Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Integrating the Boston Harbor Islands national recreation area
With the Boston Public Schools Curriculum

Photo Credit: Jennifer Felicetti

Boston Harbor Islands NRA Connections
to the FOSS Weather and Water Unit
used in the Boston Public Schools Sixth Grade
Science Classrooms

Adapted from FOSS Unit: Weather and Water
by Jennifer Felicetti-Magsino, Dawn Tesorero, Caroline Owens
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Lesson Connections Overview

Students at the middle school level often question how they might impact the community as they are "just kids." This unit offers sixth grade students the opportunity to make a difference as informed stewards to their city neighbors and as protectors to the greater world community and the Earth.

Boston Public Schools serve approximately 57,000 students in 125 different schools (source: http://www.bostonpublicschools.org/files/bps_at_a_glance_12-0419_0.pdf). There are 11,710 middle school students in the 6th-8th grades. Based on these numbers, this curriculum will target 6th grade students. We have the potential to benefit over 3,903 students each year.

The Boston Public School students speak 77 different languages of origin. The top nine first languages of our students are Spanish, Haitian creole, Cape Verdean creole, Chinese, Vietnamese, Portuguese, Somali, French, and Arabic. Many of these languages have origins on islands. As climate change is noted to have a considerable effect on island communities, the Boston Harbor Island lessons presented here allow for a personal connection to these students whose homelands are islands, and therefore subject to a greater impact from climate change.

In the Boston Public Schools, FOSS (Full Option Science System) kits are used to support the teaching of science. FOSS is a research-based science curriculum for grades K–8 developed at the Lawrence Hall of Science, University of California at Berkeley. We adapt lessons from the Weather and Water unit to link to both FOSS and the students' local national park in order to assist students with understanding climate change.

The Boston Harbor Islands are a mystery for many students. These islands are, on average, only three miles from our classrooms, yet they remain unvisited by most of our students and families. The islands in this park belong to them, and these lessons are an attempt at assisting the students to develop and enhance a greater sense of ownership and stewardship.

Our *Weather, Water, and Warming: Boston Harbor Islands Climate Change Connections* will begin with FOSS Lesson 9: Weather and Climate as our overview. Students will take on the role of Boston Harbor Islands Park Meteorology Rangers. As park meteorologists concerned with the effects of Climate Change and Global Warming they will need to develop a strong foundation on the basics of weather, observing its effect on islands like these in our own backyard and then interpreting climate change for themselves. The culminating activity has students sharing their learning with the public at the Boston Harbor Islands Visitors Pavilion.

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Making Connections to the Common Core Standards

Schools nationwide adhere to Common Core Standards for curriculum and learning goals. The math and literacy standards are already in effect; however, science standards are still a long way from completion. With that delay in mind, four additions were made to the literacy standards which aim to specifically address the question of scientific literacy.

In science classes, our students process information from a variety of written sources. Literacy is a crucial component of success. The *Weather, Water, and Warming: Boston Harbor Islands Climate Connections* curriculum is designed to meet the four Common Core Standards of scientific literacy.

From the Common Core Literacy Standards:

Literacy is being able to use the processes of communication to effectively interact with the people and phenomena in our world.

Our students will read and respond to non-fiction writings.

Integration of Knowledge and Ideas

7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

8. Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

9. Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

Range of Reading and Level of Text Complexity

10. Read and comprehend complex literary and informational texts independently and proficiently.

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FOSS Summary

What is FOSS?

FOSS, or Full Option Science System, is a research-based science curriculum for grades K–8 developed at the Lawrence Hall of Science, University of California at Berkeley. FOSS is also an ongoing research project dedicated to improving the learning and teaching of science.

The FOSS project began over 20 years ago, during a time of growing concern that our nation was not providing young students with an adequate science education. The FOSS program materials are designed to meet the challenge of providing meaningful science education for all students in diverse American classrooms and preparing them for life in the 21st century. Development of the FOSS program was, and continues to be, guided by advances in the understanding of how youngsters think and learn.

Science is an active enterprise, made active by our human capacity to think. Scientific knowledge advances when scientists observe objects and events, think about how they relate to what is known, test their ideas in logical ways, and generate explanations that integrate the new information into the established order. Thus the scientific enterprise is both what we know (content) and how we come to know it (process). The best way for students to appreciate the scientific enterprise, learn important scientific concepts, and develop the ability to think critically is to actively construct ideas through their own inquiries, investigations, and analyses. The FOSS program was created to engage students in these processes as they explore the natural world.

There are a number of features that distinguish the FOSS program. These include:

• Research-based and nationally field-tested
FOSS was developed through a rich collaboration of scientists, educational researchers, curriculum developers, assessment specialists, teachers, administrators, community members, and parents. FOSS combines proven teaching strategies with field-tested materials to promote scientific literacy and student achievement.

• Classroom-tested
FOSS is the result of academic research on learning interwoven with practical experiences in classrooms. FOSS helps all educators teach and manage inquiry-based science. The carefully designed instructional sequences and thoroughly tested equipment provide support for teachers with different experience levels in science.

• Students learn science by doing science
FOSS engages students in inquiry. Students construct an understanding of science concepts through their own investigations and analyses, using laboratory equipment, student readings, and interactive technology. Students exercise logical thinking and decision-making skills appropriate to their age level.

• Integrated reading, writing, and mathematics
FOSS helps develop basic skills within the context of learning science through student readings, science journals, student projects, and the use of mathematics to quantify and communicate results of investigations and experiments.

• Assessment system
The FOSS assessment system uses a number of formative and summative strategies to help teachers and students monitor their progress and measure their ability to apply the concepts they have learned. The system includes teacher observations, student sheets, response sheets, student self-assessments, and end-of-module and summative exams. The FOSS assessment system is an ongoing research project at Lawrence Hall of Science.

The development of FOSS has been supported by the National Science Foundation, the University of California at Berkeley, and Delta Education, the FOSS publisher/partner.

A summary of the FOSS Weather and Water curriculum unit can be found at this link:

http://lhsfoss.org/scope/folio/pdfs/Weather_Water.pdf

Source: http://lhsfoss.org/introduction/index.html

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FOSS National Correlation

The following pages outline the National Standards as they relate to the FOSS Curriculum. The full document can be found at this link:

http://lhsfoss.org/scope/correlations/pdfs/NSES5-8_10.23.07.pdf

CATEGORY	STANDARD	CONCEPTS AND PRINCIPLES	Models and Designs	Variables	Levers and Pulleys	Mixtures and Solutions	Solar Energy	Landforms	Food and Nutrition	Environments	Planetary Science	Earth History	Weather and Water	Human Brain and Senses	Diversity of Life	Populations and Ecosystems	Electronics	Chemical Interactions	Force and Motion
SCIENCE AS INQUIRY	ABILITIES NECESSARY TO DO SCIENTIFIC INQUIRY	Identify questions that can be answered through scientific investigations.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Design and conduct a scientific investigation.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Use appropriate tools and techniques to gather, analyze, and interpret data.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Develop descriptions, explanations, predictions, and models using evidence.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Think critically and logically to make the relationships between evidence and explanations.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Recognize and analyze alternative explanations and predictions.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Communicate scientific procedures and explanations.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Use mathematics in all aspects of scientific inquiry.		X	X	X	X		X		X	X	X	X	X	X	X	X	X

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	Understandings about scientific inquiry	Different kinds of questions suggest different kinds of scientific investigations.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Current scientific knowledge and understanding guide scientific investigations. Different scientific domains employ different methods, core theories, and standards to advance scientific knowledge and understanding.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Mathematics is important in all aspects of scientific inquiry.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories. The scientific community accepts and uses such explanations until displaced by better scientific ones.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Science advances through legitimate skepticism. Asking questions and querying other scientists' explanations is part of scientific inquiry.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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		Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data. All of these results can lead to new investigations.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PHYSICAL SCIENCE	**Properties and changes of properties in matter**	A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample. A mixture of substances often can be separated into the original substances using one or more of the characteristic properties.				X													
		Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties.				X												X	
		Chemical elements do not break down…There are more than 100 known elements that combine in a multitude of ways to produce compounds, which account for the living and nonliving substances that we encounter.																X	

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	Motions and Forces	The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.		X															X
		An object that is not being subjected to a force will continue to move at a constant speed and in a straight line.																	X
		If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.			X														X
	Transfer of Energy	Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.					X				X		X	X		X	X	X	X
		Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.					X						X					X	

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		Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object—emitted by or scattered from it—must enter the eye.					X							X					
		Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced.	X														X		
		In most chemical or nuclear reactions, energy is transferred into or out of a system. Heat, light, mechanical motion, or electricity might all be involved in such transfers.														X		X	
		The Sun is a major source of energy for changes on the Earth's surface. The Sun loses energy by emitting light. A tiny fraction of that light reaches the Earth, transferring energy from the Sun to the Earth. The Sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.					X						X			X			

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LIFE SCIENCE	**Structure and function in living systems**	Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include cells, organs, tissues, organ systems, whole organisms, and ecosystems.												X	X	X			
		All organisms are composed of cells—the fundamental unit of life. Most organisms are single cells; other organisms, including humans, are multicellular.													X				
		Cells carry on the many functions needed to sustain life. They grow and divide, thereby producing more cells. This requires that they take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs.													X				

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		Specialized cells perform specialized functions in multicellular organisms. Groups of specialized cells cooperate to form a tissue, such as a muscle. Different tissues are in turn grouped together to form larger functional units, called organs. Each type of cell, tissue, and organ has a distinct structure and set of functions that serve the organism as a whole.												X	X				
		The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control, and coordination, and for protection from disease. These systems interact with one another.							X					X					
		Disease is a breakdown in structures or functions of an organism. Some diseases are the result of intrinsic failures of the system. Others are the result of damage by infection by other organisms.							X					X					

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	Reproduction and Heredity	Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms produce sexually.													X	X			
		In many species, … Sexually produced offspring never are identical to either of their parents.													X	X			
		Every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another.														X			
		Hereditary information is contained in genes, located in the chromosomes of each cell. Each gene carries a single unit of information. An inherited trait of an individual can be determined by one or by many genes, and a single gene can influence more than one trait. A human cell contains many thousands of different genes.														X			

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		The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited and others result from interactions with the environment.														X			
	Regulation and Behavior	All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.								X					X	X			
		Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the range required to survive.																	
		Behavior is one kind of response an organism can make to an internal or environmental stimulus. A behavioral response requires coordination and communication at many levels, including cells, organ systems, and whole organisms. Behavioral response is a set of actions determined in part by heredity and in part from experience.								X				X	X	X			

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		An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species evolutionary history.														X			
	Populations and Ecosystems	A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.														X			
		Populations of organisms can be categorized by the function they serve in an ecosystem…Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.														X			

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		For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.								X						X			
		The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition…														X			
	Diversity and Adaptations of Organisms	Millions of species of animals, plants, and microorganisms are alive today. Although different species might look dissimilar, the unity among organisms becomes apparent from an analysis of internal structures, the similarity of their chemical processes, and the evidence of common ancestry.													X				

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		Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally-occurring variations in populations…														X			
		Extinction of species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the Earth no longer exist.										X				X			

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Earth Science	**Structure of the Earth System**	The solid Earth is layered with a lithosphere; hot, convecting mantle; and dense, metallic core.										X							
		Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geologic events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.										X							
		Landforms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.						X				X							
		Some changes in the solid Earth can be described as the "rock cycle." Old rocks at the Earth's surface weather, forming sediments that are buried, then compacted, heated, and often recrystallized into new rock. Eventually, new rocks may be brought to the surface by forces that drive plate motions, and the rock cycle continues.										X							

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		Soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria. Soils are often found in layers, with each having a different chemical composition and texture.										X							
		Water, which covers the majority of the Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the Earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.					X						X						
		Water is a solvent. As it passes through the water cycle it dissolves minerals and gases and carries them to the oceans.						X				X	X					X	
		The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different properties at different elevations.				X							X						

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		Clouds, formed by the condensation of water vapor, affect weather and climate.											X						
		Global patterns of atmospheric movement influences local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.					X						X						
		Living organisms have played many roles in the earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.										X							
	Earth's History	The earth processes we see today, including erosion, movement of the lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past. Earth history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.									X	X							
		Fossils provide important evidence of how life and environmental conditions have changed.										X							

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	Earth in the Solar System	The Earth is the third planet from the Sun in a system that includes the Moon, the Sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The Sun, an average star, is the central and largest body in the solar system.					X				X								
		Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the Moon, and eclipses.					X												
		Gravity is the force that keeps planets in orbit around the Sun and governs the rest of the motion of the solar system. Gravity alone holds us to the Earth's surface and explains the phenomena of the tides.									X								X
		The Sun is the major source of energy for phenomena on the Earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the Sun's energy hitting the surface, due to the tilt of the Earth's rotation on its axis and the length of the day.					X						X		X				

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Science and Technology	**Abilities of technological design**	Identify appropriate problems for technological design.	X																
		Design a solution or a product.	X	X	X	X	X										X		
		Implement a proposed design.	X	X	X		X										X		
		Evaluate completed technological designs or products.	X	X	X	X	X										X		
		Communicate the process of technological design.	X	X	X	X	X										X		
	Understandings about science and technology	Scientific inquiry and technological design have similarities and differences. Scientists propose explanations for questions about the natural world, and engineers propose solutions relating to human problems, needs, and aspirations.	X	X	X		X	X			X	X	X	X			X		X
		Many different people in different cultures have made and continue to make contributions to science and technology.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Science and technology are reciprocal.	X	X			X				X			X			X		
		Perfectly designed solutions do not exist.																	
		Technological designs have constraints.	X														X		

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		Technological solutions have intended benefits and unintended consequences. Some consequences can be predicted, others cannot.	X														X		
Science in Personal and Social Perspectives	Personal Health	Regular exercise is important to the maintenance and improvement of health.																	
		The potential for accidents and the existence of hazards imposes the need for injury prevention.																	
		The use of tobacco increases the risk of illness.																	
		Alcohol and other drugs are often abused substances. Such drugs change how the body functions and can lead to addiction.												X					
		Food provides energy and nutrients for growth and development.							X							X			
		Sex drive is a natural human function that requires understanding.																	

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		Natural environments may contain substances (for example, radon and lead) that are harmful to human beings. Maintaining environmental health involves establishing or monitoring quality standards of soil, water, and air use.																	
	Populations, Resources, and Environments	When an area becomes overpopulated, the environment will become degraded due to the increased use of resources.														X			
		Causes of environmental degradation and resource depletion vary from region to region and from country to country.								X									
	Natural Hazards	Internal and external processes of the earth system cause natural hazards, events that change or destroy human and wildlife habitats, damage property, and harm or kill humans. Natural hazards include earthquakes, landslides, wildfires, volcanic eruptions, floods, storms, and even possible impacts of asteroids.									X	X	X			X			

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		Human activities also can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal. Such activities can accelerate many natural changes.						X								X			
		Natural hazards can present personal and societal challenges because misidentifying the change or incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much cost for unneeded preventive measures.																	
	Risks and Benefits	Risk analysis considers the type of hazard and estimates the number of people that might be exposed and the number likely to suffer consequences. The results are used to determine the options for reducing or eliminating risks.																	
		Students should understand the risks associated with natural hazards (fires, floods, tornadoes, etc.), with chemical hazards (pollutants in air, water, soil, and food), with biological hazards (pollen, viruses, bacteria, and parasites), social hazards, and with personal hazards.										X	X			X			

CATEGORY	STANDARD	CONCEPTS AND PRINCIPLES	Models and Designs	Variables	Levers and Pulleys	Mixtures and Solutions	Solar Energy	Landforms	Food and Nutrition	Environments	Planetary Science	Earth History	Weather and Water	Human Brain and Senses	Diversity of Life	Populations and Ecosystems	Electronics	Chemical Interactions	Force and Motion
		Individuals can use a systematic approach to thinking critically about risks and benefits.														X			
		Important personal and social decisions are made based on perceptions of benefits and risks.																	
	Science and Technology in Society	Science influences society through its knowledge and world view.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Societal challenges often inspire questions for scientific research, and social priorities often influence research priorities through the availability of funding for research.																	
		Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. etc.															X		
		Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

CATEGORY	STANDARD	CONCEPTS AND PRINCIPLES	Models and Designs	Variables	Levers and Pulleys	Mixtures and Solutions	Solar Energy	Landforms	Food and Nutrition	Environments	Planetary Science	Earth History	Weather and Water	Human Brain and Senses	Diversity of Life	Populations and Ecosystems	Electronics	Chemical Interactions	Force and Motion
		Scientists and engineers work in many different settings, including colleges and universities, businesses and industries, specific research institutes, and government agencies.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Scientists and engineers have ethical codes requiring that human subjects involved with research be fully informed about risks and benefits associated with the research before the individuals choose to participate. etc.																	
		Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Students should understand the difference between scientific and other questions. They should appreciate what science and technology can reasonably contribute to society and what they cannot do.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

