Scope and Sequence Models for Building Vertical Science Literacy

For use in the teaching of

Atmosphere, Weather and Climate
Water and Watersheds
Ecosystems and Habitats

Prepared by
NH Education and Environment Team

August 2007

Acknowledgements

Several very talented teachers assisted with the development of this project. The NH Education and Environment Team is very grateful for their wisdom and diligence in vertically integrating activities from our educational materials with the ***NH Curriculum Frameworks for Science Literacy***. These teachers include:

- Ina Ahern, Plymouth Regional High School
- Debra Ames-Kimball, Exeter Area High School
- Linda Carson, Hillsboro-Deering Middle School
- Val Dyer, Henniker Community School
- Val Germain, Henniker Community School
- Kristen Jarvis, Gilmanton Elementary School
- Betsy Rybeck-Lynd, Plainfield Elementary School

This project was funded by a grant from the New Hampshire Department of Education, in fulfillment of the Math and Science Partnership Title IIB of No Child Left Behind Act of 2001, Public Law 107-110.

This document is a work in progress. As it is used by school districts and the NHEET members in support of vertically integrated science teaching, lessons will be learned about those parts that work well and others that may be improved. As this happens, this document will be revised and electronic updates will be posted to www.nhplt.org.

The **NH Education and Environment Team** is a partnership of:

- NH GLOBE Program, North Country Educational Services GLOBE Partnership
- NH Project Learning Tree
- NH Project WET of the NH Department of Environmental Services
- NH Project WILD of the NH Fish and Game Department
- Project HOME of the NH Fish and Game Department
- USDA Forest Service, State & Private Forestry, Northeastern Area, Conservation Education
- USDA Forest Service, White Mountain National Forest, Conservation Education

Contents

A Vision for Vertically Integrated Science Literacy

The New Hampshire Frameworks for Science Literacy, revised in September, 2006, were designed to serve as a guide for curriculum development in all the state's K–12 schools. Teachers are encouraged to use the frameworks to develop a sequence for teaching key concepts or themes that lead their students through a progression of steps designed to increase their knowledge and understanding of a specific topic from grade to grade. Ideally, the skills necessary for later learning are introduced and practiced in the early grades. Basic content is then introduced, with an increasing level of knowledge and complexity added to the subject each succeeding year. Finally, in the higher grades, teachers give students opportunities to apply their knowledge through the exploration of complex issues and integration of concepts. The vertical integration process requires communication among teachers at all grade levels to ensure that the teaching of concepts spirals student learning toward greater depth and complexity. The vision guiding the revision of the frameworks is that teachers would use them to develop spiraling learning sequences for themes that are taught in succeeding years.

Three scope and sequence models are offered as examples of how vertical integration can be accomplished. They use common environmental themes and selected activities from the nationally based Projects Learning Tree, WET, WILD, and HOME; and protocols and activities from the GLOBE Program. Additionally, process oriented Project HOME affords an opportunity for synthesizing prior learning through wildlife habitat enhancement projects.

The Educational Programs

The GLOBE Program is an international K-12 science education program designed as a partnership among scientists for the implementation of data collection at schools to augment on-going research. Data is collected in a range of areas, including atmosphere, earth as a system, hydrology, land cover and soil; and shared with other students and scientists worldwide. For students to post their data on the GLOBE website, teachers must be trained in the individual protocols that pertain to each type of data collected; however, teachers and students can collect data for their own use without being trained and simply follow the protocols outlined on the GLOBE website's Teacher's Guide. The data sets and information about GLOBE in New Hampshire may be accessed on-line at www.globe.gov.

Project HOME (Homes for Wildlife in the Schoolyard), sponsored by the New Hampshire Fish and Game Department, is an award-winning, interdisciplinary, K-8 program for enhancing wildlife habitat and creating outdoor classrooms on school grounds. Students learn in the landscape of their schoolyards and take positive action for wildlife and their habitats. Project HOME emphasizes community-building and developing land stewardship. The curriculum guide, ***Homes for Wildlife***, and a workshop for teachers, other school staff and interested community members, provide the essential information, tools and resources, including inventory and mapping techniques, fundraising, and curriculum integration, to implement a habitat enhancement project in the schoolyard. More information about Project HOME may be found at www.WildNH.com/Education/ed_project_HOME.htm

Project Learning Tree (PLT) offers an award-winning series of activities for students in pre-kindergarten to grade twelve. The curriculum was first developed in 1973, in collaboration with hundreds of teacher and natural resource professionals. As the national environmental education program of the American Forest Foundation, it is continually updated and revised to address changes in educational theory and methods. The materials and activities address both the natural and built environment, including forests, wildlife, water, air, energy, climate change and more. New Hampshire Project Learning Tree (NHPLT) is an independent, non-profit organization that augments the national materials with state specific information for New Hampshire educators and students. More information about NHPLT may be found at www.nhplt.org.

