animal behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalizations and colorful plumage to attract mates for breeding. • Examples of animal behaviors that affect the probability of plant reproduction could include (a) transferring pollen or seeds and (b) creating conditions for seed germination and growth. • Examples of plant structures that affect the probability of plant reproduction could include bright flowers attracting butterflies that transfer pollen, flower nectar, and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury. State Assessment Boundary: • Natural selection is not expected in state assessment.

Lesson: In class lesson on food chains and food webs and how these relationships impact population size and growth. (45-60 min)

Learning objectives: Students will learn how plants and animals interact in an ecosystem and how changes to any one member of an ecosystem can impact all of the other organisms in an ecosystem. Impact of humans on an ecosystem will be discussed.

Lesson: Guided nature walk (45-60 min)

Learning objectives: Students will participate in a guided nature walk around the green spaces in their school yard or local trail. Students will learn how plants and animals interact in an ecosystem and how changes to any one member of an ecosystem can impact all of the other organisms in an ecosystem. Impact of humans on an ecosystem will be discussed.

State standards addressed:

LS2. Ecosystems: Interactions, Energy, and Dynamics

7.MS-LS2-1. Analyze and interpret data to provide evidence for the effects of periods of abundant and scarce resources on the growth of organisms and the size of populations in an ecosystem.

7.MS-LS2-2. Describe how relationships among and between organisms in an ecosystem can be competitive, predatory, parasitic, and mutually beneficial and that these interactions are found across multiple ecosystems. Clarification Statement: • Emphasis is on describing consistent patterns of interactions in different ecosystems in terms of relationships among and between organisms.

7.MS-LS2-3. Develop a model to describe that matter and energy are transferred among living and nonliving parts of an ecosystem and that both matter and energy are conserved through these processes. Clarification Statements: • Cycling of matter should include the role of photosynthesis, cellular respiration, and decomposition, as well as transfer among producers, consumers (primary, secondary, and tertiary), and decomposers. • Models may include food webs and food chains. State Assessment Boundary: • Cycling of specific atoms (such as carbon or oxygen), or the biochemical steps of photosynthesis, cellular respiration, and decomposition are not expected in state assessment.

7.MS-LS2-4. Analyze data to provide evidence that disruptions (natural or human-made) to any physical or biological component of an ecosystem can lead to shifts in all its populations. Clarification Statement: • Focus should be on ecosystem characteristics varying over time, including disruptions such as hurricanes, floods, wildfires, oil spills, and construction.

7.MS-LS2-5. Evaluate competing design solutions for protecting an ecosystem. Discuss benefits and limitations of each design. * Clarification Statements: • Examples of design solutions could include water, land, and species protection and the prevention of soil erosion. • Examples of design solution constraints could include scientific, economic, and social considerations.

7.MS-LS2-6(MA). Explain how changes to the biodiversity of an ecosystem—the variety of species found in the ecosystem—may limit the availability of resources humans use. Clarification Statement: Examples of resources can include food, energy, medicine, and clean water.

Grade 8

Lesson: In class lesson on structures and processes: Dragon genetics. How environmental and genetic factors influence growth of an organism. (60 – 90 minutes)

Learning objectives: Students will learn about genetics and how traits are passed on from parents to offspring. They will learn about Natural selection, dominant and recessive traits, alleles, homozygous and heterozygous allele pairs, genotypes and phenotypes and how to use a Punnett square to predict probability of traits occurring. Students will work in pairs to "create a dragon". The "parent dragon pairs" will use a coin flip to determine allele pairs for each trait, with heads representing a dominant allele and tails representing a recessive allele. Through extended discussion students will learn how environmental factors and genetic factors impact growth and development of organisms.

State standards addressed:

LS1. From Molecules to Organisms: Structures and Processes

8.MS-LS1-5. Construct an argument based on evidence for how environmental and genetic factors influence the growth of organisms. Clarification Statements: • Examples of environmental conditions could include availability of food, light, space, and water. • Examples of genetic factors could include the genes responsible for size differences in different breeds of dogs, such as Great Danes and Chihuahuas. • Examples of environmental factors could include drought decreasing plant growth, fertilizer increasing plant growth, and fish growing larger in large ponds than they do in small ponds. • Examples of both genetic and environmental factors could include different varieties of plants growing at different rates in different conditions. State Assessment Boundary: • Methods of reproduction, genetic mechanisms, gene regulation, biochemical processes, or natural selection are not expected in state assessment.

LS4. Biological Evolution: Unity and Diversity

8.MS-LS4-4. Use a model to describe the process of natural selection, in which genetic variations of some traits in a population increase some individuals' likelihood of surviving and reproducing in a changing environment. Provide evidence that natural selection occurs over many generations. Clarification Statements: • The model should include simple probability statements and proportional reasoning. • Examples of evidence can include Darwin's finches, necks of giraffes, and peppered moths. State Assessment Boundary: • Specific conditions that lead to natural selection are not expected in state assessment.

8.MS-LS4-5. Synthesize and communicate information about artificial selection, or the ways in which humans have changed the inheritance of desired traits in organisms. Clarification Statement: • Emphasis is on the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, and gene therapy).

High School

Lesson: What contains carbon? (45-60 min)

Learning objectives: Students will be able to recognize that carbon is an extremely common element and can be found in many forms, in both living and non-living things, recognize that carbon moves between the Earth's four spheres (lithosphere, hydrosphere, atmosphere and biosphere), and articulate some ways that carbon impacts us and the earth.