CATEGORY	STANDARD	CONCEPTS AND PRINCIPLES	Models and Designs	Variables	Levers and Pulleys	Mixtures and Solutions	Solar Energy	Landforms	Food and Nutrition	Environments	Planetary Science	Earth History	Weather and Water	Human Brain and Senses	Diversity of Life	Populations and Ecosystems	Electronics	Chemical Interactions	Force and Motion
History and Nature of Science	**Science as a human endeavor**	Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields such as the health professions. Some scientists work in teams, and some work alone, but all communicate extensively with others.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Science requires different abilities, depending on such factors as the field of study and type of inquiry. Science is very much a human endeavor...etc.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Nature of Science	Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Etc.		X						X	X					X			X
		In areas where active research is being pursued and in which there is not a great deal of experimental or observational evidence and understanding, it is normal for scientists to differ with one another about the interpretation of the evidence or theory being considered. etc.									X	X							

CATEGORY	STANDARD	CONCEPTS AND PRINCIPLES	Models and Designs	Variables	Levers and Pulleys	Mixtures and Solutions	Solar Energy	Landforms	Food and Nutrition	Environments	Planetary Science	Earth History	Weather and Water	Human Brain and Senses	Diversity of Life	Populations and Ecosystems	Electronics	Chemical Interactions	Force and Motion
		It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists [or students]. etc.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	History of Science	Many individuals have contributed to the traditions of science. Studying some of these individuals provides further understanding of scientific inquiry, science as a human endeavor, the nature of science, and the relationships between science and society.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		In historical perspective, science has been practiced by different individuals in different cultures. In looking at the history of many peoples, one finds that the scientists and engineers of high achievement are considered to be among the most valued contributors to their culture.	X	X		X		X			X								
		Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently take for granted.	X	X						X	X	X	X	X	X	X	X	X	X

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Massachusetts Standards

The following pages outline the FOSS Correlation to the Massachusetts Science and Technology Framework. The full document can be found at this link:

http://www.delta-education.com/science/foss/correlations/Massachusetts.pdf

Massachusetts Science and Technology Curriculum Framework Correlation to Full Option Science System

The following is a correlation of the grades PreK-2, 3-5 and 6-8 portions of the Massachusetts Science and Technology Curriculum Framework to Full Option Science System. This correlation shows <u>representative</u> examples of investigations and activities from the FOSS program which address the Science and Technology Content Standards. A citation does not include all of the investigations or activities from FOSS that might address a particular standard.

Where possible, the examples listed for Grades PreK-2 and 3-5 sections of the Strands 1-3 correlation include the suggested technology extensions.

The examples of FOSS investigations cited below for Grades 6-8 are from FOSS modules developed for grades 5-6 and from the FOSS Middle School modules developed for Grades 6-8.

February 2005
Updated July 2008
Updated October 2008

Earth and Space Sciences Grades 6-8 Learning Standards

Note: The FOSS modules referenced with page numbers in the Grades 6-8 section are those developed in the original FOSS program for grades 5 and 6 as well as the eight FOSS Middle School modules currently available. Eventually there will be nine FOSS Middle School Modules: Planetary Science, Human Brain and Senses, Earth History, Electronics, Diversity of Life, Weather and Water, Populations and Ecosystems, Chemical Interactions, and Force and Motion. FOSS Middle School Modules in late stages of field-testing (likely to be available within the next few years) will be referenced in italics as their correlation seems appropriate.

Mapping the Earth

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
1. Recognize, interpret, and be able to create models of the earth's common physical features in various mapping representations, including contour maps.	Landforms, Investigation 1, Parts 1-3 Investigation 2, Parts 1-2 Investigation 4, Parts 1-3 *Landforms FOSS Science Stories* Earth History, Investigation 3, Parts 1-3 Investigation 4, Part 3 *Earth History Resources student book*	 Pages 8-24 Pages 8-22 Pages 8-24 *Pages 33-36* Pages 88-107 Pages 138-146 *Pages 100-105*

Earth's Structure

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
2. Describe the layers of the solid earth, incl. the lithosphere, the hot convecting mantle, and the dense metallic core.	*Landforms FOSS Science Stories* *Earth History Resources student book*	*Pages 27-34* *Pages 100-105*

Heat Transfer in the Earth System

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
3. Differentiate among radiation, conduction, and convection, the three mechanisms by which heat is transferred through the earth's system.	Solar Energy Investigation 2, Parts 1-2 Investigation 4, Parts 1-3 WWW.FOSSWEB.com Solar Energy Water Planet, Investigation 3, Parts 1-2 *Water Planet FOSS Science Stories* Weather and Water Investigation 4, Parts 1-2 Investigation 5, Parts 1-3 *Weather and Water Resources student book*	 Pages 8-24 Pages 8-28 Movie Clips, How Weather Occurs Pages 125-144 *Pages 42-51* Pages 121-139 Pages 152-174 *Pages 22-26, 32-33*

4. Explain the relationship among the energy provided by the sun, the global patterns of atmospheric movement, and the temperature differences among water, land, and atmosphere.	Solar Energy Investigation 2, Parts 1-2 Investigation 3, Parts 1-2 *Solar Energy FOSS Science Stories* Water Planet, Investigation 3, Part 2 *Water Planet FOSS Science Stories* Weather and Water Investigation 3, Parts 1-3 Investigation 9, Part 3 *Weather and Water Resources* student book	Pages 8-24 Pages 8-23 *Pages 1-3,16-17, 22-25* Pages 136-144 *Pages 46-51* Pages 93-110 Pages 311-314 *Pages 22-24*

Earth's History

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
5. Describe how movement of the earth's crustal plates causes both slow changes in the earth's surface (e.g. formation of mountains and ocean basins), and rapid ones (e.g. volcanic eruptions and earthquakes).	*Landforms FOSS Science Stories* *Earth History Resources* student book	*Pages 22-25, 30-32* *Pages 100-105*
6. Describe and give examples of ways in which the earth's surface is built up and torn down by natural processes, including deposition of sediments, rock formation, erosion, and weathering.	Landforms, Investigation 2, Parts 1-2 *Landforms FOSS Science Stories* Earth History, Investigation 4, Parts 1-6 Investigation 8, Parts 1-3 *Earth History Resources* student book	Pages 8-22 and *Pages 15-21,28-29* Pages 113-163 Pages 266-269 *Pages 64-75-78, 81-83*
7. Explain and give ex. of how physical evidence, such as fossils and surface features of glaciation, supports theories that earth has evolved over geologic time.	Earth History, Investigation 7, Parts 1-2 *Earth History Resources* student book	Pages 227-244 *Pages 76-88,95-97*

Earth and Space

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
8. Recognize that gravity is a force that pulls all things on and near the earth toward the center of the earth. Gravity plays a major role in the formation of planets, stars and solar system and in	*Models and Designs FOSS Science Stories* *Solar Energy FOSS Science Stories* Water Planet, Investigation 1, Part 2	*Pages 5-10* *Pages 40-44* Pages 59-66

Life Sciences Grades 6-8 Learning Standards

The FOSS modules referenced with page numbers in the Grades 6-8 section are those developed in the original FOSS program for grades 5 and 6 as well as the eight FOSS Middle School modules currently available. Eventually there will be nine FOSS Middle School Courses: Planetary Science, Human Brain and Senses, Earth History, Electronics, Diversity of Life, Weather and Water, Populations and Ecosystems, Chemical Interactions, and Force and Motion. FOSS Middle School Modules in late stages of field-testing (likely to be available within the next few years) will be referenced in italics as their correlation seems appropriate.

Classification of Organisms

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
1. Classify organisms into the currently recognized kingdoms according to characteristics that they share. Be familiar with organisms from each kingdom.	Living Systems, Investigation 1, Part 1 *Living Systems FOSS Science Stories* Diversity of Life Investigation 3, Part 2 Investigation 4, Parts 1-2 Investigation 10, Parts 1-3 *Diversity of Life Resources student book*	Pages 51-57 *Pages 1-3* Pages 108-115 Pages 133-141 Pages 302-321 *Pages 17, 24-30, 65-70*

Cells and Systems

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
2. Recognize that all organisms are composed of cells, and that many organisms are single-celled (unicellular), e.g., bacteria, yeast. In these single-celled organisms, one cell must carry out all the basic functions of life.	*Food and Nutrition FOSS Science Stories* Diversity of Life Investigation 3, Parts 1-3 Investigation 4, Parts 1-2 Investigation 10, Parts 1-3 *Diversity of Life Resources student book* Diversity of Life CD-ROM	*Pages 41-43* Pages 102-122 Pages 133-141 Pages 302-321 *Pages 8, 9, 24-30* "Ribbon of Life"
3. Compare and contrast plant and animal cells, including major organelles (cell membrane, cell wall, nucleus, cytoplasm, chloroplasts, mitochondria, vacuoles).	Diversity of Life Investigation 3, Parts 1-3 Investigation 4, Parts 1-2 *Diversity of Life Resources student book* Diversity of Life CD-ROM	Pages 102-122 Pages 133-141 *Pages 24-26, 27-30, 37* "Ribbon of Life"
4. Recognize that within cells, many of the basic functions of organisms (e.g., extracting energy from food and getting rid of waste) are carried out. The way in which cells function is similar in all living organisms.	*Food and Nutrition FOSS Science Stories* Diversity of Life Investigation 3, Parts 2-3 Investigation 4, Part 2 Diversity of Life CD-ROM *Diversity of Life Resources* student book	*Pages 41-43* Pages 108-122 Pages 137-139 "Ribbon of Life" *Pages 21-30, 35-38*

Systems in Living Things

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
5. Describe the hierarchical organization of multicellular organisms from cells to tissues to organs to systems to organisms.	Living Systems, Investigation 1, Parts 1-3 *Living Systems FOSS Science Stories* Diversity of Life Investigation 4, Part 2 Diversity of Life CD-ROM Human Brain and Senses, Investigation 8, Parts 1-2 *Human Brain and Senses Resources* student book	Pages 51-70 *Pages 1-13* Pages 137 – 139 "Ribbon of Life" Pages 240-253 *Pages 29-30, 36-38, 45-46, 57-79*
6.Identify the general functions of the major systems of the human body (digestion, respiration, reproduction, circulation, excretion, protection from disease, and movement, control and coordination) and describe ways that these systems interact with each other.	*Food and Nutrition FOSS Science Stories* Human Brain and Senses Investigation 2, Parts 1-3 Investigation 7, Parts 1-3 Investigation 8, Parts 1-2 *Human Brain and Senses Resources* student book Living Systems, Investigation 1, Parts 1-3 *Living Systems FOSS Science Stories* *Note: skeletal and muscular systems are addressed thoroughly in the FOSS Grade 3-4 module Human Body.*	*Pages 6-9,15-20,44-50* Pages 67-84 Pages 210-230 Pages 240-252 *Pages 29-30, 43-46, 57-79* Pages 51-70 *Pages 2-13*

Reproduction and Heredity

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
7. Recognize that every organism requires a set of instructions that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another.	*Models and Designs FOSS Science Stories* Populations and Ecosystems Investigation 9, Parts 1-4 *Populations and Ecosystems Resources* student book	*Pages 4* Pages 262-291 *Pages 46-63*
8. Recognize that hereditary information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes.	Populations and Ecosystems Investigation 9, Parts 1-4 *Populations and Ecosystems Resources* student book	Pages 262-291 *Pages 46-63*

9. Compare sexual reproduction (offspring inherit half of their genes from each parent) with asexual reproduction (offspring is an identical copy of the parent's cell).	*Diversity of Life Resources* student book *Populations and Ecosystems Resources* student book	*Pages 26,40-45,53-54, 61-62* *Pages 52-54*

Evolution and Biodiversity

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
10. Give examples of ways in which genetic variation and environmental factors are causes of evolution and the diversity of organisms.	*Environments FOSS Science Stories* *Diversity of Life Resources* *Earth History Resources* Populations and Ecosystems Investigation 8, Parts 1-2 Investigation 10, Parts 1-3 *Populations and Ecosystems Resources* student book	*Pages 9-17, 49-52* *Pages 28-30,35-39,60-64* *Pages 64-67* Pages 228-244 Pages 293-317 *Pages 31-45, 58-61*
11.Recognize that evidence drawn from geology, fossils, and comparative anatomy provide the basis for the theory of evolution.	*Models and Designs FOSS Science Stories* *Diversity of Life Resources* *Earth History Resources* Populations and Ecosystems Investigation 8, Parts 1-2 Investigation 10, Parts 1-3 *Populations and Ecosystems Resources* student book	*Pages 11-16* *Pages 27-30, 66-70* *Pages 37-41,68-71,73-88* Pages 228-244 Pages 293-317 *Pages 42-45, 58-61*
12. Relate the extinction of species to a mismatch of adaptation and the environment.	Populations and Ecosystems Investigation 8, Parts 1-2 Investigation 10, Parts 1-3 *Populations and Ecosystems Resources* student book	Pages 228-244 Pages 293-317 *Pages 22-23, 42-45, 58-61*

Living Things and Their Environment

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
13. Give examples of ways in which organisms interact and have different functions within an ecosystem that enable the ecosystem to survive.	Environments Investigation 2, Part 4 Investigation 4, Parts 1-3 *Environments FOSS Science Stories* Diversity of Life Investigation 7, Part 2 *Diversity of Life Resources* Populations and Ecosystems Investigation 3, Parts 1-3 Investigation 4, Parts 1-2 Investigation 7, Part 1 *Populations and Ecosystems*	Pages 26-32 Pages 8-22 *Pages 1-8,9-17,27-35,38-45, 53-55* Pages 224-229 *Pages 40-50* Pages 90-107 Pages 119-129 Pages 210-218

	Resources student book	Pages 6-7, 14-31

Energy and Living Things

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
14. Explain the roles and relationships among producers, consumers, and decomposers in the process of energy transfer in a food web.	Environments, Investigation 4, Part 3 *Environments FOSS Science Stories* *Diversity of Life Resources* Populations and Ecosystems Investigation 3, Parts 1-3 Investigation 4, Parts 1-2 Investigation 5, Parts 1-4 Investigation 7, Part 1 *Populations and Ecosystems Resources* student book	Pages 19-22 *Pages 6,28,39-41,43-44* *Pages 36-39* Pages 90-107 Pages 119-129 Pages 142-170 Pages 210-218 *Pages 14-24, 64-68*
15. Explain how dead plants and animals are broken down by other living organisms and how this process contributes to the system as a whole.	*Environments FOSS Science Stories* Diversity of Life Investigation 10, Parts 1-3 *Diversity of Life Resources* Populations and Ecosystems Investigation 3, Part 3 Investigation 4, Parts 1-2 Investigation 5, Parts 1-4 *Populations and Ecosystems Resources* student book	*Pages 38-41* Pages 302-321 *Pages 65-70* Pages 104-108 Pages 142-170 Pages 119-130 *Pages 14-24, 64-68*
16. Recognize that producers (plants that contain chlorophyll) use the energy from sunlight to make sugars from carbon dioxide and water through a process called photosynthesis. This food can be used immediately, stored for later use, or used by other organisms.	Living Systems, Investigation 3, Parts 1-2 *Living Systems FOSS Science Stories* Environments Investigation 4, Part 3 *Environments FOSS Science Stories* *Food and Nutrition FOSS Science Stories* *Solar Energy FOSS Science Stories,* *Diversity of Life Resources* Populations and Ecosystems Investigation 5, Parts 1-4 *Populations and Ecosystems Resources* student book	Pages 118-135 *Page 31-36, 47-48* Pages 19-22 *Pages 39-41* *Pages 41-43* *Page 1* *Pages 36-39* Pages 119-130 *Pages 14-24*

Changes in Ecosystems over Time

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
17. Identify ways in which ecosystems have changed throughout geologic time in response to physical conditions, interactions among organisms, and the actions of humans. Describe how changes may be catastrophes such as volcanic eruptions or ice storms.	Environments, Investigation 3, Parts 1-3 Investigation 5, Parts 1-3 *Environments FOSS Science Stories* *Earth History Resources* Populations and Ecosystems Investigation 6, Parts 1-3 *Populations and Ecosystems Resources student book*	 Pages 8-22 Pages 8-22 *Pages 39-42, 43-45, 49-52* *Pages64-67, 81-86, 100-105* Pages179-198 *Pages 25-31*
18. Recognize that biological evolution accounts for the diversity of species developed through gradual processes over many generations.	*Diversity of Life Resources* *Note: the Diversity of Life module introduces students to the vast diversity of species that exist on earth. Information about biological evolution is found mostly in the Scientific and Historical Background of the teacher guide.* Populations and Ecosystems Investigation 8, Parts 1-2 Investigation 10, Parts 1-3	*Pages 31-39,60-64* Pages 228-244 Pages 293-317

Physical Sciences
Grades 6-8 Learning Standards

The FOSS modules referenced with page numbers in the Grades 6-8 section are those developed in the original FOSS program for grades 5 and 6 as well as the eight FOSS Middle School modules currently available. Eventually there will be nine FOSS Middle School Courses: Planetary Science, Human Brain and Senses, Earth History, Electronics, Diversity of Life, Weather and Water, Populations and Ecosystems, Chemical Interactions, and Force and Motion. FOSS Middle School Modules in late stages of field-testing (likely to be available within the next few years) will be referenced in italics as their correlation seems appropriate.