Project WET (Water Education for Teachers) is a national inter-disciplinary, activity-based, K-12 environmental education program that focuses on water, including watersheds, pollution, the water cycle, groundwater and the chemical properties of water. The hands-on, interactive activities are used to supplement water-related lessons taught in the classroom, or in a non-formal educational setting. First introduced in 1984, Project WET materials were developed and field-tested by hundreds of educators and resource managers working with thousands of students nationwide. The New Hampshire Department of Environmental Services, Drinking Water and Groundwater Bureau staff has been offering Project WET educator training since 1997. More information about Project WET may be found at www.des.nh.gov/wet.

Project WILD (Wildlife in Learning Design) is an international, interdisciplinary, activity-based, K-12 supplementary curriculum that focuses on wildlife. It provides strong support in the teaching of natural resource conservation and environmental education concepts, such as habitats, food webs, ecosystems, adaptations and wildlife management. Its goal is to assist students in developing the awareness and knowledge necessary to result in informed decision-making and responsible behavior as adults concerning the conservation of wildlife and the environment. First developed in 1980, Project WILD has been sponsored by the New Hampshire Fish and Game Department in the state since 1985, with additional support from the New Hampshire Wildlife Trust. More information about Project WILD can be found at www.Wildnh.com/Education/project_WILD.htm

New Hampshire Education and Environment Team

In 2002, Projects Learning Tree, WET, WILD and HOME, the GLOBE Program and the U.S. Department of Agriculture (USDA) Forest Service Conservation Education Program in New Hampshire created an alliance called the New Hampshire Education and Environment Team (NHEET). The projects and programs support the teaching of science and environmental education and encourage teachers to take their students outdoors for inquiry-based, experiential learning. The alliance was created to increase the impact and reach of each of the individual member's programs through collaboration and a pooling of resources. By working together through NHEET, higher levels of content and concept integration can be achieved, extending each of the program's missions and benefiting educators, administrators and ultimately, students statewide. Some NHEET accomplishments include joint publicity and workshops, an annual weeklong summer institute and a graduate-level course at the University of New Hampshire called *Earth as a System for Educators*. Contact information for NHEET is in the appendix.

Three Models for Vertical Integration in Science

Ideally, teachers at each grade level strive to increase their students' knowledge and abilities to integrate concepts in science, in other disciplines, and in their lives in general. Increasing responsibilities frequently put constraints on teachers' time and limit opportunities for cooperative planning within a school or district. Too often, teachers are in the position of teaching the same topic, without knowing what has been taught before, and what will be taught after. The result is that teachers at succeeding grade levels may teach the basics of a concept repeating what has been done in previous years. By grade twelve students may have insufficient knowledge and understanding of important topics.

The scope and sequence models included are based on three universal science themes covered in most New Hampshire schools and commonly taught at several different grade levels. The common themes are:

- Atmosphere, weather and climate
- Water and watersheds
- Ecosystems and habitats

The scope and sequence models are examples of how vertical integration of knowledge can be achieved through grades K-12 by aligning the ***New Hampshire Frameworks for Science Literacy*** with the NHEET programs' activities. The scope and sequence models included do not represent complete curricula, but rather, provide suggested activities that help students achieve the level of content and understanding indicated in the science frameworks for the different grade spans and three common themes.

The scope and sequence models outline a way to teach what is already being taught, while also incorporating the environment in a meaningful, inquiry-based format that is aligned with the frameworks. Teaching using environmental themes and affording opportunities for field investigations are ways to engage students in learning how natural systems work and are inter-connected. It helps enhance the understanding of science as an inquiry process that is used by scientists in their research. Hands-on, inquiry-based learning leads students through a process of personal discovery to understanding. They learn how to recognize and identify relationships based on evidence and see how explanations can be logically developed. The activities included in each of the NHEET programs are designed to encourage this type of learning.