Lesson: Carbon Cycle Role-Play: (45min)

Learning objectives: Students will be able to: recognize that there is a finite amount of carbon on earth, model how carbon moves around in the environment, from one place to another, identify how humans influence the carbon cycle.

Lesson: In class lesson on the carbon cycle and climate change (60 min)

Learning objectives: Students will use a computer model and applet to learn about the carbon cycle and climate change and see how human activity can impact the carbon cycle and climate change. https://galenmckinley.github.io/CarbonCycle/educators/

State standards addressed:

ESS2. Earth's Systems

HS-ESS2-6. Use a model to describe cycling of carbon through the ocean, atmosphere, soil, and biosphere and how increases in carbon dioxide concentrations due to human activity have resulted in atmospheric and climate changes.

Lesson: In class lesson on human impact to climate change (60-90min)

Learning objectives: Students will analyze US government climate action plans and evaluate possible human interactions to mitigate climate change.

https://obamawhitehouse.archives.gov/blog/2015/12/02/enhancing-americas-natural-resources-reduce-impacts-climate-change

https://obamawhitehouse.archives.gov/share/climate-action-plan

State standards addressed:

ESS3. Earth and Human Activity

HS-ESS3-1. Construct an explanation based on evidence for how the availability of key natural resources and changes due to variations in climate have influenced human activity. Clarification Statements: • Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils (such as river deltas), high concentrations of minerals and fossil fuels, and biotic resources (such as fisheries and forests). • Examples of changes due to variations in climate include changes to sea level and regional patterns of temperature and precipitation. 2016 Massachusetts Science and Technology/Engineering Curriculum Framework 71

HS-ESS3-2. Evaluate competing design solutions for minimizing impacts of developing and using energy and mineral resources, and conserving and recycling those resources, based on economic, social, and environmental cost-benefit ratios. * Clarification Statement: • Examples include developing best practices for agricultural soil use, mining (for metals, coal, tar sands, and oil shales), and pumping (for petroleum and natural gas).

HS-ESS3-3. Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity. Clarification Statements: • Examples of factors related to 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 related to human sustainability include agricultural efficiency, levels of conservation, and urban planning. • Examples of factors related to biodiversity include habitat use and fragmentation, and land and resource conservation.

HS-ESS3-5. Analyze results from global climate models to describe how forecasts are made of the current rate of global or regional climate change and associated future impacts to Earth systems. Clarification Statement: • Climate model outputs include both climate changes (such as precipitation and temperature) and associated impacts (such as on sea level, glacial ice volumes, and atmosphere and ocean composition)

Lesson: Guided nature walk (45-60 min)

Learning objectives: Complete a biodiversity study of a specified area around the high school. Have students look for the variety of flora and fauna present in a small section of the school grounds. Discuss the food chains and food webs evident by their data collection. Discuss the relationships within the organisms of the food web, carrying capacity of the area and how energy is transferred through the trophic levels. Have students hypothesize how changes to the ecosystem can impact one or more of the organisms present and what impact this might have on the food web and flow of energy.

State standards addressed:

LS2. Ecosystems: Interactions, Energy, and Dynamics

HS-LS2-1. Analyze data sets to support explanations that biotic and abiotic factors affect ecosystem carrying capacity. Clarification Statements: • Examples of biotic factors could include relationships among individuals (e.g., feeding relationships, symbioses, competition) and disease. • Examples of abiotic factors could include climate and weather conditions, natural disasters, and availability of resources. • Example data sets can be derived from simulations or historical data. 76 2016 Massachusetts Science and Technology/Engineering Curriculum Framework

HS-LS2-2. Use mathematical representations to support explanations that biotic and abiotic factors affect biodiversity, including genetic diversity within a population and species diversity within an ecosystem. Clarification Statements: • Examples of biotic factors could include relationships among individuals (feeding relationships, symbiosis, competition) and disease. • Examples of abiotic factors could include climate and weather conditions, natural disasters, and availability of resources. •

Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.

HS-LS2-4. Use a mathematical model to describe the transfer of energy from one trophic level to another. Explain how the inefficiency of energy transfer between trophic levels affects the relative number of organisms that can be supported at each trophic level and necessitates a constant input of energy from sunlight or inorganic compounds from the environment. Clarification Statement: • The model should illustrate the “10% rule” of energy transfer and show approximate amounts of available energy at each trophic level in an ecosystem (up to five trophic levels).

HS-LS2-5. Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere. Clarification Statements: • The primary forms of carbon include carbon dioxide, hydrocarbons, waste (dead organic matter), and biomass (organic materials of living organisms). • Examples of models could include simulations and mathematical models. State Assessment Boundary: • The specific chemical steps of respiration, decomposition, and combustion are not expected in state assessment.

HS-LS2-6. Analyze data to show ecosystems tend to maintain relatively consistent numbers and types of organisms even when small changes in conditions occur but that extreme fluctuations in conditions may result in a new ecosystem. Construct an argument supported by evidence that ecosystems with greater biodiversity tend to have greater resistance to change and resilience. Clarification Statement: • Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption, fires, the decline or loss of a keystone species, climate changes, ocean acidification, or sea level rise.

HS-LS2-7. Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health. * Clarification Statement: • Examples of solutions can include captive breeding programs, habitat restoration, pollution mitigation, energy conservation, and ecotourism.