Properties of Matter

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
1. Differentiate between weight and mass, recognizing that weight is the amount of gravitational pull on an object.	Levers and Pulleys Investigation 1, Parts 1-3 Mixtures and Solutions Investigation 2, Parts 1-4 Force and Motion Investigation 7 Part 1 Planetary Science Investigation 5, Part 3	 Pages 8-28 Pages 8-28 Pages256-261 Pages 164-167
2. Differentiate between volume and mass. Define density.	Mixtures and Solutions, Investigation 1, Part 2 Investigation 2, Parts 1-4 Food and Nutrition, Investigation 2, Parts 1-3 Planetary Science Investigation 8, Parts 3-4 Weather and Water Investigation 5, Part 1 *Weather and Water Resources* student book *Note: volume and mass are also defined and studied in great detail in the Grades 3-4 module Measurement.*	 Pages 16-20 Pages 8-28 Pages 8-25 Pages 260-270 Pages 152-162 *Pages 27-31*
3. Recognize that the measurement of volume and mass requires understanding of the sensitivity of measurement tools (e.g. rulers, graduated cylinders, balances) and knowledge and appropriate use of digits.	Mixtures and Solutions, Investigation 2, Parts 1-4 Variables Investigation 2, Parts 1-3 *Variables FOSS Science Stories* Food and Nutrition, Investigation 1, Part 1 Investigation 2, Parts 1-3 Living Systems, Investigation 2, Part 1 Investigation 3, Parts 2-3	 Pages 8-28 Pages 8-27 Pages 10-14 Pages 8-15 Pages 8-25 Pages 85-98 Pages 126-141

	Planetary Science Investigation 8, Parts 3-4 Weather and Water Investigation 5, Part 1	 Pages 260-270 Pages 152-162
4. Explain and give examples of how mass is conserved in a closed system.	Mixtures and Solutions Investigation 2, Parts 1-3 *Weather and Water* *Resources* student book *Chemical Interactions* *Resources* student book	 Pages 8-25 *Pages 45-47* *Pages 63-67, 71*

Elements, Compounds, and Mixtures

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
5. Recognize that there are more than 100 elements that combine in a multitude of ways to produce compounds that make up all of the living and nonliving things that we encounter.	*Mixtures and Solutions FOSS Science Stories* Chemical Interactions Investigation 2, Parts 1-2 *Chemical Interactions* *Resources student book*	*Pages 3-6, 23-24, 32-42* Pages 70-80 *Pages 3-13, 63-67, 73-77*
6. Differentiate between an atom (the smallest unit of an element that maintains the characteristics of that element) and a molecule (the smallest unit of a compound that maintains the characteristics of that compound).	Mixtures and Solutions Investigation 1, Parts 1-4 *Mixtures and Solutions FOSS Science Stories* Chemical Interactions Investigation 9, Parts 1-4 Investigation 10, Parts 1-2 *Chemical Interactions* *Resources student book* *Video: Atoms and Molecules*	 Pages 8-29 *Pages 25-28* Pages 280-312 Pages 323-336 *Pages 63-67*
7. Give basic examples of elements and compounds.	Mixtures and Solutions Investigation 2, Parts 1-4 *Mixtures and Solutions FOSS Science Stories* Chemical Interactions Investigation 2, Parts 1-2 Investigation 9, Parts 1-4 Investigation 10, Parts 1-2 *Chemical Interactions* *Resources student book*	Pages 8-29 *Pages 3-6, 7-8, 11-12, 25-28* Pages 70-80 Pages 280-312 Pages 323-336 Pages 3-13, 63-67, 73-77
8. Differentiate between mixtures and pure substances.	Mixtures and Solutions Investigation 1, Parts 1-4 (Note: the investigations and readings from the entire module reinforce the concept.) Chemical Interactions Investigation 1, Parts 1-2 Investigation 2, Parts 1-2 Investigation 8, Part 1 Investigation 9, Parts 1-4 *Chemical Interactions*	Pages 8-29 Pages 41-58 Pages 70-80 Pages 248-255 Pages 280-312

	Resources student book	*Pages 1-13, 49-53, 63-67*
9. Recognize that a substance (element or compound) has a melting point and a boiling point, both of which are independent of the amount of the sample.	Chemical Interactions Investigation 6 Investigation 7, Parts 1-4 *Chemical Interactions Resources student book*	 Pages 178-187 Pages 204-228 *Pages 44-48*
10. Differentiate between physical changes and chemical changes.	Mixtures and Solutions Investigation 1, Parts 1-4 Investigation 4, Parts 1-3 *Mixtures and Solutions FOSS Science Stories* Food and Nutrition Investigation 2, Parts 1-3 Earth History Investigation 5, Parts 1-3 Investigation 8, Parts 1-2 *Earth History Resources* student book Chemical Interactions Investigation 1, Parts 1-2 Investigation 4, Parts 1-3 Investigation 5, Part 1 Investigation 7, Parts 1-5 Investigation 8, Parts 1-3 Investigation 9, Parts 1-4 Investigation 10, Parts 1-2 *Chemical Interactions Resources student book*	 Pages 8-29 Pages 8-24 *Pages 1-4, 23-28* Pages 8-25 Pages 175-187 Pages 254-265 *Pages 81-82, 89-97* Pages 41-58 Pages 122-141 Pages 153-158 Pages 204-234 Pages 248-268 Pages 280-312 Pages 323-336 *Pages 49-53, 63-67*

Motion

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
11. Explain and give examples of how the motion of an object can be described by its position, direction of motion, and speed.	Levers and Pulleys, Investigation 3, Part 1-2 Models and Designs Investigation 3, Parts 1-3 and Math Extensions Force and Motion Investigations 1-5 *Force and Motion Resources* student book Planetary Science, Investigation 3, Part 4 Investigation 7, Parts 2-4 *Planetary Science Resources* student book	Pages 8-20 Pages 8-25 Pages 37-155 *Pages 3-6, 17-19, 27-35* Pages 105-110 Pages 222-235 *Pages 97-100*
12. Graph and interpret distance vs. time graphs for	Levers and Pulleys, Investigation 1, Part 2 Models and Designs	Pages 18-23

constant speed.	Investigation 3, Parts 1-3 Variables Investigation 3, Part 4 Force and Motion Investigations 2-4 *Force and Motion Resources* student book	Pages 8-25, Math Ext. Page 31, Math Ext. Pages 67-155 *Pages 17-19, 27-35*

Forms of Energy

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
13. Differentiate between potential and kinetic energy. Identify situations where kinetic energy is transformed into potential energy and vice versa.	*Weather and Water Resources* student book	*Pages 22-26*

Heat Energy

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
14. Recognize that heat is a form of energy and that temperature change results from adding or taking away heat from a system.	Solar Energy, Investigation 2, Parts 1-2 Investigation 3, Parts 1-2 *Solar Energy FOSS Science Stories,* Weather and Water Investigation 4, Parts 1-2 *Weather and Water Resources* student book Chemical Interactions Investigation 5, Parts 1, 3 Investigation 6 Investigation 7, Parts 1-5 *Chemical Interactions Resources student book*	 Pages 8-24 Pages 8-23 *Pages 1-5, 16-34* Pages 125-139 *Pages 22-26* Pages 153-158, 165-171 Pages 178-187 Pages 204-234 *Pages 32-48*
15. Explain the effect of heat on particle motion through a description of what happens to particles during a change of phase.	*Weather and Water Resources* student book Chemical Interactions Investigation 5, Part 2 Investigation 7, Parts 2-5 *Chemical Interactions Resources student book* *Video: Particles in Solid, Liquid and Gas*	*Pages 22-26* Pages 159-164 Pages 210-234 *Pages 18-27, 32-48*

16. Give examples of how heat moves in predictable ways, moving from warmer objects to cooler ones until they reach equilibrium.	Solar Energy, Investigation 2, Parts 1-2 Investigation 4, Parts 1-3 Weather and Water Investigation 4, Part 2 *Weather and Water Resources* student book Chemical Interactions Investigation 5, Part 1	 Pages 8-24 Pages 8-33 Pages 132-139 *Pages 22-26* Pages 153-158

Technology/Engineering

Grades 6-8 Learning Standards

The FOSS modules referenced with page numbers in the Grades 6-8 section are those developed in the original FOSS program for grades 5 and 6 as well as the eight FOSS Middle School modules currently available. Eventually there will be nine FOSS Middle School Courses: Planetary Science, Human Brain and Senses, Earth History, Electronics, Diversity of Life, Weather and Water, Populations and Ecosystems, Chemical Interactions, and Force and Motion. FOSS Middle School Modules in late stages of field-testing (likely to be available within the next few years) will be referenced in italics as their correlation seems appropriate.

1. Materials, Tools, and Machines

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
1.1 Given a design task, identify appropriate materials (e.g., wood, paper, plastic, aggregates, ceramics, metals, solvents, adhesives) based upon specific properties and characteristics (e.g., weight, strength, hardness, and flexibility).	Models and Designs Investigation 4, Parts 1-2 *Models and Designs FOSS Science Stories* Solar Energy Investigation 4, Parts 1-4 *Solar Energy FOSS Science Stories* Human Brain and Senses Investigation 3, Parts 1-3 Electronics Investigation 5, Part 3 *Force and Motion Resources* student book	 Pages 6-15 *Pages 23-28, 44-47, 52-55* Pages 8-33 *Pages 16-17, 29-39* Pages 92-110 Pages 171-174 Pages 41-49
1.2 Identify and explain appropriate measuring tools, hand tools, and power tools used to hold, lift, carry, fasten, and separate, and explain their safe and proper use.	*Levers and Pulleys FOSS Science Stories* Mixtures and Solutions Investigation 1, Parts 1-4 Investigation 3, Parts 2-3 Variables, Investigation 2, Parts 1-3 Investigation 4, Parts 1-3 Electronics Investigation 2, Part 3	*Pages 1-27* Pages 8-29 Pages 15-24 Pages 8-28 l Pages 8-23 Pages 99-103
1.3 Identify and explain the safe and proper use of measuring tools, hand tools, and machines (e.g., band saw, drill press, sanders, hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) needed to construct a prototype of an engineering design.	*Note: safety guidelines are provided in the Teacher Manual for ALL FOSS Investigations and also in Safety Posters included in each kit. Students construct structures in many FOSS modules.* *See for example:* Models and Designs Investigation 4, Parts 1-2 Variables, Investigation 2, Parts 1-3 Investigation 4, Parts 1-3	 Pages 6-15 Pages 8-28 Pages 8-23

2. Engineering Design

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
2.1 Identify and explain the steps of the engineering design process, i.e. identify the need or the problem, research the problem, develop possible solutions, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s), and redesign.	Models and Designs Investigation 2, Parts 1-2 Investigation 3, Parts 1-3 Investigation 4, Parts 1-3 Solar Energy Investigation 4, Parts 1-4 Electronics Investigation 9, Part 2 *Force and Motion Resources* student book Human Brain and Senses Investigation 9, Parts 1-2 Planetary Science Investigation 5, Parts 1-5	 Pages 8-24 Pages 8-23 Pages 6-20 Pages 8-33 Pages 284-297 *Pages 41-49* Pages 264-275 Pages 154-174
2.2 Demonstrate methods of representing solutions to a design problem, e.g., sketches, orthographic projections, multiview drawings.	Environments Investigation 1, Part 1 Landforms Investigation 3, Part 3 Models and Designs Investigation 2, Parts 1-2 Investigation 4, Parts 1-3 Solar Energy Investigation 4, Parts 1-4 *Variables FOSS Science Stories* Electronics Investigation 5, Parts 1-3 Human Brain and Senses Investigation 3, Part 3 Planetary Science Investigation 2, Parts 1-2	 Pages 8-15 Pages 20-27 Pages 8-24 Pages 6-20 Pages 8-33 *Pages 18-20, 32-33* Pages 161-174 Pages 106-110 Pages 64-77
2.3 Describe and explain the purpose of a given prototype.	*Models and Designs FOSS Science Stories* *Force and Motion Resources* student book *Note: this standard is not addressed in these specific terms, but students document their design process in lab notebooks and presentations both in classroom design experiences (such as the humdinger) and in end of module projects suggested for every Grade 5-6 FOSS Module.*	*Page 28* *Pages 41-49*
2.4 Identify appropriate materials, tools, and machines needed to construct a prototype of a given engineering design.	Models and Designs Investigation 2, Parts 1-2 Investigation 4, Parts 1-3 Solar Energy Investigation 4, Parts 1-4 *Force and Motion Resources* student book	 Pages 8-24 Pages 6-20 Pages 8-33 *Pages 41-49*

2.5 Explain how such design features as size, weight, shape, function, and cost limitations would affect the construction of a given prototype.	Models and Designs Investigation 4, Parts 1-3 Solar Energy Investigation 4, Parts 1-4	Pages 6-20 Pages 8-36
2.6 Identify the five elements of a universal systems model: goal, inputs, processes, outputs, and feedback.	*Models and Designs FOSS Science Stories*	*Pages 1-10 (discusses engineering and technology and even models and systems, but not the "universal system model")*

3. Communication Technologies

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
3.1 Identify and explain the components of a communication system, i.e. source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination.	Electronics, Investigation 4, Part 2 *Electronics Resources* student book *Planetary Science Resources* student book *Human Brain snd Senses Resources* student book	Pages 149-152 *Pages 34-36* *Pages 74-77, 90-96* *Pages 59-79*
3.2 Identify and explain the appropriate tools, machines, and electronic devices (e.g. drawing tools, computer-aided design, and cameras) used to produce and/or reproduce design solutions (e.g., engineering drawings, prototypes, and reports).	*Force and Motions Resources* student book	*Pages 41-49*
3.3 Identify and compare communication technologies and systems, i.e. audio, visual, printed, and mass communication.	Electronics, Investigation 4, Part 2 *Electronics Resources* student book	Pages 149-152 *Pages 34-36*
3.4 Identify and explain how symbols and icons (e.g., international symbols and graphics) are used to communicate a message.	*Mixtures and Solutions FOSS Science Stories* *Electronic Resources* student book *Planetary Science Resources* student book	*Pages 6. 32-37* *Page 3* *Pages 74-77, 90-96*

4. Manufacturing Technologies

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
4.1 Describe and explain the manufacturing systems of custom and mass production.	*Models and Designs FOSS Science Stories* *Electronics Resources*	*Pages 25-36* *Pages 18-21*

4.2 Explain and give examples of the impacts of interchangeable parts, components of mass-produced products, and the use of automation, e.g., robotics.	*Models and Designs FOSS Science Stories* *Electronics Resources*	*Pages 25-36* *Pages 18-21*
4.3 Describe a manufacturing organization, e.g., corporate structure, research and development, production, marketing, quality control, distribution.		
4.4 Explain basic processes in manufacturing systems, e.g., cutting, shaping, assembling, joining, finishing, quality control, and safety.	*Models and Designs FOSS Science Stories* *Electronics Resources*	*Pages 23-24* *Pages 18-21*

5. Construction Technologies

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
5.1 Describe and explain parts of a structure, e.g., foundation, flooring, decking, call, roofing systems.	Solar Energy Investigation 4, Parts 1-4	Pages 8-36
5.2 Identify and describe three major types of bridges (e.g., arch, beam, and suspension) and their appropriate uses (e.g., site, span, resources, load).		
5.3 Explain how the forces of tension, compression, torsion, bending, and shear affect the performance of bridges.		
5.4 Describe and explain the effects of loads and structural shapes on bridges.		