Methodology

To develop the three scope and sequence models, activities and/or protocols were selected from the NHEET programs that supported each of the three themes of atmosphere, weather and climate; water and watersheds; and habitats and ecosystems. Those activities were reviewed and the selection refined. They were then grouped according to their correlation with the ***New Hampshire Frameworks for Science Literacy*** breakdown of grade spans: K-2, 3-4, 5-6, 7-8 and 9-12. From those groupings, specific activities, protocols or field investigations were selected. Through the integration of the identified experiences and activities for each theme and grade span, a spiraling K-12 sequence of activities was created for each of the themes that encompassed pre-field experiences, field experiences, post-field experiences and a culminating activity. Also identified were Project HOME extensions, an integration of other disciplines and additional resource suggestions for each theme and grade span. Finally, the three vertically integrated scope and sequence models were created by combining the activities identified from each grade span for each of the themes.

Integrating the Scope and Sequence Models Into Your School Curriculum

A Guide for Curriculum Coordinators, Curriculum Committees, and Teachers

The three scope and sequence models contained in the guide demonstrate for teachers and administrators how the ***New Hampshire Frameworks for Science Literacy*** can be used to design vertically aligned curricula. The models can be used to:

- Help teachers work with their colleagues to foster K-12 science literacy and coherence.
- Model how other science topic strands may be developed.
- Integrate activities from the NHEET partner programs and the outdoors into different curriculum strands at each grade level.
- Gain support for using the ***New Hampshire Frameworks for Science Literacy*** as envisioned, as a developmentally appropriate guideline for choosing activities and experiences that build through the grade levels to achieve a higher level of complexity in science concepts through high school.

A New Hampshire Education and Environment Team plan to achieve full integration would ideally include:

- An initial meeting for all those in a district teaching science, where the NHEET scope and sequence models are introduced for one or more of the topic strands; documentation of existing science practice within their district for teaching the three themes should be readily accessible for referencing.
- Training in the five NHEET programs, including activities and protocols, for groups of teachers within each grade span.
- Teachers and administrators choosing activities and protocols to be implemented at each grade level within each of the grade spans, in a way most appropriate within their school district.
- On-going NHEET support for the integration of the vertically aligned scope and sequence models.
- Additional topic strands introduced in the same manner in subsequent years.

If a plan for full integration cannot be achieved, teachers and students can benefit from a partial adoption of a scope and sequence model topic strand, involving teachers at multiple grade levels. As with the full integration plan, teachers must be trained to use all the programs, including activities and protocols. Individual teachers may also use the scope and sequence models to enhance their curricula.

Observation Skills for Science Fieldwork
Kindergarten – Grade 4 Scope and Sequence

To use the environment as a context for learning, your students must first be given opportunities to learn how to be good observers of the natural world. Whether you are taking your students out into the field for the first time or the tenth time, observation is a learned skill that is best mastered with practice. By observing, discussing and recording what they see, students not only build essential science process skills, but also the vocabulary that is essential to further science discovery. New Hampshire Education and Environment Team resources have many observation activities that can support these skills. The following are a few suggestions.

Essential Question: How Can We Use Our Senses To Explore Our Schoolyard?

Kindergarten – Grade 2

- The **Shape of Things** (PLT) Students use "sight" to find and match several familiar shapes to shapes in their environment.
- **Peppermint Beetle** (PLT) Students use "smell" to explore the forest and animal behavior.
- **Sounds Around** (PLT) Students identify and map "sounds" in their environment.
- **Get in Touch With Trees, Part A** (PLT) Students use "touch and sight" to locate different objects found in a forest.
- **Stream Sense** (WET) Students observe a stream using all of their senses.
- **Water Detectives** (GLOBE) Students use their senses to identify mystery substances.
- **Color Inventory Card** (HOME, ch.1) Students match colors they see on the school site with colors in a box of crayons.

Grades 3 – 4

- **Peppermint Beetle Variation** (PLT) Students describe and identify different smells that are common to them.
- **Learning to Look, Looking to See** (WILD) Students practice their observation skills, including memory, by utilizing things found in the schoolyard environment.
- **Get in Touch With Trees** Part B (PLT) Students use "touch" to find a mystery tree.
- **Graphananimal** (WILD) Students look for pretend evidence of animals in the classroom before going outside to discover real signs of animals. Note: Use pictures of animal signs (ex. tracks, snake skins, scat) instead of pictures of the animals themselves as the activity suggests.
- **Life in the Fast Lane** (WET) Students use a data sheet to record observations and collect data of a temporary wetland.
- **Rainy Day Hike** (WET) Students learn about watersheds by observing and collecting data about water flowing over their school grounds.
- **25 Words Inventory Card** (HOME, Ch. 1) Students investigate all parts of the schoolyard and come up with words to best describe different areas.

