

2016 Massachusetts Science Curriculum Frameworks addressed in Harvard Forest Schoolyard Ecology Projects

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Quick Reference List of Relevant Elementary Science Standards: Grades 3-5

3-ESS2-1. Use graphs and tables of local weather data to describe and predict typical weather during a particular season in an area.

3-ESS2-2. Obtain and summarize information about the climate of different regions of the world to illustrate that typical weather conditions over a year vary by region.

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.

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.

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.

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.

3-LS4-5. Provide evidence to support a claim that the survival of a population is dependent upon reproduction.

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.

4-LS1-1. Construct an argument that animals and plants have internal and external structures that support their survival, growth, behavior, and reproduction.

5-ESS1-2. Use a model to communicate Earth's relationship to the Sun, Moon, and other stars that explain (a) why people on Earth experience day and night, (b) patterns in daily changes in length and direction of shadows over a day, and (c) changes in the apparent position of the Sun, Moon, and stars at different times during a day, over a month, and over a year.

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.

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.

Quick Reference List of Relevant Middle School Science Standards

Grades 6-8

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.

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.

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.

8.MS-ESS1-1b. Develop and use a model of the Earth-Sun system to explain the cyclical pattern of seasons, which includes Earth's tilt and differential intensity of sunlight on different areas of Earth across the year.

8.MS-ESS3-5. Examine and interpret data to describe the role that human activities have played in causing the rise in global temperatures over the past century.

8.MS-LS1-5. Construct an argument based on evidence for how environmental and genetic factors influence the growth of organisms.

Quick Reference List of Relevant High School Science Standards

Grades 9-12

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems over different time scales result in changes in climate. Analyze and interpret data to explain that long-term changes in Earth's tilt and orbit result in cycles of climate change such as Ice Ages.

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.

HS-LS1-5. Use a model to illustrate how photosynthesis uses light energy to transform water and carbon dioxide into oxygen and chemical energy stored in the bonds of sugars and other carbohydrates.

HS-LS2-1. Analyze data sets to support explanations that biotic and abiotic factors affect ecosystem carrying capacity.

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.

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.

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.

Quick Reference of Mass. Science Practices Aligned with HF Schoolyard Ecology

Elementary School: Grades 3-5:

(Page 35, 2016 Mass. Science Framework)

3. *Use graphical representations to show differences in organisms' life cycles; develop a model of a wave to communicate wave features; use a particulate model of matter to explain phase changes; identify limitations of models; use a model to test cause and effect relationships.*
4. *Use graphs and tables of weather data to describe and predict typical weather during a season; analyze and interpret maps of Earth's physical features; use data to evaluate and refine design solutions.*
7. *Construct an argument that animals and plants have internal and external structures that support their survival, growth, behavior, and reproduction; distinguish among facts, reasoned judgment based on data, and speculation in an argument.*
8. *Obtain and summarize information about the climate of different regions*

Middle School: Grades 6-8:

(Page 47, Mass. Science Framework)

3. *Examine and interpret data to describe the role human activities have played in the rise of global temperatures over time; construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships; distinguish between causal and correlational relationships in data; consider limitations of data analysis.*

High School: Grades 9-12:

(Page 66, Mass. Science Framework)

2. *Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.*
6. *Apply scientific reasoning, theory, and/or models to link evidence to the claims and assess the extent to which the reasoning and data support the explanation or conclusion.*
7. *Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence and challenging ideas and conclusions, and determining what additional information is required to solve contradictions.*

Connection to the Mass. Frameworks Rationale:

It is important to note that the strongest ways the Schoolyard projects can help meet Mass. State frameworks is by providing a real life context to experience science concepts and practices. The “Rationale” section of the Mass. Frameworks in the Appendix does a good job articulating the importance of providing such contexts in the following excerpt taken from the NRC document that provided the basis for both the current Mass. Framework and the federal Next Generation Science Standards (NGSS):