6. Transportation Technologies

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
6.1 Identify and compare examples of transportation systems and devices that operate on each of the following: land, air, water, and space.	*Levers and Pulleys FOSS Science Stories* Variables, Investigation 3, Parts 1-3 *Variables FOSS Science Stories* Models and Designs Investigation 3, Parts 1-3 *Models and Designs FOSS Science Stories* *Force and Motion Resources* student book Planetary Science Investigation 7, Parts 1-5	*Pages 9, 23-25* Pages 8-23 *Pages 15-33* Pages 8-23 *Pages 17-40, 44-47* *Pages 3-16, 27-35* Pages 207-238

6.2 Given a transportation problem, explain a possible solution using the universal systems model.	Planetary Science Investigation 7, Parts 1-5 *Models and Designs FOSS Science Stories*	Pages 207-238 (Students design a way to get to the moon, but "universal systems model" is not specifically mentioned.) *Pages 17-19, 25-40 explore issues in transportation, and even models and systems, but not the "universal system model")*
6.3 Identify and describe three subsystems of a transportation vehicle or device, i.e. structural, propulsion, guidance, suspension, control, and support.	Variables, Investigation 3, Parts 1-4 *Models and Designs FOSS Science Stories*	Pages 8-27 FOSS *Pages 25-28, 44-47*
6.4 Identify and explain lift, drag, friction, thrust, and gravity in a vehicle or device, e.g., cars, boats, airplanes, rockets.	*Variables FOSS Science Stories* Force and Motion Investigation 6, Parts 2-4 *Force and Motion CDRom*	*Pages 15-33,38* Pages 229-245 *Force Bench*

7. Bioengineering Technologies

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
7.1 Explain examples of adaptive or assistive devices, e.g., prosthetic devices, wheelchairs, eyeglasses, grab bars, hearing aids, lifts, braces.	Human Brain and Senses, Investigation 3, Parts 1-2 *Human Brain and Senses Resources* and *Human Brain and Senses CD-ROM* *Note: Hearing aids are discussed in the Grades 3-4 module Physics of Sound.*	Pages 92-105 *Pages 25-28, 34-35*
7.2 Describe and explain adaptive and assistive bioengineered products, e.g., food, bio-fuels, irradiation, integrated pest management.	*Environments FOSS Science Stories*	*Pages 46-49*

Inquiry Grades 6-8 Learning Standards

Lifelong learners are able to use the methods of inquiry to participate in scientific investigation and technological problem solving.

LEARNING STANDARDS Grades 6-8	***FOSS INVESTIGATION/ ACTIVITY***	***PAGE NUMBER(S)***
1. Design an investigation or problem, specifying variables, to be changed, controlled, and measured	Mixtures and Solutions Investigation 1, Part 4 Variables Investigation 4, Parts 1-3 Environments Investigation 6, Part 1 Levers and Pulleys Investigation 4, Parts 1-2 Water Planet, Investigation 3, Part 1 Planetary Science Investigation 5, Parts 1-4 Electronics Investigation 5, Part 3 Force and Motion Investigation 8, Part 2 Weather and Water Investigation 2, Part 2	 Pages 25-29 Pages 8-23 Pages 8-22 Pages 8-20 Pages 125-135 Pages 154-173 Pages 171-174 Pages 294-301 Pages 69-80
2. Use more complex tools, technologies and appropriate measurement units to make observations, collect and organize qualitative and quantitative data, e.g., microscopes, graduated cylinders, computer probes, stress and impact testers, and timers.	Food and Nutrition Investigation 2, Parts 1-3 Mixtures and Solutions Investigation 1, Parts 1-4 Variables Investigation 3, Part 2 Levers and Pulleys Investigation 1, Parts 1-3 Water Planet, Investigation 3, Part 1 Living Systems Investigation 2, Part 1 Investigation 3, Part 3 Electronics Investigation 2, Parts 1-4 Human Brain and Senses Investigation 1, Part 1 Diversity of Life Investigation 2, Parts 1-3 Force and Motion Investigation 5, Parts 1-4 Weather and Water Investigation 1, Parts 1-2 *Note: Every FOSS Middle School module has a CD-ROM component, which is an integral part of the program, to be used by students and teachers. See for example:* Planetary Science, Investigation 2, Parts 1-2	 Pages 8-25 Pages 8-29 Pages 16-22 Pages 8-28 Pages 125-135 Pages 85-98 Pages 136-141 Pages 89-107 Pages 37-40 Pages 65-92 Pages 169-201 Pages 43-56 Pages 55-78
3. Present and explain data and findings using multiple	Variables Investigation 1, Parts 1-3 Landforms	 Pages 8-28

representations including tables, mathematical and physical models, demonstrations and graphs.	Investigation 4, Parts 1-3 Models and Designs Investigation 2, Parts 1-2 Water Planet, Investigation 3, Part 1 Living Systems Investigation 3, Part 3 Electronics Investigation 2, Parts 1-4 Planetary Science Investigation 5, Parts 1-5	Pages 8-24 Pages 8-21 Pages 125-135 Pages 136-141 Pages 89-107 Pages 143-175
4. Communicate scientific procedures, results, and explanations using appropriate science and technology terminology.	*Note: Every FOSS Grades 5-6 module and many of the FOSS Middle School modules involve an end-of-unit project with a presentation to the class. See for example:* Solar Energy Investigation 4, Part 4 Environments Investigation 6, Part 3 ***Mid-module examples*:** Models and Designs, Investigation 3, Parts 1-2 Water Planet, Investigation 2, Parts 1-3 Living Systems Investigation 2, Part 1 Human Brain and Senses Investigation 5, Parts 1-4 Earth History Investigation 1, Parts 1-2 Diversity of Life Investigation 3, Part 3	 Pages 29-33 Pages 18-22 Pages 8-19 Pages 80-100 Pages 85-98 Pages 145-176 Pages 33-49 Pages 116-123
5.Explanations and procedures may be critiqued and revised, but data must never be changed to match the expected results.	Models and Designs Investigation 2, Parts 1-2 Environments, Investigation 1, Parts 1-2 Variables, Investigation 3, Part 3 Water Planet, Investigation 3, Part 1 Living Systems Investigation 3, Part 3 Planetary Science, Investigation 5, Parts 1-5 Electronics, Investigation 3, Parts 1-4 Human Brain and Senses Investigation 4, Parts 1-3	 Pages 8-21 Pages 8-19 t Pages 20-23 Pages 125-135 Pages 136-141 Pages 143-175 Pages 119-135 Pages 120-143

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Climate Change: Background Information

The difference between weather and climate is a very important concept to explain to students. We are all used to the weather changing from day to day: temperature, precipitation, humidity, and wind are all aspects of daily weather. Climate, on the other hand, is the long-term pattern of weather over many decades. One especially cold day in winter does not mean that the climate is cooling, just as an isolated heat wave is not evidence for global warming.

Climate scientists do agree, though, that the Earth's average temperature has increased significantly over the past 150 years. Along with this warming we have seen changes in *patterns* of precipitation, storms, humidity, and the lengths of seasons. The average yearly temperature has gone up about 1.5°F since 1900[1] – which may not seem like much, until you consider that the average temperature at the peak of the last ice age was only about 10°F cooler than today's. A seemingly small change in degrees can make a huge difference in the climate we experience.

The Earth relies on the 'greenhouse effect' to maintain a climate that can support life – without any atmosphere, the planet's average surface temperature would be about 0°F[2]. The direct rays of the Sun don't do much to warm the Earth. While some of their energy is absorbed by land and water, most of it bounces back towards outer space. Gases in our atmosphere trap some of that reflected energy, causing the air to heat up and warm the ground and oceans by conduction and radiation.

When we burn fossil fuels to make electricity or power our cars, carbon dioxide is released into the atmosphere along with other greenhouse gases. These extra gases trap even more reflected heat, amplifying the greenhouse effect and causing the Earth's temperature to rise. Many people deny that human activities could be having an effect on the planet's entire climate. However, most (about 93%) of today's global warming has been shown by scientists to be the result of human-caused greenhouse gas emissions[3].

[1] Gonzalez, P. 2011. Climate change impacts and carbon in U.S. national parks. ParkScience 28(2): 10-15.
[2] National Center for Science and the Environment. 2012. Complex Climate Interactions. http://ncse.com/climate/teaching/complex-interactions. Link checked 8/14/2012.
[3] Gonzalez, 2011.

One could argue that the Earth has gone through many periods of warming and cooling in its history, and that the climate change we are seeing is a normal phase. While global climate does naturally change, its current pace is extremely rapid. If carbon dioxide concentrations continue to increase at their current rate then by 2100 the planet will be hotter than it has been at any time in the last 2 million years[4]. In the past, such rapid changes in global climate have been linked with mass extinction events like the end of the dinosaurs. Even a smaller increase, though, could still have severe negative effects on coastal ecosystems.

Some results of climate change that we are already seeing include warmer oceans, changes in species' habitats and ranges, earlier springs and later falls, warmer winters, droughts, and flooding. Sea level rise and more frequent storms make islands like those in Boston Harbor increasingly vulnerable to erosion, with salt marshes and other coastal habitats particularly at risk. The many species that call Boston Harbor's intertidal zones home are already threatened by climate change.

Projected effects of continued change include even higher temperatures and humidity, extinction of colder-weather species and replacement by invasive species from warmer zones, and sea level rise that could seriously damage coastal cities[5]. Luckily, it is well within our power to mitigate and prevent these effects by lowering greenhouse gas emissions. Climate change education should include a focus on the importance of renewable energy, living sustainably, and reducing fossil fuel consumption to protect the future of our planet.

[4] Davidson, A. 2005. The climate of man. The New Yorker. http://wesjones.com/climate4.htm
[5] Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles. 2007. *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions.* Synthesis report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists (UCS).

About the Boston Harbor Islands National Park Area

Boston Harbor Islands National Park Area, established in 1996, is a collection of 34 islands and peninsulas. The Boston Harbor Islands system offers an amazing natural and cultural environment. The primary **significance** of the park's resources resides in:

- the only drumlin field in the United States that intersects a coast, formed by the glaciers some 15,000 years ago
- opportunities for solitude and personal renewal, and land- and water-based education and recreation within an urban area
- an environmental success story that returned these waters and islands to health
- an island complex composed of 1,200 acres of land, cultural resources, open space, wildlife habitats, and 35 miles of relatively undeveloped shoreline; all inside an area of 50 square miles

This curriculum draws from two of the park's interpretive themes:

Islands on the Edge: Since their ancient formation by rising sea level, the Boston Harbor Islands have literally been on the edge of the continent, places where land meets sea. With the growth of Boston and its surrounding communities, the islands came to be unusual for their lack of inhabitants and development at the edge of a major metropolitan area. The sub-themes:

1. <u>On the Edge of the Continent</u>:
    a. The edge between land and sea has changed over time, both through natural processes including erosion and sea-level rise, and human actions, such as the filling of the Boston waterfront.
    b. Glaciers formed these drumlins, probably in two stages ending 15,000 years ago. This is one of the only locations in the world where a drumlin field intersects a coastline.
    c. The islands also mark an edge between salt and fresh water, creating a vital and unusual habitat for many species.

2. <u>On the Edge of the City</u>:
    a. Boston Harbor Islands national park area consists of 34 islands (and former islands) close to one of America's major metropolitan areas.
    b. The Boston Harbor Islands are a rare example of a relatively unspoiled and largely uninhabited natural environment on the edge of a major urban center. Thus it provides an unusual opportunity to engage area children and families in natural resource stewardship. And it provides habitat not commonly associated with an urban area.

A Beacon for Sustainable Development and Renewable Resources: Boston Harbor Islands and their management can demonstrate the use of renewable resources and "green" technology to meet present needs without compromising the ability of future generations to meet their needs.

a. Park managers, educators and visitors can participate in the stewardship of the natural environment through recycling, sustainable development, and the use of "green" technologies both within the park and elsewhere.
b. A significant renewable energy potential is available on the islands in the form of wind, sun, and tide.
c. Park management policies promote utilization of renewable energy and sustainable practices in plan, design, and construction.

Additional connections we identified are

- How the park stories have changed over time in regards to weather
- How the stories have changed over time in regards to the founding of the park “on the edge of a city”
- Islands are impacted first by climate change (aka. global warming) and severe weather; they are the canary in the coal mine.
- How can these islands be compared to other islands that you know?

Boston Harbor Islands National Park area (BHI) is a barometer for environmental change, both past, present and future. The islands themselves, mounds of debris left behind by the glaciers when the planet began to thaw at the end of the last ice age, are evidence of a climate in constant transition. For the past 12,000 years, the elements have scoured these “drowned drumlins,” shaping the terrain in favor of prevailing winds. Today the climate continues to determine the configuration of the harbor landscape, but the rate of change underscores an alarming degree of human interference in the natural cycle.

The National Park Service and the BHI make education a priority. These islands provide an outdoor classroom that is on average about three miles away from Boston public schools and homes. Here students may observe the forces of humans and nature on the islands, while recording weather observations and reviewing long-term weather data to identify the local climate. We encourage the students of today, excited by their connection to the Harbor and understanding their role as citizens, to become the stewards of tomorrow.

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Field Trip Guide

Depending on schedule and classroom resources, visiting one or more of the islands can be a strong benefit to this curriculum. Different locations may be more or less appropriate based on the timing of the field trip. Of the 34 islands in the harbor, 12 are publicly accessible; most are easier to get to between May and October while ferries are running.

As of September 2012, public ferries are operated by Boston's Best Cruises. Boston boats leave from Long Wharf, north of the Aquarium. Whenever possible, students should travel to the boats by public transit in order to emphasize how close their homes and schools are to the harbor. Arriving by T also empowers the students to return on their own. The Aquarium stop on the blue line is closest to Long Wharf, although Government Center (green) and State Street (orange) are both within half a mile. The EDIC dock is best accessed by the Silver Line SL1 or SL2.

Please visit the NPS site (www.nps.gov/boha/forteachers/planafieldtrip) for all required permits, scheduling information and/or additional curriculum. You can also contact the park's education team at 617-233-8666 during business hours.

Features such as a calendar of events, island guides, and teacher resources are available at the park's website (www.bostonharborislands.org). In scheduling the field trip, teachers should keep in mind seasonal weather and links to specific lessons. It may also be useful to consult a tide chart (try www.boatma.com/tides/Boston-Harbor.html).

An island visit can be the perfect time to discuss renewable energy with students. The Harbor Islands are well suited for solar and wind power because there is strong year-round ocean breeze to run the wind turbines, and little shade from buildings or trees to block sun from solar panels. All DCR composting toilets are solar powered.

While all islands offer access to natural beauty, shoreline habitats, and the harbor itself, each also has its own unique features. The following table outlines specific benefits of the eight most accessible islands.

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Island Resources

Island	Resources	Access	Possible lesson
Deer	Three windmills; solar PV panels; methane-based power plant; hydroelectric generator from treated wastewater; efficient LED lighting; composting toilets	The peninsula is accessible by car, through Winthrop. *http://www.mwra.state.ma.us/02org/html/sti.htm*	• What is Climate? • Wind Turbines • Climate Change & Renewables
Spectacle	PV panels on visitor's center; electric trucks for maintenance; reuse of gray water for irrigation; composting toilets; salt marsh	Public ferry from Long Wharf	• Climate Change & Renewables • What is Climate? • The Oceans are Dense • Heating the Earth
Georges	Composting toilets; PV panels providing ~30% of island's energy; running water; salt marsh	Public ferry from Long Wharf	• Climate Change & Renewables • What is Climate? • Heating the Earth
Lovells	Portable PV panels used during active season to provide power for yurts; composting toilets	Public ferry (connect from Georges)	• What is Climate?
Peddocks	PV panels; can see Hull windmill from boat or shore; composting toilets	Public ferry from Hingham, Hull, or Georges	• Wind Turbines • What is Climate? • Climate Change & Renewables
Thompson	Recycling; beach cleanup; composting; education programs; salt marsh/forest/meadow; composting toilets	Private boat (Outward Bound) During the summer, public access and NPS tours on weekends. Access at the EDIC dock.	• What is Climate? • The Oceans are Dense • Heating the Earth
Grape	Composting toilets; fresh and salt marshes	Public ferry from Hingham, Hull, or Georges	• What is Climate? • Heating the Earth • The Oceans are Dense
Little Brewster	Lighthouse is solar powered	Group & public ferry service available mid June through Columbus Day. Access by Central Wharf on the south side of the New England Aquarium	• What is Climate?

Lesson Plans

Introduction

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Title of Lesson: Introduction to the Islands

Main Idea: To get students thinking about ideas and information they will encounter while learning about Boston Harbor and its islands, and prepare them for a field expedition to one of the islands. This introduction will help them connect with the islands and engage the material more deeply. The map activity will orient students and provide them with their own personal tool to use on a field expedition in the harbor.

Objectives:

- Learn about the port of Boston and its trade and nautical routes
- Map reading (Identifying landforms, describing landforms using relative location)
- Estimate calculations and solve problems involving proportional relationships
- Practical application of predicting, hypothesizing, and measuring

Materials:

- A large wall map of Boston Harbor and islands OR a computer with projector to show a satellite map of Boston Harbor
- A large poster paper for the class KWL chart
- Surveys
- Introductory presentation (available on NPS website)
- Charts (also on website)
- Red, green, and yellow markers
- Clipboards with marked strings and pencils (for field trip)

Key Concepts:

- Boston Harbor is a part of the Atlantic Ocean. It is also an estuary, a place where fresh and seawater meet and mix. Several rivers (The Charles, Mystic, Neponset, Fore, Back, Weir) drain into the Harbor.
- The Harbor includes 34 islands (or peninsulas that were islands at one time).
- A harbor is a protected area of a larger body of water that provides a safe place for boats and ships to dock. Harbors are usually protected from the strong winds, currents, and storms that occur in the open ocean. They are deep enough for boats to approach docks safely.
- An island is a landmass that is surrounded by water.
- Harbors connect us to the ocean. Harbors offer many advantages, including access to shipping and trade, a source of food, a safe place for boats, and connections to rivers. Consequently, many civilizations started and thrived along harbors. Many of the world's major cities exist on harbors.

- Boston is a civilization that has grown up on the ocean and the Harbor has influenced its weather and climate, development (fishing, shipping), culture (immigration, for example), and history (Boston Tea Party, for example).
- A large population and development around a harbor impacts the harbor water (because of pollution from boats, industries, wastewater, and sewage). If water in the harbor is damaged, marine life may leave the harbor. Large scale fishing can deplete shellfish and fish in harbor waters.
- Most Boston Public Schools are within ½ to 3 miles of the Harbor. The Curley is about 3 miles from the Harbor.

Activity:

Whole Class Discussion: Constructing a Class KWL Chart

Explain that the whole class KWL chart will be a way of sharing knowledge within the group and sharing topics students want to learn about. The chart can remain on the wall throughout the course of the curriculum. As the class completes other activities, students can fill in what they have learned so that the chart becomes a way of documenting students' cumulative learning about climate, weather, and the harbor.

Ask students to share their ideas for the first two columns. Discuss these briefly with the class and record selected ideas on the class chart.

If the topics do not come up in students' comments, you can ask these questions:

- What kinds of life are there in Boston Harbor? (plankton; invertebrates such as lobsters, sea stars, mussels, clams, crabs, seaweeds; fish; seals; and porpoises)
- What do you know about the water in Boston Harbor? (Tides cause water in the Harbor to rise and fall twice a day. The depth, temperature, and saltiness of the water vary around the Harbor. The water in the Harbor was terribly polluted until the mid 1980's. Most of the pollution was caused by pumping raw sewage into the Harbor. Since 1998, all sewage goes to a treatment plant on Deer Island. The water in the harbor is not perfectly clean, but is a great deal cleaner than it had been.)
- How do people know where to go when they are traveling in the Harbor? (They must understand tides and know how to use navigational aids, such as GPS, charts that show the depth of the water and the position of buoys.)

As you share understandings and information with students and as new questions arise, record these on the KWL chart. Encourage students to record responses personally as well.

Have the map of Boston Harbor where all students can see it. You may instead want to use a computer and projector to project a Google map.

Invite students to name islands they know about (for example, the Dominican Republic, Cape Verde Islands, Ireland, Australia).

Review the definition of an island (a landmass that is surrounded by water).

Ask students if they know how many islands are in Boston Harbor. Have students take guesses. Invite students to locate and count islands in the Harbor. Invite students to name any harbor islands they know.

Ask students to:

a. Identify general landforms, such as peninsulas, beaches, rivers.
b. Identify specific landmarks they may know (Deer Island, Nahant, Logan Airport, South Boston docks, Carson Beach, UMass, Columbia Point).
c. Locate rivers that run into the Harbor (Mystic, Charles, Neponset, Fore, Weir).

Ask students how far the school is from the Harbor. Invite students to locate your school on the map. (You may need to help them do this.) Using a string or ruler and the map scale, have a student volunteer measure the distance from the school to the nearest place in the Harbor. Have students calculate these distances in feet, yards, meters, or miles.

You may want to have students measure other distances (from their houses to the Harbor, or from the school to Thompson or Spectacle Island, for example.)

Lead a discussion about why people live and develop cities around harbors. (They provide access to shipping and trade, a source of food, a safe place for boats, and connections to rivers). Ask if they can find evidence on the map that shows why harbors are advantageous places. You can point out the way the harbor is squeezed into a tight area and that the arms of land to the north (Deer Island) and south (Nantasket/town of Hull) protect it from the open ocean.

Discuss the question: What are things that could damage a harbor, because a lot of people live around it. (Pollution from industries, wastewater, sewage; overfishing; destroying habitats for marine organisms).

Small Groups: Completing the *Boston Harbor Survey*

Divide students into small groups and provide each student with a *Boston Harbor Survey*. (See attached). Explain that these questions are about topics they will learn about in a presentation about Boston Harbor. They will take this survey again after the presentation. They will be able to compare their pre and post versions of the survey to see how much they learned.

Have them discuss and answer the survey questions. Explain that they may not know the answers to these questions, but that they can use the information they already know, the KWL chart, and the map to help them make guesses.

Presentation

Present the orientation slideshow, available at the NPS website. (http://www.nps.gov/boha/forteachers/harbor-orientation.htm)

Go back to the class KWL chart. Fill in what students have learned from the presentation and post-survey.

Chartmaking

Help students to familiarize themselves with a black and white Boston Harbor Nautical Chart. Review the definitions of

- buoys (floating aids to navigation, anchored to the bottom of the harbor, which convey information by color, shape, number, and flashes)
- beacons (aids to navigation that are permanently fixed to Earth's surface, such as Boston Light, and convey information by color, shape, number, and flashes)
- channels (safe deep water passages in the harbor, marked by buoys)
- nautical mile (a unit of length used by ship captains and other navigators)

Students will color the mainland and the islands with a yellow marker to differentiate the land from the water. The entire area of the city on the left side of the chart need not be shaded solid - a yellow outline of land meeting water is fine.

Students will mark the red, green, and occasional yellow buoys with the appropriate color.

- Channels are often marked on the chart with dotted lines.
- Red and green buoys mark channels in the harbor. "The boat goes between the red and the green."
- Red buoys will always be even numbered; green buoys will always be odd numbered.
- Buoy numbers are always in quotation marks, e.g. R "2", or G "3", to distinguish them from the other small numbers on the chart which designate water depth.
- Yellow buoys mark places for ships to anchor.

During the field expedition, each student should have a clipboard for their charts and other work sheets. A pencil will be attached to the clipboard by a string with three red marks, where the distance between any two red marks is equal to one nautical mile on their chart.

Students should use their charts to find their departure point, route, destination, and designated landmarks. They can measure distances with the scale on their charts and the string on their clipboard.

Adapted from a lesson plan developed by David Weinstein in partnership with the NPS and TIOBEC.

Boston Harbor Survey Answer Key

1: a. The Boston Harbor is about **3** miles from the Curley School.

2: c. There are about **30** islands in Boston Harbor.

3: d. The Boston Harbor has been shaped by **glaciers, people, wind, and tidal erosion**.

4: c. The rising and falling **tides** are caused by **the moon and the sun**.

5: d. People live around harbors for **all of the above** reasons: food, shelter, and connection to rivers.

6: c. The first people to live around Boston Harbor were **Native Americans**.

7: b. Today, Boston Harbor is **dirtier** than when only the Native Americans lived here.

8: c. When you flush the toilet, your waste goes to a **wastewater treatment plant**.

9: a. Compared to when *you* were born, the harbor today is **cleaner**.

10: b. **Harbor seals and porpoises** have returned to make Boston Harbor their home and hunting ground.

11: d. Climate change affects the Boston Harbor islands by **all of the above** factors.

12: d. **You and I** own the Boston Harbor Islands National Park.

Lesson One

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Title of Lesson: What is Climate?

FOSS Weather and Water Connection: Investigation 9: Weather and Climate

Main Idea: To have students "stumble upon" the difference between Weather and Climate and to differentiate each of these from the greenhouse effect.

Objectives:

- Students will be able to identify the differences between weather and climate
- Increased exposure to and use of graphs
- Practical application of mean, mode, median

Materials:

- Data in delineations of year and decades, enough for ½ of the class to have each
- Graphing paper
- Colored pencils
- Rulers
- Bulletin board, or long hallway
- Construction paper for displaying work

Activity:

As a class review the weather data (don't spend too much time now, you'll have more time when student work is completed).
Class is organized into groups of 4 students.
Within each group students will be paired to work together.
One pair will work with the year-to-year data, and one pair will work with the decades of data. Each pair in the class will be given a different set of data to analyze.

Students will be asked to graph the data presented to them.
They will be expected to include:

- title
- key
- proper spacing
- proper placement and label of x and y axis
- contrasting colors
- correct measurements/units

Once the graphing is done, students will place their graphs in chronological order along the hallway wall for a strong graphic representation of the data. This will help to highlight the climate change as opposed to changing weather patterns.

Reflection:

Think, Pair, Write, Share activity: In whole class discussion, students will be asked to compare and contrast the data (think). In their groups of four, they will discuss the patterns related to which data they themselves graphed and share this with the other members of their group (pair). They will be asked to determine which part(s) of the data represent climate, and which represent weather. Students will then write summaries of what patterns they see and summaries of their discussions (write). They will then be asked to share their notebook entries with the entire class as a whole (share).

Assessment:

See next page for full page reproducible rubric for the graphing activity.

Review entries in notebooks for the correct use of terms weather and climate.

Homework:

Review handout and add to resources section of your science notebook. Imagine that your little cousin who is in 5th grade has asked you what this handout is all about. Write two full and complete paragraphs that explain the handout to your cousin. Be sure to use the following words in the correct manner: weather, climate, and greenhouse effect.

Definitions: Word Wall Words:

"Climate is what is in your closet; Weather is what you wear today!"

Weather: The state of the atmosphere at a given time, including temperature, humidity, cloud cover, precipitation type, and presence of aerosols.

Climate: A pattern of weather conditions over a period of many years or centuries.

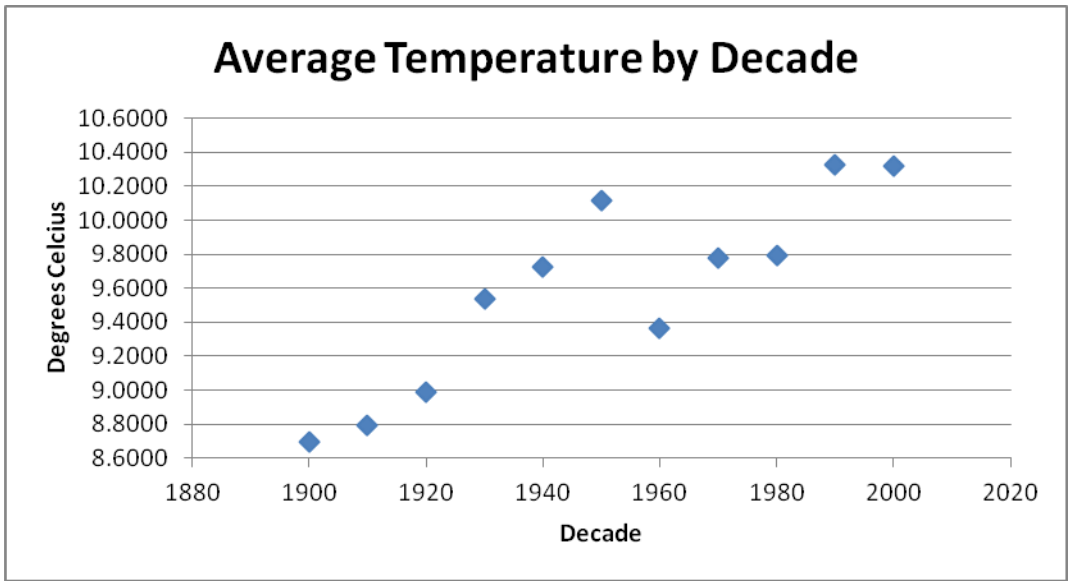
Greenhouse effect: The heating of the atmosphere by trapped solar radiation.

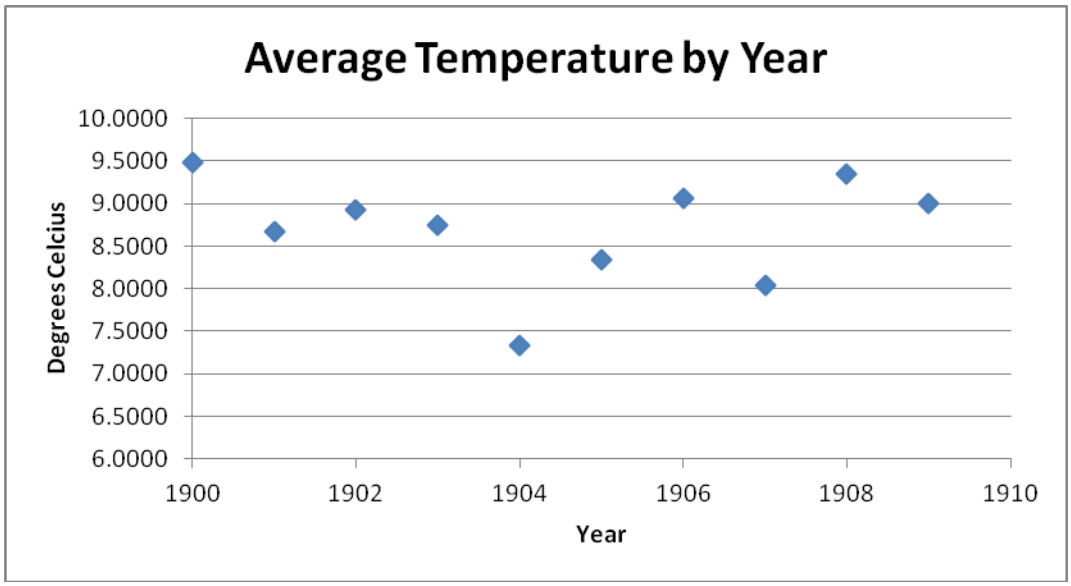
Definitions source: FOSS Weather and Water (online) Glossary
http://fossweb.com/resources/vocab/Weather_and_Water_Definitions.pdf

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Lesson One Data

Students can use this data to compare weather trends - for example, month to month or year to year - with climate trends over the period of a century. Groups using precipitation data should be aware of whether their information is in inches per month or per year.





Weather and Climate Data from the Boston Harbor Islands

Decade	Avg. Temp. (°C)	Precipitation (inches/yr)
1900	8.7	43.3
1910	8.8	40.6
1920	9.0	43.3
1930	9.5	43.8
1940	9.7	40.2
1950	10.1	48.7
1960	9.4	42.7
1970	9.8	47.3
1980	9.8	46.4
1990	10.3	47.9
2000	10.3	51.2

Data provided by PRISM Climate Group via Northeast Temperate Network

Weather and Climate Data from the Boston Harbor Islands

Year	Avg. Temp. (°C)	Precipitation (inches/yr)
1895	8.7	43.6
1896	8.7	40.9
1897	9.0	42.9
1898	9.3	53.7
1899	9.1	39.2
1900	9.5	46.3
1901	8.7	50.4
1902	8.9	42.0
1903	8.7	44.8
1904	7.3	42.5
1905	8.3	38.0
1906	9.1	43.8
1907	8.0	45.5
1908	9.3	37.1
1909	9.0	42.8
1910	9.1	34.9
1911	9.2	40.0
1912	8.7	39.2
1913	10.0	42.6
1914	8.4	37.3
1915	9.2	41.5
1916	8.3	41.7
1917	7.6	41.9
1918	8.4	38.8
1919	8.9	48.0
1920	8.2	51.0
1921	9.8	45.2
1922	9.3	47.3
1923	8.5	41.1
1924	8.5	36.9
1925	9.4	43.4
1926	8.1	40.1
1927	9.6	44.1
1928	9.3	42.3
1929	9.2	41.7
1930	9.7	35.6
1931	10.1	44.3
1932	9.7	46.9
1933	9.4	49.0
1934	9.0	40.1

Year	Avg. Temp. (°C)	Precipitation (inches/yr)
1935	9.0	39.8
1936	9.2	51.2
1937	10.0	45.0
1938	9.9	51.2
1939	9.2	34.8
1940	8.4	41.3
1941	9.9	29.6
1942	9.7	43.8
1943	9.2	35.2
1944	9.8	40.9
1945	9.7	51.4
1946	10.1	40.2
1947	9.8	41.7
1948	9.5	44.8
1949	11.2	32.9
1950	9.9	37.9
1951	10.2	48.0
1952	10.5	39.9
1953	11.1	57.3
1954	10.0	58.8
1955	10.0	55.2
1956	9.5	49.4
1957	10.6	34.5
1958	9.1	56.5
1959	10.2	50.0
1960	9.7	43.4
1961	9.7	46.6
1962	8.8	47.4
1963	9.5	39.2
1964	9.4	38.1
1965	9.2	26.4
1966	9.6	38.7
1967	8.9	48.2
1968	9.2	45.9
1969	9.6	52.7
1970	9.3	44.2
1971	9.6	38.4
1972	9.1	59.6
1973	10.7	49.1
1974	9.6	43.6
1975	10.3	53.7
1976	9.8	40.2
1977	10.0	51.2

Year	Avg. Temp. (°C)	Precipitation (inches/yr)
1978	9.1	42.0
1979	10.2	51.2
1980	9.4	32.4
1981	9.8	42.3
1982	9.5	48.4
1983	10.5	62.8
1984	10.0	52.9
1985	9.9	38.5
1986	9.7	48.4
1987	9.7	47.7
1988	10.0	41.9
1989	9.5	49.2
1990	11.1	49.0
1991	11.0	48.3
1992	9.3	45.6
1993	9.8	45.7
1994	10.2	49.4
1995	10.0	39.2
1996	9.8	58.7
1997	9.8	38.4
1998	11.2	58.9
1999	11.2	45.4
2000	9.9	50.8
2001	10.9	42.1
2002	11.0	49.3
2003	9.6	53.2
2004	9.9	49.4
2005	10.1	56.1
2006	11.2	58.7
2007	10.3	43.5
2008	10.5	57.5
2009	9.9	51.5
2010	11.4	54.3
2011	11.0	56.6

Data provided by PRISM Climate Group via Northeast Temperate Network

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

How to Draw A Line Graph

Step	What To Do	How To Do It
1	**Identify the variables**	a. Independent Variable - (controlled by the experimenter) • Goes on the X axis (horizontal) • Should be on the left side of a data table. b. Dependent Variable - (changes with the independent variable) • Goes on the Y axis (vertical) • Should be on the right side of a data table.
2	**Determine the variable range.**	a. Subtract the lowest data value from the highest data value. b. Do each variable separately.
3	**Determine the scale of the graph.**	a. Determine a scale, (the numerical value for each square), that best fits the range of each variable. b. Spread the graph to use MOST of the available space.
4	**Number and label each axis.**	• This tells what data the lines on your graph represent.
5	**Plot the data points.**	a. Plot each data value on the graph with a dot. b. You can put the data number by the dot, if it does not clutter your graph.
6	**Draw the graph.**	a. Draw a curve or a line that best fits the data points. b. Most graphs of experimental data are not drawn as "connect-the-dots".
7	**Title the graph.**	a. Your title should clearly tell what the graph is about. b. If your graph has more than one set of data, provide a "key" to identify the different lines.