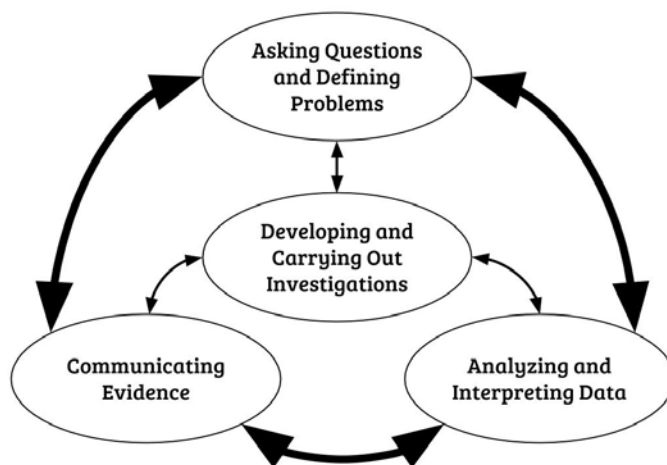
Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science. Participation in these practices also helps students form an understanding of the crosscutting concepts and disciplinary ideas of science and engineering; moreover, it makes students’ knowledge more meaningful and embeds it more deeply into their worldview.^[1]

The actual doing of science or engineering can also pique students’ curiosity, capture their interest, and motivate their continued study; the insights thus gained help them recognize that the work of scientists and engineers is a creative endeavor—one that has deeply affected the world they live in. Students may then recognize that science and engineering can contribute to meeting many of the major challenges that confront society today, such as generating sufficient energy, preventing and treating disease, maintaining supplies of fresh water and food, and addressing climate change.

Any education that focuses predominantly on the detailed products of scientific labor—the facts of science—without developing an understanding of how those facts were established or that ignores the many important applications of science in the world misrepresents science and marginalizes the importance of engineering.

NRC, 2012, pp. 42–43

Also in the *Rationale*, is the following conceptual diagram, which illustrates the points brought out in the previous text.



To see the full rationale including the 8 Scientific Practices that are included in NGSS, see page 96 of the Mass. Science Frameworks.

Many lesson plans and educational resources to support this project are available to teachers on the Harvard Forest website. These concepts and practices are addressed at our Harvard Forest Schoolyard Ecology workshops for teachers. We highly recommend that teachers attend the Summer Institute; Looking at Data; and Spring Workshop at Harvard Forest to succeed in developing curricula that best address the conceptual framework and science practices outlined in the Mass. Frameworks. Aligning Schoolyard project work to the standards will require additional classroom work to make conceptual understanding and practices come into fuller view for the students.

More about Harvard Forest Schoolyard Ecology: Our projects provide a scientific protocol co-developed and guided by professional scientists that encourage student participation in field based scientific investigation in walking distance to schools. Thousands of students in grades 4-12 participate each year in these studies at their school sites. Many classes share their data on our online database. Teachers are supported year round by a Schoolyard Coordinator, Project Ecologist and Data Manager. Introductory sessions are held each August in the Harvard Forest Schoolyard Ecology Summer Institute for teachers. All project protocols and written resources are available free of charge on our website for use by any teacher or group leader. Participating teachers are offered free access to a “Looking at Data” workshop in the fall where they can learn how to graph project data and analyze patterns or stories in the data. Teachers gather again in the Spring Workshop to share how they have integrated project themes in their classrooms and schoolyards as well as learn about seasonal changes related to their projects on a guided woods walk with a project Ecologist.

Links to explore:

HF Schoolyard Research project themes and protocols: <http://harvardforest.fas.harvard.edu/research-projects>

Online database: http://harvardforest2.fas.harvard.edu/asp/hf/php/k12/k12_project.php

School Field-site Maps: <http://harvardforest.fas.harvard.edu/participating-schoolyard-field-sites>

Teacher Workshops: <http://harvardforest.fas.harvard.edu/workshops>

Next Generation Science Standards Links to Harvard Forest Schoolyard Ecology: <http://harvardforest.fas.harvard.edu/sites/harvardforest.fas.harvard.edu/files/Harvard%20Forest%20Schoolyard%20Eco-NGSS%20Connections%202015>