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Line Graph Evaluation Rubric

Name:	**Score:**

This rubric is used to verify specific tasks performed when constructing a line graph. If the task has been completed accurately all points are awarded. Reduced points for each task may be awarded if necessary. No points are awarded if the task is not complete.

Category	Scoring Criteria	Points	Student Evaluation	Teacher Evaluation
Variables ***20 points***	The independent variable is drawn on the X axis.	**10**		
	The dependent variable is drawn on the Y axis.	**10**		
Layout ***12 points***	The scale is such that the graph covers most of the page.	**10**		
	Rectangular graph paper is turned so that the variable with the widest range is drawn along the widest side of the paper.	**2**		
Axis Identification ***4 points***	Grid lines on each axis are clearly and neatly numbered.	**2**		
	Each axis is clearly and neatly labeled, including the units in which each variable is measured.	**2**		
Graph Data ***6 points***	Each data point is indicated by an obvious, but not overly large dot.	**2**		
	The value of the data for the dependent variable is neatly written by each data point. *(These numbers must be done without cluttering the graph.)*	**2**		
	The line plotted for the graph is neatly done and appropriate. *(Most graphs should be drawn as "best-fit" lines or curves.)*	**2**		
Title & Key ***4 points***	A descriptive title is neatly printed in the largest area inside the graph area. *(Graph titles are not printed in the margin of the paper.)* If more than one line is drawn on a single graph, a "key" is provided near the title to identify the lines. *(This is only done if there is more than one line on the graph.)*	**4**		
Score	**Total Points**	**46**		

Climate Change

Burning fuel to make electricity or drive cars creates greenhouse gases. These gases act like a warm blanket wrapped around the earth, keeping the sun's heat in so that the planet gets warmer and warmer.

As the Earth heats up, melting ice from the Arctic and the Antarctic causes the level of the ocean to get higher. Cities near the coast, like Boston, are in danger of flooding.

Higher ocean levels also put the habitats in the Boston Harbor Islands in danger. Salt marshes are tidal right now, but they will be underwater when the ocean rises. The animals who live there will have to either adapt to the new environment or migrate somewhere else to survive.

Using less gas and electricity helps to protect our planet's future.

Caroline Owens 2012

Lesson Two

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Title of Lesson: Wind Turbines

FOSS Weather and Weather Connection: Investigation 2: Where's the Air?

Boston Harbor Islands Field Trip Connection:

- Deer Island has three wind turbines and one hydro turbine
- Hull has two wind turbines

Main Idea: To have students recognize that air can be captured and used for energy. Students will organize presentations timed to coordinate with the fifth graders trip out to the islands.

Objectives:

- Students will recognize that there are many ways to capture air (in the syringe, in a jar, with a wind turbine, and an anemometer)
- Understand the engineering of how a wind turbine operates
- Become familiar with the design process
- Present learning in oral presentation

Materials:

- Internet connection
- Map of the Boston Harbor
- rulers
- construction paper
- pencils, pins, soda straws, stapler, scissors, cone pattern, tape, plastic bottle with narrow neck, stopwatch

Activity:

Each of the groups will research and present their learning in a 3- minute presentation to the 5th grade class (ideally, before their trip to the Boston Harbor Islands).

As a class, students will identify on a map the wind turbine locations in the Boston Harbor Islands.

There will be limited class time for students to work on this assignment, as the bulk of the work will be done independently, and for homework. Class time will be used for the groups to meet to organize and collaborate on their information.

Groups will be expected to pass in a written report and then present this report to the fifth graders on their topic as it relates to Wind Turbines – specifically in the Boston Harbor Islands.

Following the presentations, the 6th graders will assist the 5th graders in making their own anemometers (directions included).

Ideally, these presentations would be timed to coordinate with the fifth graders trip out to the islands.

Assessment:

See FOSS presentation guidelines included at end of lesson.

Homework:

Three days to prepare for presentation for the fifth grade class(es).

Class will be equally divided into four groups:

1. Engineering Design Process
2. Benefits of the Wind Turbine
3. Pro-Wind Energy
4. Con-Wind Energy

Each student will make an anemometer, to be used as a weather collection tool with class, and as an exemplar model when working with the 5th grade students.

Extension: Complete the lesson and activity on designing wind turbines. This can be an excellent crossover project with the students' math class. The class will discuss renewable energy and wind power, as well as the concept of variables in scientific testing. Groups of children will then assume roles of wind energy companies. Each 'company' has a fixed budget and must attempt to design the most cost-efficient wind turbine. A complete lesson plan from *Clean Air, Cool Planet* (http://www.cleanair-coolplanet.org/) is attached.

To assist students with citing their information sources:

How to Write a Sixth Grade Works Cited Page

By Robert Ceville, eHow Contributor

One of the key features of your sixth grade report is the Works Cited page, which lists all of the sources you used in your research. Properly listing your sources is required in order to avoid plagiarism, and to give credit to those who have supplied you with the facts and statistics that helped you write your paper. Your Works Cited page also reflects the work that you put into your report.

Instructions:

- 1 List all of your sources in alphabetical order. Begin with the author's last name. Add a comma, and then include the author's first name. Follow this with a period. If the source has two authors, follow the first author's name with the second author's name. The second author's name should be written in regular order. If you are using a source like an encyclopedia, there may not be an author clearly listed. In this case, begin with the title's first letter.

- 2 Begin each citation line at the margin. The other lines of the citation should be indented.

- 3 Follow the author's name with the title of the book, magazine, software, or internet source you used in your research. Put the title in italics, or underline it. Surround the title with quotation marks, and include a period after it. Make sure that you pay close attention to spelling and punctuation, and write the title down exactly.

- 4 Write the location of publication after the source's title, and follow it with a period. You do not need to include the location if the information is unavailable.

- 5 Write the year of publication and the page you are citing specifically, each followed by a period. If you are citing an online source, write down the URL of the website that contains the information you used. Place an arrow on each end of the URL, positioned as though they are brackets.

Source:http://www.ehow.com/how_7893749_write-sixth-grade-works-cited.html

When creating your Works Cited Page, remember to:

- Begin the Works Cited on a new page, but number consecutively (i.e., if the last page of your essay is page 3, the Works Cited is page 4)
- Alphabetize each entry by first letter
- Use italics for all titles of books, magazines, films, etc.
- You do NOT need to include the URL on internet sources unless specifically required.
- Put quotation marks around the titles of poems, short stories, and articles
- Indent the 2nd line, the 3rd line, and all subsequent lines of each citation
- Double-space all entries

Correct citation	**Type of citation**
Gorman, Elizabeth. *Prairie Women.* New Haven: Yale University Press, 1986.	Book (One author)
Caper, Charles and Lawrence T. Teamos. *How to Camp*. Philadelphia: Doubleday, 1986.	Book (Two authors)
Ellis, Doris et.al. *History of Japan.* New York: Harcourt, Brace and World, Inc., 1989.	Book (Three or more authors)
Vanderkirk, Pamela, ed. *Ten Short Plays*. Los Angeles: Nowell Book Co., 1982.	Book (One editor)
Lockhard, David J. and Charles Heimler, eds. *The Oregon Trail.* New York: Bonanza Books, 1992.	Book (Two editors)
Carlson, David et.al., eds. *Encyclopedia of Animal Life*. Boston: Houghton Mifflin Co., 1985.	Book (Three or more editors)
Allende, Isabel. "Toad's Mouth." Trans. Margaret Sayers Peden. *A Hammock beneath the Mangoes: Stories from Latin America*. Ed. Thomas Colchie. New York: Plume, 1992. 83-88.	Book (Single work from an anthology)
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Keats, John. *Poetical Works*. 1884. *Bartleby.com: Great Books Online.* Ed. Steven van Leeuwen. May 1998. 5 May 2003 <http://www.columbia.edu/126/>.	Book Online (Part of Scholarly Project)
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Doctorow, E.L. Introduction. *Sister Carrie*. By Theodore Dreiser. New York: Bantam, 1985. v-xi.	Introduction, Preface, Foreword, or Afterword
Stowe, Harriet Beecher. "Sojourner Truth, the Libyan Sibyl." 1863. *The Heath Anthology of American Literature*. Ed. Paul Lauter et al. Vol. 1. Lexington, Heath, 1994. 2425-33.	One volume of multivolume work
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Dunn, Samuel. "Re: Any Ideas for My Country Project." E-mail to Tom Jones. 26 Feb. 2003.	E-mail
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"Gorilla attacks Martian." *National Enquirer* 16 Mar. 1999: A-14.	Newspaper Article, (Unsigned)
Bradley, Donald. "Is There a Right Way?" *Kansas City Star* 23 May 1999: 2-4. SIRS Researcher. Alabama Virtual Library.. 28 Feb. 2003. <http://www.avl.lib.al.us/>.	Newspaper Article, Online News Subscription Service (SIRS)
"Charles Frazier." *Contemporary Authors Online*. 2001. Galegroup.com. Alabama Virtual Library. 28 February 2003 <http://www.avl.lib.al.us>.	Gale Literary Criticism Online (Unsigned)
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Schrock, Kathleen. "Digital Gadgets." *Kathy Schrock's Guide for Educators*. 20 February 2002. Discovery Channel. 11 March 2003. <http://school.discovery.com/schrockguide/gadgets.html>. "Great Gatsby Study Guide." *studyguide.org.* 5 January 2002. 11 March 2003. <http://www.studyguide.org/gatsby_study_guide.htm>. Note: If no title for the page is provided, write Home page (do not underline and do not use quotation marks).	Web page (Personal or Professional)
The Cinderella Project. Ed. Michael N. Salda. Vers. 1.1. Dec. 1997. De Grummond Children's Lit. Research Collection, University of Southern Mississippi. 9 March 2003. <http://www-dept.usm.edu/~engdept/cinderella/cinderella.html>.	Web page from a university (scholarly online project)
"Langston Hughes Poetry Circles." February 2003. National Council of Teachers of English. 10 March 2003. <http://www.ncte.org/special/LangstonHughes/>.	Web page (Professional Organization)

* While you may wish to consult a general reference source like a comprehensive encyclopedia for background information, avoid using and citing such resources in documented literary papers. More specialized sources are preferred.

** The following resources are NOT credible and should never be used or cited in a documented literary paper: SparkNotes©, Cliff's© Notes, PinkMonkey Notes©, and similar sources. Be very cautious in your use of resources from the Internet. Essays by middle school and high school students should certainly not be deemed reliable. Similarly, comments on books which are randomly submitted by readers lack credibility.

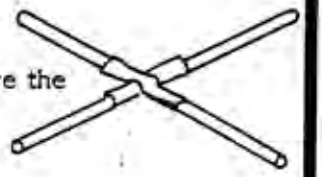
Note: The above citations serve as examples of how to format entries on Works Cited pages of student research papers. These examples may or may not be actual published literary works, and you should not be disappointed if the internet web site URLs are not functional. Again, this page is simply a set of examples to help you format a paper written in MLA style.

Source: http://www.studyguide.org/MLAdocumentation.htm

How can you measure wind energy?

Some places have a lot of wind and others don't. For example, places that are higher or more open usually have stronger winds. Before you bought or built a windmill, you would want to be sure that your location had enough wind. But how can you measure the wind?

An anemometer is used to measure wind energy. You sometimes see them at airports.

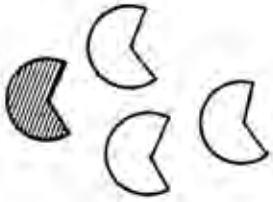


You are going to make a simple anemometer and measure the wind energy around your school.

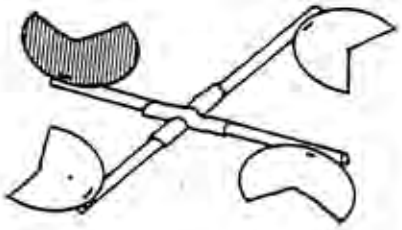
Materials for each anemometer:

pencil, pin, two soda straws, stapler, scissors, cone pattern, paper, tape, bottle with a narrow neck, stopwatch or watch with a second hand.

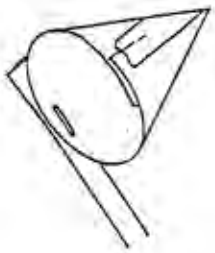
Steps

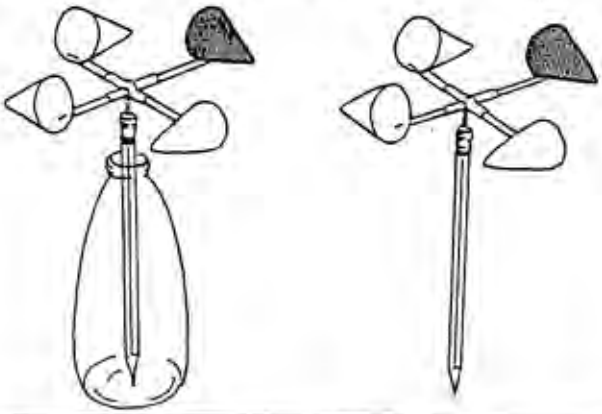


1. Staple 2 straws so they make an X. Reinforce with tape.
2. Cut out patterns for 4 cones. Color one cone red.



3. Staple one cone pattern to each straw end, so they all face the same way.
4. Curve each cone pattern to form a cone, and tape.
5. Pin the center of the X to the pencil eraser.
6. Insert the pencil in a narrow necked bottle, so that you can hold the bottle and the anemometer will spin freely.





Additional lessons may be found at R.E.A.C.T. Renewable Energy Activities Choices for Tomorrow, Renewable Energy Laboratory Education Programs, http://www.nrel.gov/docs/gen/fy01/30927.pdf

What is the Engineering Design Process?

The engineering design process involves a series of steps that lead to the development of a new product or system. In this design challenge, students are to complete each step and document their work as they develop their lunar plant growth chamber. The students should be able to do the following:

STEP 1: Identify the Problem -- Students should state the challenge problem in their own words. Example: How can I design a _____ that will _____?

STEP 2: Identify Criteria and Constraints -- Students should specify the design requirements (criteria). Example: Our growth chamber must have a growing surface of 10 square feet and have a delivery volume of 3 cubic feet or less. Students should list the limits on the design due to available resources and the environment (constraints). Example: Our growth chamber must be accessible to astronauts without the need for leaving the spacecraft.

STEP 3: Brainstorm Possible Solutions -- Each student in the group should sketch his or her own ideas as the group discusses ways to solve the problem. Labels and arrows should be included to identify parts and how they might move. These drawings should be quick and brief.

STEP 4: Generate Ideas -- In this step, each student should develop two or three ideas more thoroughly. Students should create new drawings that are orthographic projections (multiple views showing the top, front and one side) and isometric drawings (three-dimensional depiction). These are to be drawn neatly, using rulers to draw straight lines and to make parts proportional. Parts and measurements should be labeled clearly.

STEP 5: Explore Possibilities -- The developed ideas should be shared and discussed among the team members. Students should record pros and cons of each design idea directly on the paper next to the drawings.

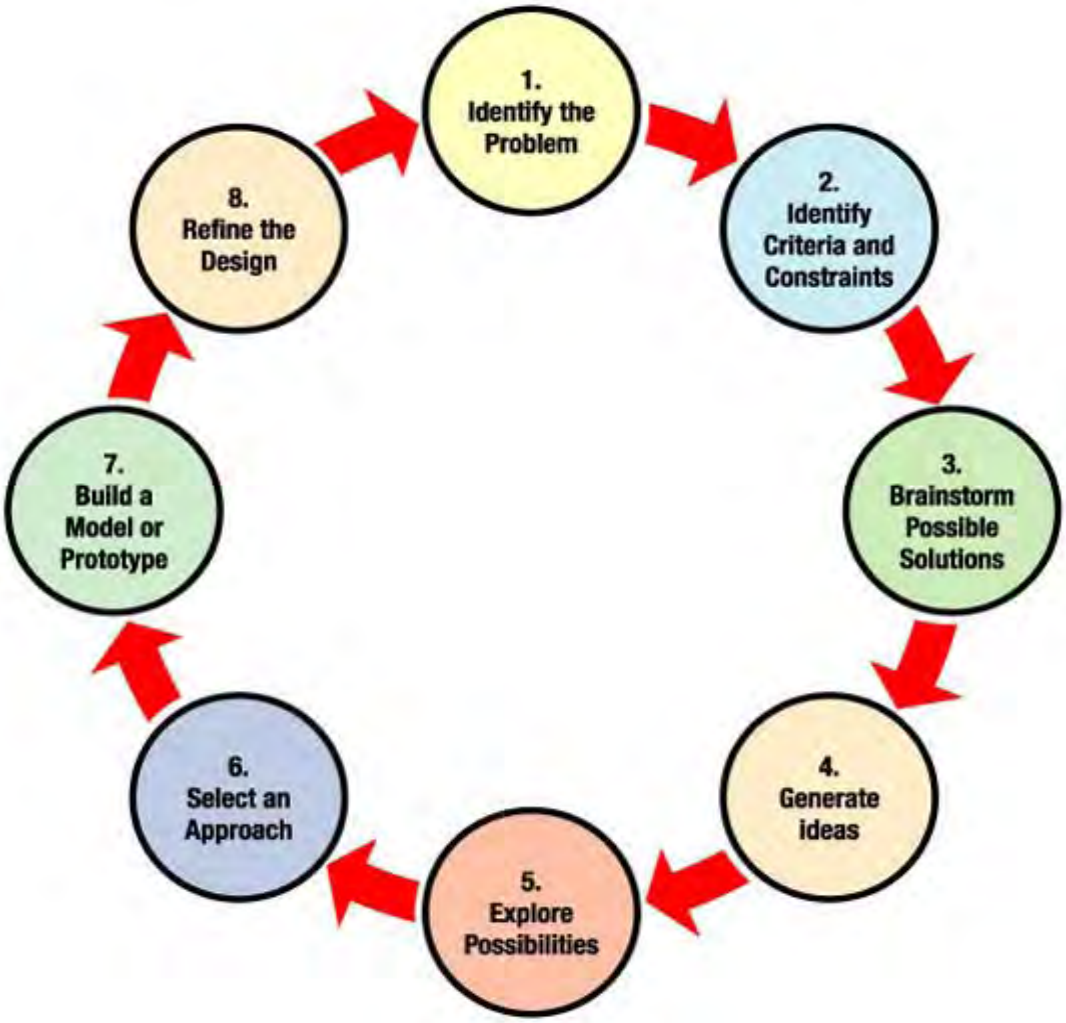
STEP 6: Select an Approach -- Students should work in teams and identify the design that appears to solve the problem the best. Students should write a statement that describes why they chose the solution. This should include some reference to the criteria and constraints identified above.

STEP 7: Build a Model or Prototype -- Students will construct a full-size or scale model based on their drawings. The teacher will help identify and acquire appropriate modeling materials and tools. See the design brief for a sample list.

STEP 8: Refine the Design -- Students will examine and evaluate their prototypes or designs based on the criteria and constraints. Groups may enlist students from other groups to review the solution and help identify changes that need to be made. Based on criteria and constraints, teams must identify any problems and proposed solutions.

Source: http://www.nasa.gov/audience/foreducators/plantgrowth/reference/Eng_Design_5-12.html

Engineering Design Process



Source: http://www.nasa.gov/audience/foreducators/plantgrowth/reference/Eng_Design_5-12.html

Name _____

Date _____

PRESENTATION GUIDELINES

You will have exactly 3 minutes to present your project to the class. In those 3 minutes you should answer these questions.

- What were you trying to find out (your question)?
- What materials or references did you need to do your project?
- What procedure did you follow to complete your project?
- What did you learn from doing your project?

When you begin speaking, you will see the *green card* held up for 2 1/2 minutes. When you see the *yellow card,* you have 30 seconds left. When you see the *red card,* it means you can finish your sentence, but you must stop within the next few seconds.

Practice your presentation so you will be sure it is at least 2 1/2 minutes long, but not more than 3 minutes long. Be sure you have included all of the information asked for above.

Name _____

Date _____

PRESENTATION GUIDELINES

You will have exactly 3 minutes to present your project to the class. In those 3 minutes you should answer these questions.

- What were you trying to find out (your question)?
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Clean Energy Climate Solutions

Introduction to the Activity Guide:
Teaching Alternative and Renewable Energy Technologies to Influence Positive Choices Affecting Climate Change

A Project of Clean Air-Cool Planet's Connecticut Science Center Collaborative
Funded by the Connecticut Clean Energy Fund

Introduction

Most people do not understand the connection between energy use and environmental impacts. The energy that fuels our economy has been so readily available and relatively inexpensive that most Americans do not know where it comes from or whether it is being used efficiently. Are they aware that, on average, the United States uses twice as much energy to produce goods and services as France or Germany, and three times as much as Japan? We must convey how the inefficient use of energy and natural resources, which contribute to our warming climate, costs more in many cases than the measures that would correct them.

There is a growing recognition that climate change and energy supply will be the most critical economic and environmental challenges of our times. While most Americans recognize the need to reduce greenhouse gas emissions, they are confused about the science of climate change and concerned about the costs of reducing the emissions that are causing global warming. When people have difficulty deciding how to respond to complex challenges, they are more inclined to deny their existence or put off dealing with them until a crisis forces them to do so.

Objective

The purpose of this project is to provide science center educators in Connecticut with resources, educational tools, lesson plans, and training to instruct young people about how clean renewable energy can be a solution to climate change.

Background

The Connecticut Clean Energy Fund (CCEF) is dedicated to achieving a sustainable balance between energy production and economic growth that will reduce the environmental impacts of climate change. CCEF supports renewable energy development and the necessary public education to encourage its citizens to adopt energy conservation practices and renewable technologies. It has contracted with Clean Air-Cool

Planet's (CA-CP), Connecticut Science Center Collaborative to develop a suite of educational tools and programs for ten of the state's science and nature centers.

CA-CP works with colleges, communities, corporations, and science centers in the Northeast to develop practical, cost effective and innovative solutions to reduce greenhouse gas emissions. Its Connecticut Science Center Collaborative combines the research of world-class scientists with the expertise of informal science educators to develop exhibits, educational programs, and teaching tools for more than 3 million visitors a year.

CA-CP has subcontracted with Talcott Mountain Science Center to manage this project because of its 30 year history of educating young people about renewable energy. The management team for the project includes the Director of Talcott Mountain, the manager of the Connecticut Science Center Collaborative, a program officer from CCEF, an exhibit designer from Jeff Kennedy and Associates, Inc.., and an independent evaluator from Goodman Research Group, Inc. The following ten science and nature centers are participating in this project: Beardsley Zoo, Children's Museum, Connecticut Audubon, CRRA's Garbage and Trash Museums, Dinosaur State Park, Discovery Museum and Planetarium, Eli Whitney Museum, Stepping Stones Museum for Children, Talcott Mountain Science Center, and Peabody Museum of Natural History.

In the first year of the project, the management team and the ten science centers identified and tested existing products on the science of climate change and renewable technologies. The management team assembled off-the-shelf tools and created educational kits on climate change as well as wind, solar, and fuel cell technologies. Staffs from ten science centers in the Collaborative have been trained to use these kits and test their effectiveness by delivering informal programs to students in grades four through six. Activity guides that contain lesson plans to accompany each kit were also developed. In year two of this project members of an Advisory Committee will review and critique these materials.

The Clean Energy Kits and Activity Guide

The Clean Energy Climate Solutions Project offers a unique activity to bridge the gap between public misconceptions about global warming and the use of renewable energy to reduce carbon emissions. The activities in this guide are designed to introduce students to real world alternatives for the production of renewable energy

The Climate Change Backpack™

These climate change activities were developed by the New England Science Center Collaborative and provide a brief down-to-Earth introduction to the science of climate change The contents are housed in a backpack which contains an extensive Presenters' Guide, graphs, maps, simulations, experiments, group activities and a variety of props (including an imitation ice core, a compact fluorescent light bulb, clothespins and a clothesline, and a geologic timeline). The purpose of the Backpack is to introduce

students to the science of climate change and provide background information on how natural systems work, how human activities can have an impact on these systems, and how we in turn are affected by that impact..

Designing for the Wind

Wind is air in motion caused by the Sun's uneven heating of our Earth. The energy in wind can be used to generate electricity. Machines called wind turbines have blades that collect wind energy when they turn. The turning blades are connected to a generator which produces energy. Wind is considered a renewable energy - as long as the sun shines there will be wind (www.eia.doe.gov). Wind represents a largely untapped source of energy that could eventually provide significant power in the Northeast. Designing for the Wind activity involves variables that will directly impact the energy output generated by wind. Variables include changing the number and angle of blades on a wind turbine.

Energy From The Sun

The sun produces heat and light which can be used as a source of energy. Sunlight is made of tiny packets of energy called photons. Scientists have developed a type of technology known as a solar cell which can absorb the sun's photons. These solar cells are made from silicon, a common element on Earth and can be combined to create a photovoltaic panel that absorbs many of the sun's photons and frees electrons. These free electrons are referred to as electrical energy. Our sun provides us with a renewable energy that can help us meet our energy needs (www.nrel.gov).

Energy From the Sun contains activities that demonstrate the photovoltaic effect. Students will learn how the changing position of the sun in the sky affects the performance of a solar cell. They will assemble cells in series and parallel circuits to measure the variation in electrical power (watts) in units of volts and amperes.

Fuel Cells For Our Future

Hydrogen, the most abundant element on Earth, is found in many organic compounds. When separated from these other compounds, it can be burned as a fuel and converted into electricity. Through a electrochemical reaction, fuel cells combine hydrogen and oxygen to produce electricity and heat (www.nrel.gov).

Fuel Cells for our Future incorporates the use of the photovoltaic array from the Energy from the Sun activity to split water through electrolysis in a reversible fuel cell unit. The resulting hydrogen and oxygen gases that are collected are then recombined in the fuel cell to produce electricity. The electrical energy produced by the electrochemical reaction is used to propel an electric car. The byproduct of this process is water.

Integrating the Kits

The activities and kits are designed to be integrated using common components and scientific concepts. Energy conversions, principles of circuits and measurement of electrical power are common concepts to all of these units. In everyday terminology, nearly every electrical storage device we use is called a "battery". In fact, most of these are actually "cells". A typical household battery (AA, AAA, C, D, etc) is actually a 1.5-volt dry cell. Dry cells can be used in series to increase voltage. For example an everyday 9-volt battery is made of six 1.5 volt cells in series. A fuel cell stack is made up of a large number of individual electro-chemical cells also combined in a series. A photovoltaic panel is comprised of many solar cells that are wired in parallel and series circuits and are combined in solar arrays to produce a desired amount of power.

The use of clean alternative forms of energy is one positive approach to reducing greenhouse gases that are the primary cause of climate change.

Another important concept is that technology and nature can work in harmony to create a minimal impact on the environment. A desirable outcome of all of these activities is to show students responsible choices for energy and the environment. Students will see how choices to replace carbon-based fuels will have a positive impact on climate change and the environment.

Activity 6: Designing for the Wind

Overview:

(photo credit Steve Weinberg)

Wind is air in motion caused by the Sun's uneven heating of our Earth. The energy in wind can be used to generate electricity. Machines called wind turbines have blades that collect wind energy when they turn. The turning blades are connected to a generator which produces energy. Wind is considered a renewable energy - as long as the sun shines there will be wind (www.eia.doe.gov).

Changes in energy production can effectively reduce greenhouse gas emissions that in turn can positively affect climate change. Wind power could be a substantial energy source for the Northeast especially at higher altitudes and coastal and offshore regions. Wind has been used throughout history to provide power for transportation and industry. Newer generating systems and windmill designs have significantly improved their dependability and efficiency. This activity takes students through the process of converting wind energy into electricity.

Objective:

In this lesson students will build and test models of wind turbines and identify the variables that affect their performance. Variables that can be tested include the number of blades attached to each windmill and the angle at which the blades are placed. This is an open ended, student generated investigation where the students make decisions that directly affect the outcome.

Vocabulary:

Turbine Generator Windmill Altitude

Central Questions:

1. Wind is generated by the differences of temperature on the planet and in the atmosphere. What source of energy is responsible for these changes? (The Sun)
2. Which factor most affects the performance of a wind turbine and it's energy output? (Wind direction, Number of blades, Angle of the blades)

3. What other design consideration might be considered to improve the performance of the wind turbine? (Blade length)

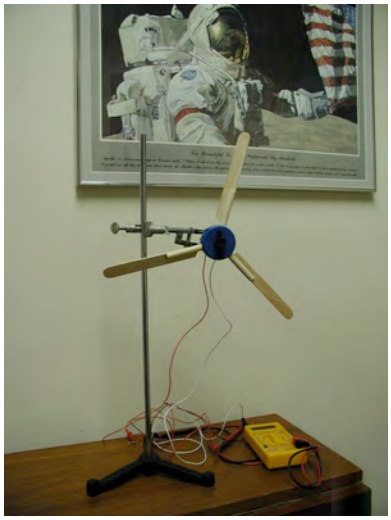
Duration: 45 minutes – 1 hour

Materials/Equipment:

6 House Fans
12 Alligator Clip leads
30 Tongue depressor blades
6 Ring Stands with test-tube clamp
6 Electric motors
6 Multimeters
6 KidWindTM Hubs

Activities:

After introducing the concept of wind power and electrical generation to your class you may set up the following experiment.



Procedure: Organize the class into wind manufacturing companies (groups of 4-5 students work well) Explain the concept of variables. Independent variables are variables manipulated by the student; these include the number of blades and angle of the blade to the wind. These variables will affect the outcome of power produced, which is the dependent variable. Another factor that may be brought into play is the relative cost of using more materials, i.e. blades, to justify the outcome of power produced. Setting up a cost for each blade, and a cost per test run against a value for volts produced can add incentive and make the students think harder about the outcome. As an example, students are given $500 startup "funds" and charged $100 for each blade used and $50 for each test run. The resulting millivolts produced will be rewarded at a rate of $1 per millivolt (1/1000th of a Volt).

(Photo Credit) Fuhrleander Wind Turbine, Lorax Energy

The fans that provide your wind power should be set up uniformly as a controlled variable so that individual design factors can be compared. Set the fans on a tabletop and have the students assemble the ring stands securing the motor tightly into the test-tube clamp and attaching this to the ring stand. (Wrapping the motors with a piece of electrical tape will prevent conduction between the leads and the clamp). Connect the wire leads from the motor to the leads on the meter with alligator clip leads. Be sure red positive and black negative wires are

consistently joined.

The angle to the wind is measured for each blade with the protractor provided. 0° is ineffective as it will cut through the wind like a knife blade and 90° will directly oppose the wind. Students may choose their experimental blade angles randomly but should keep track of them on the data table provided.

Each group will assemble their windmill hub and determine changes in angle and number of blades for each experiment. The meter will be set on the 2000-millivolt scale (2v) where students can measure 3 significant figures. The fan should be turned on high and the windmill must be set at a uniform distance from the fan (two feet works well). The fan placement and speed should be the same for all groups. The students will record their results for each test on the data table.

Groups should be able to complete 5 to 10 tests in a 45 minute to 1 hour session. Stopping halfway through the activity often generates excitement, as everyone wants to know which variable was most effective.

Results: More blades may give the appearance of going faster but that may be an illusion of seeing more blades spinning rather than actually spinning faster. Generators increase their output exponentially with increases of rotational speed, so designs that make the blades spin faster will produce greater outputs. The wind industry is using variations of 2- and 3-blade windmills, 3 being the most efficient but on large-scale projects 2-blade and occasionally 1-blade designs are more cost effective. In our experiment students could use 4 blades although balance, because of blade placement, becomes a factor. The optimum angle is between 70°and 80° - students will experience dramatic changes in their results. By doubling the speed of the turbine, the power increases by a factor of eight.

$$P = \frac{1}{2} p \pi r^2 v^3$$

Power is equal to ½ p (density of air) x π x (radius of blades)^2 x (wind velocity)^3

Have the students graph the results for the entire class with milivolts on the X-axis and blade angle on the Y-axis. Different numbers of blades can be graphed in different colors. The resultant graph should resemble a J shaped curve that dramatically rises to a peak and drops off. Discuss the results and implications to the wind industry.

Additional Resources/References

American Wind Energy Association
www.awea.org

National Renewable Energy Laboratory's

Wind Powering America program
www.windpoweringamerica.gov

Wind Energy Resource Atlas
http://rredc.nrel.gov/wind/pubs/atlas/

The Kid Wind Project
http://www.kidwind.org/

Answers.com
http://www.answers.com/topic/wind-turbine

Wikipedia on Wind
http://www.answers.com/topic/wind-turbine#after_ad2

Wind Activity Record Sheet

Blade Pitch (0-90°)	Two Blade Output (millivolts) Blades _2	Multi Blade Output (millivolts) Blades ____	Conclusions
Trial 1 ____°			
Trial 2 ____°			
Trial 3 ____°			
Trial 4 ____°			
Trial 5 ____°			
Trial 6 ____°			
Best ____°			

Windmill materials are available for use free of charge at the New England Aquarium's Teacher Resource Center.
Please contact them at trc@neaq.org or by phone at 617-973-6590.

Materials:

- 6 windmill blades.
- One motor.
- 2 red wires
- 2 black wires
- One fan (don't forget to place the fan on the box for better air movement!)
- One extension cord (grey).
- One steel rod.
- One iron black foot
- One Kelvin meter
- One windmill degree measuring card
- Enjoy

To operate the Windmill:

- Use the two bottom holes of your Kelvin measuring device. Kelvin[6] is a unit of measurement. It measures the thermal electricity produced by the windmill.
- The black wire connects on the bottom hole. The middle hole is used for the red wire.
- To measure Kelvin, use the green section to the right of the dial. Point the knob to 2000u.
- Connect the black wires first to black.
- Connect the red wires to red and white.

[6] One Kelvin degree is equivalent to one Celsius degree (C°). The difference between the two temperature scales: All motion within an atom ceases at zero Kelvin (K) also known as absolute zero. Water freezes at zero degrees Celsius, which is approximately 273.16K. Source: map.gsfc.nasa.gov/site/glossary.html

Lesson Three

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Title of Lesson: Heating the Earth

FOSS Weather and Water Connection: Investigation 4: Heat Transfer Part 1 Radiation

Boston Harbor Islands Field Trip Connection:

- Thompson Island has brackish marsh, freshwater marsh, and salt water
- Spectacle Island has fresh water available and salt water
- Grape Island has fresh water marsh and salt water
- Georges Island has fresh water available and salt water

Main Idea: To compare four earth materials and determine which uses the most energy and use this lab activity to assist with understanding that the Sun is the major source of energy that heats the atmosphere and that energy moves from one material to another by radiation and conduction.

Objectives:

- Students will collect and measure temperature data
- Students will be able to describe how the atmosphere is heated
- Recognize that energy moves from one material to another by radiation
- Explain how radiant energy from the Sun heats solid and liquid materials

Materials:

- Sand, soil, fresh water, ocean salt water (can be gathered onsite at the island)
- Thermometers, plastic baggies, graphing paper, timer

Activity:

Students will complete Investigation 4: Heat Transfer activity in class as outlined in the FOSS curriculum. In summary, this lesson has students comparing the temperature of 4 Earth Materials (sand, soil, air, water). Students observe the differential heating of earth materials.

They will then perform this experiment again on the island, this time using both fresh and salt water for the experiment. The collection of data from the field experiments will be brought back to class and analyzed. Students will then graph the data and complete a lab report.

Assessment:

Completed data table

Completed graph

Completed lab report rubric

Homework:

Using the data table from the field expedition, graph your group's results.

Complete a lab report of this experiment, model of lab report included.

Extension: If possible, this lesson can be greatly enriched by repeating the experiment on one of the islands. Students will make hypotheses about density and then test them by measuring the salinity in three different aquatic environments around the island: a salt marsh, a fresh pond, and the shoreline. They will learn to take water samples and have the opportunity to discuss the importance of preserving a variety of habitats. If time allows, when students return to the classroom they can complete a challenge activity in which they are given three unidentified solutions and must guess which environment each sample came from. A full lesson plan, adopted from the Outward Bound program on Thompson Island, is attached.

Name _____

Period _____ Date _____

EARTH-MATERIAL TEMPERATURES CHART

Time 3-minute intervals	Sand		Soil		Water		Air	
	Temp.	Temp. change	Temp.	Temp. change	Temp.	Temp. change	Temp.	Temp. change

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Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Model Lab Report

Experiment Date:
Submitted Date:
Name(s):

TITLE: (The name of the lab)

PURPOSE: (Description of the main objectives of the lab)

INTRODUCTION: (A brief introduction to the work you performed. This should include any relevant equations)

MATERIALS: (List all materials that you used in this lab)

METHODS: (Summary of the steps you completed, in past tense)

RESULTS: (Display information that you collected, calculations, observations, etc)

DATA ANALYSIS: (Data tables, charts, graphs)

ANALYSIS: (List all questions and answers)

CONCLUSION: (A summary of what you learned from the lab or whether your hypothesis was correct)

REFERENCES: (Works cited if any research was done)

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Science Lab Report Rubric

	4 Points	3 Points	2 Points	1 Point
Introduction/Purpose	Presents a concise lead-in to the report	Gives too much information – more like a summary	Gives very little information	Does not give information about what to expect in the report
Materials	Complete list of materials needed for the lab	Missing 1 item needed for the lab	Missing 2 to 3 items needed for the lab	Missing more than 3 items needed for the lab
Methods	Presents easy-to-follow steps which are logical and adequately detailed	Most of the steps are understandable; some lack detail or are confusing	Some of the steps are understandable; most lack detail and are confusing	Not sequential; most steps are missing or are confusing
Results	Results are clearly organized so it is easy for the reader to see trends. Includes all appropriate labels	Results are clear and labeled, trends are not obvious	Results are unclear, missing labels, trends are not obvious at all	Data table/graph missing; information is inaccurate
Discussion/Analysis	The data & observations are analyzed accurately, trends are noted, enough data was gathered to establish a conclusion	Analysis somewhat lacking insight, enough data collected, though additional data would be more powerful	Analysis is lacking insight, not enough data was collected to establish trends or analysis does not follow data	Analysis is poor, not enough data, inaccurate analysis
Conclusion	Presents a logical explanation for findings and addresses all questions	Presents a logical explanation for all findings and addresses only 2 of the questions	Presents a logical explanation for findings and addresses 1 question	Presents a logical explanation for findings and addresses none of the questions
Timeliness	Report handed in on time	1 day late	2-3 days late	1 week late
Grammar/Spelling	All grammar and spelling are correct	Only 1 or 2 errors	More than 2 errors	Very frequent grammar/spelling errors
Attractiveness	Clean and neat presentation, illustrations provided		Legible writing, well formed characters, lacking illustrations	Illegible writing, not organized, loose pages

Lesson Four

Weather, Water, and Warming
Boston Harbor Island Climate Connections

Title of Lesson: The Oceans are Dense

FOSS Weather and Water Connection: Investigation 5: Convection

Main Idea: Cold water is denser than hot water, and salt water is denser than fresh. As global warming raises the temperature and lowers the salinity of ocean waters, animals' habitats are altered and damaged because of changing densities.

Objectives:

- Students will learn to calculate density
- Students will apply their learning of density to design a model toy

Materials:

- Response Sheet
- If completing for extra credit: jar, water, salt, plastic beads

Activity:

Students will complete worksheet about density, highlighting their learning as it applies to phytoplankton.

Assessment:

Math work complete and correct

All work shown

Explanation of the shake-up toy shows an understanding of density

Name_____ Date_____

Response Sheet – Density

Rico wants to make a shake-up toy for his little sister that explains what he has learned in school about how global warming changes the density of sea water, affecting ocean food chains.

*How does global warming change the density of the ocean?*_____

_____

_____

He knows that the least dense water forms a layer on the top of the ocean. Lots of fish live in this layer where they can catch **phytoplankton** to eat. For his toy, he will use plastic beads as phytoplankton so his sister can see that in ocean water, the phytoplankton float near the top.

Rico mixes up 500 ml of salt solution. He weighs it and finds its mass to be 585 g. Will his shake-up toy work the way he wants it to if he uses this salt solution? Why or why not?

Show your math on the back of this worksheet.

Object or material	Density
Plastic beads	1.12 g/ml
Salt solution	

_____

_____

_____

_____

_____

_____

Words to Know:

Phytoplankton- plankton consisting of free-floating algae and microorganisms. Phytoplankton form the beginning of the food chain for aquatic animals and fix large amounts of carbon, which would otherwise be released as carbon dioxide.

Salinity- refers to the salt concentration of a body of water.

Global Warming - an average increase in the Earth's temperature, which in turn causes changes in climate.

Lesson Five

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Title of Lesson: Dew Point

FOSS Weather and Water Connection: Investigation 6: Water In the Air

Main Idea: Students will practice reading a scientific article, and connect their knowledge of weather and water to the Boston Harbor Islands.

Objectives:

- Students will make the connection between temperature and dew point
- Students will learn to calculate humidity using math equations
- Students will understand the effects of humidity and temperature on the weather they experience

Activity:

Students will read the dew point article and review key vocabulary in groups or as a class. They will then individually answer the questions provided. This will give the students the opportunity to reflect upon their reading and to summarize the lesson connections to their study of climate change.
Students will also complete the math worksheet on relative humidity. If each student is assigned a different month, the class as a whole can put their answers on the board and discuss the patterns of humidity and dew point throughout the year.

Assessment:

Worksheet completion with full and complete sentences.

Student answers should show an understanding of the connections between dew point and increased temperatures.

Correct math.

Name_____ Date_____

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Understanding Dew Point

Written by Caroline Owens.

Meteorologists record the temperature and wind each day. They also measure the **humidity**. Humidity is a description of how much water vapor there is in the air. Once they know the humidity and the temperature of the air, they can use a simple formula to find the **dew point**. This dew point helps scientists to predict whether or not it is going to rain.

Air can only hold so much water vapor. Warm air can hold more water vapor than cold air, but there is always a maximum limit. When the air cannot hold any more vapor, we refer to it as **saturated**. Saturation is also known as **100% relative humidity**, and occurs when the air temperature is equal to the dew point.

If the relative humidity is more than 100%, some of the water vapor falls out as drops of liquid water. This is called **condensation**, and it explains why clouds make rain. You have probably observed condensation on a hot day when water appears on the outside of a glass of cold water. We also sometimes call condensation **dew**, such as when it occurs in the grass on chilly summer mornings.

As air cools down, its ability to hold water vapor decreases. This means that cooling air will cause it to become more and more saturated. The temperature to which air must cool in order to reach 100% relative humidity is the **dew point**. Once the air has cooled to its dew point, condensation will occur.

Why does condensation usually form in the mornings? The coldest part of the day occurs just before sunrise, so this is often when air reaches its dew point temperature. Condensation in air close to the ground can lead to **fog**, which disappears later in the day as the sun warms up the air.

Warm air has a higher dew point than cold air. As the temperature changes throughout the day, the dew point changes too.

Humidity also affects the dew point. Because the two measurements are predictably related, humidity can be used as a **variable** to find dew point. If the relative humidity is only 50%, the air has to cool down 10 degrees to become saturated. But you can use the formulas on the next page to see for yourself that if the relative humidity is 90%, the air will reach its saturation point after cooling only 2 degrees. This means that humid air has a higher dew point than dry air.

In the fall as the temperature decreases and dry air sets in, a lower dew point is more common. You may have seen **frost** on the ground on winter mornings. This happens when the dew point is below freezing. The dew point can never be higher than the actual air temperature. When the dew point and air temperature are equal, the air is **saturated**.

Dew point is one of the most important tools that weathermen have because they can use it to find the relative humidity. Think about a hot, stormy day in the summer. Does it feel different before and after the rain? When the air is very humid, hot days seem hotter and cold days seem colder to us.

These formulas give an approximate value for relative humidity. (This approach is accurate to within about 1°C as long as the relative humidity is above 50%):

$$T_{dp} \approx T - \frac{100 - RH}{5};$$

and

$$RH \approx 100 - 5(T - T_{dp});$$

T = temperature
dp = dew point
≈ = approximate (almost equal to)
RH = relative humidity

Use the formulas and at least 2 months from the data tables to calculate the relative humidity on your own. Show your work.

For example: in April 2011, the dew point was 2.8°C and the average temperature was 9.6°C.

1. ***RH*** ≈ 100 – 5×(T-dp)
2. ***RH*** ≈ 100 – 5×(9.6-2.8)
3. ***RH*** ≈ 100 –5×6.8
4. ***RH*** ≈ 100 –34
5. ***RH*** ≈ 66

Answer: The average relative humidity in April 2011 was about 66%.

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YEAR	MONTH	dp	T	RH (%)
2010	January	-7.9	-2.1	
2010	February	-6.9	-0.2	
2010	March	-1.0	6.1	
2010	April	2.5	11.3	
2010	May	7.6	16.6	
2010	June	14.3	20.9	
2010	July	16.7	24.6	
2010	August	15.3	22.4	
2010	September	13.1	19.4	
2010	October	5.6	12.1	
2010	November	-0.1	6.3	
2010	December	-6.5	-0.6	

YEAR	MONTH	dp	T	RH (%)
2011	January	-8.6	-3.6	
2011	February	-8.6	-1.7	
2011	March	-4.4	3.2	
2011	April	2.8	9.6	66
2011	May	9.8	14.6	
2011	June	12.9	18.9	
2011	July	17	23.9	
2011	August	16.7	22.2	
2011	September	14.7	19	
2011	October	6.8	12.8	
2011	November	3.4	9.3	
2011	December	-1.9	3.5	

For more information on dew point you can read the Bulletin of the American Meteorological Society: http://journals.ametsoc.org/doi/abs/10.1175/BAMS-86-2-225

Name_____ Date_____

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Questions related to the *Understanding Dew Point* reading:

Ms. Felicetti's class wants to take a boat trip around the Boston Harbor Islands. They are going to use their understanding of dew point to help them decide what clothes and jackets they will need to bring. As a class, they listen to the weather report on the radio. The weatherman predicts a sunny day with a dew point of 12° Celsius.

When the students get to the boat at 8 AM, it is so foggy that they can barely see the water!

1. Explain why the morning is so foggy even though the weatherman predicted a sunny day. (He wasn't wrong!)

2. Using what you know about dew point, estimate the temperature at 8 AM.

3. When the students get to Peddocks Island at noon, will there still be fog? Why or why not?

4. *"As the air temperature and relative humidity rise, so does the dew point."*
How does this statement apply to our study of climate change and global warming?

Extra credit: Using what you learned in lesson 3, explain on the back of this sheet why there is more morning fog near the water! Remember that air is colder at night than during the day.

Weather, Water, and Warming
Boston Harbor Islands Climate Connections

Culminating Activity: Presentations at the Pavilion

Investigation	Title	Presentation
1	What is Weather?	Students will make weather tools and teach the public how to use them.
2	Where's the Air?	Students will build anemometers and use them to demonstrate that air can be captured, as well as sharing their presentations on wind turbines.
3	Seasons and Sun	Students will use model globe from FOSS kit and a flashlight to demonstrate solar angle and its effect on seasons.
4	Heat Transfer	Students will use the four Earth materials to demonstrate temperature change in sunlight and shade.
5	Convection	Students will demonstrate the density of oceans and the atmosphere by making a shake-up toy.
6	Water In The Air	Students will present information about clouds and use the pressure-temperature demonstration to create a cloud.
7	The Water Planet	Students will design a water cycle game and teach the public to play it.
8	Air Pressure and Wind	Students will construct a bottle-in-a-jar pressure indicator and use it to demonstrate air pressure.