Reading the Charts

Grade Level Expectation Flow Charts

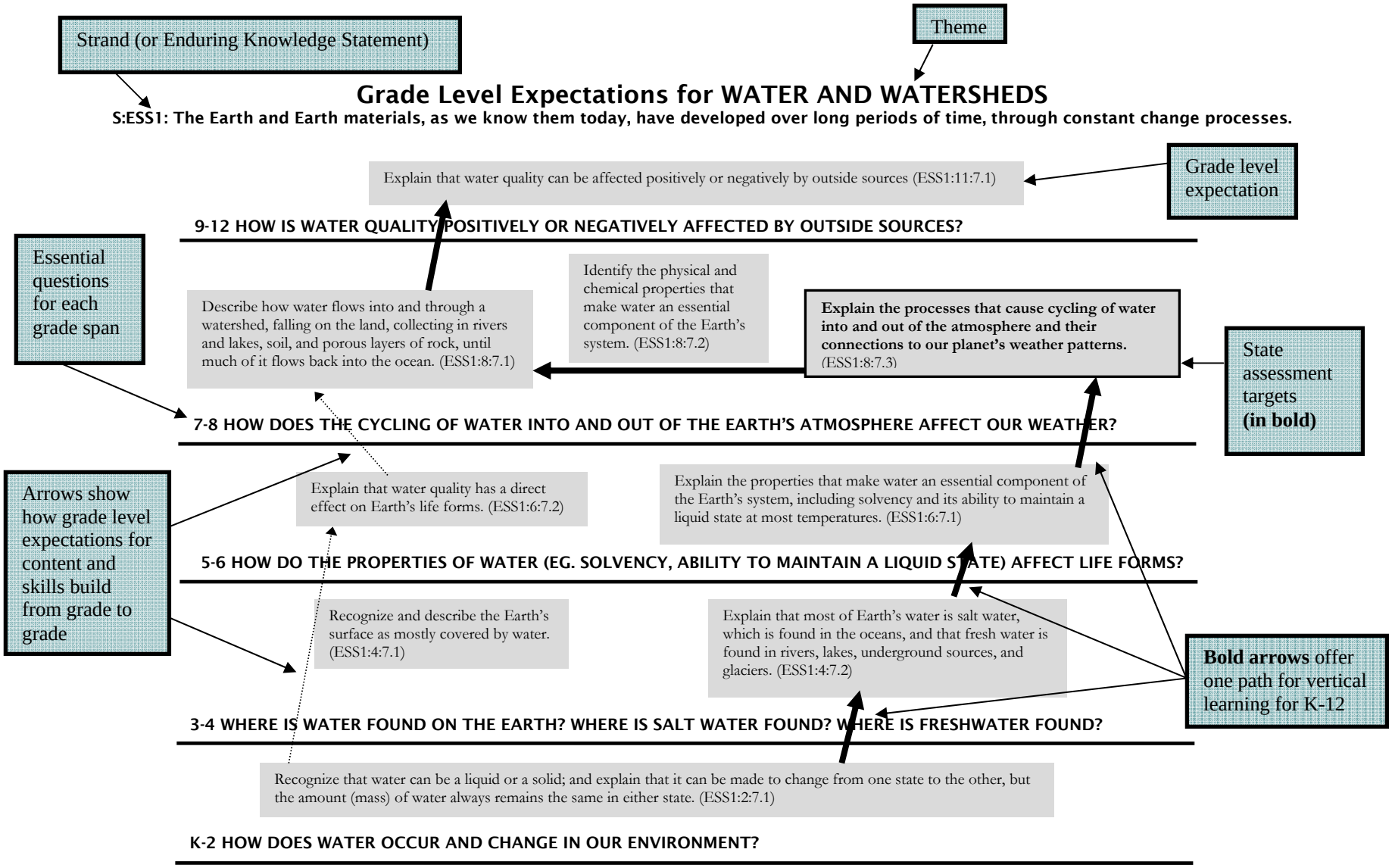
Each of the three major themes is organized into charts using a consistent format. The first is a flow chart of the grade level expectations for a specific strand from the ***New Hampshire Frameworks for Science Literacy*** (see page 8). The frameworks in **bold** are the **state target assessments**. The flow chart shows teachers the level of knowledge their students should have already achieved, what they are expected to know at the completion of the grade span and what new level of knowledge will be expected for them to achieve in the next grade span. The arrows show how content and skills are connected and built upon from grade to grade as identified by the strand and as related to the theme. The bold arrows represent one path of vertical learning from K-12.

Scope and Sequence Charts

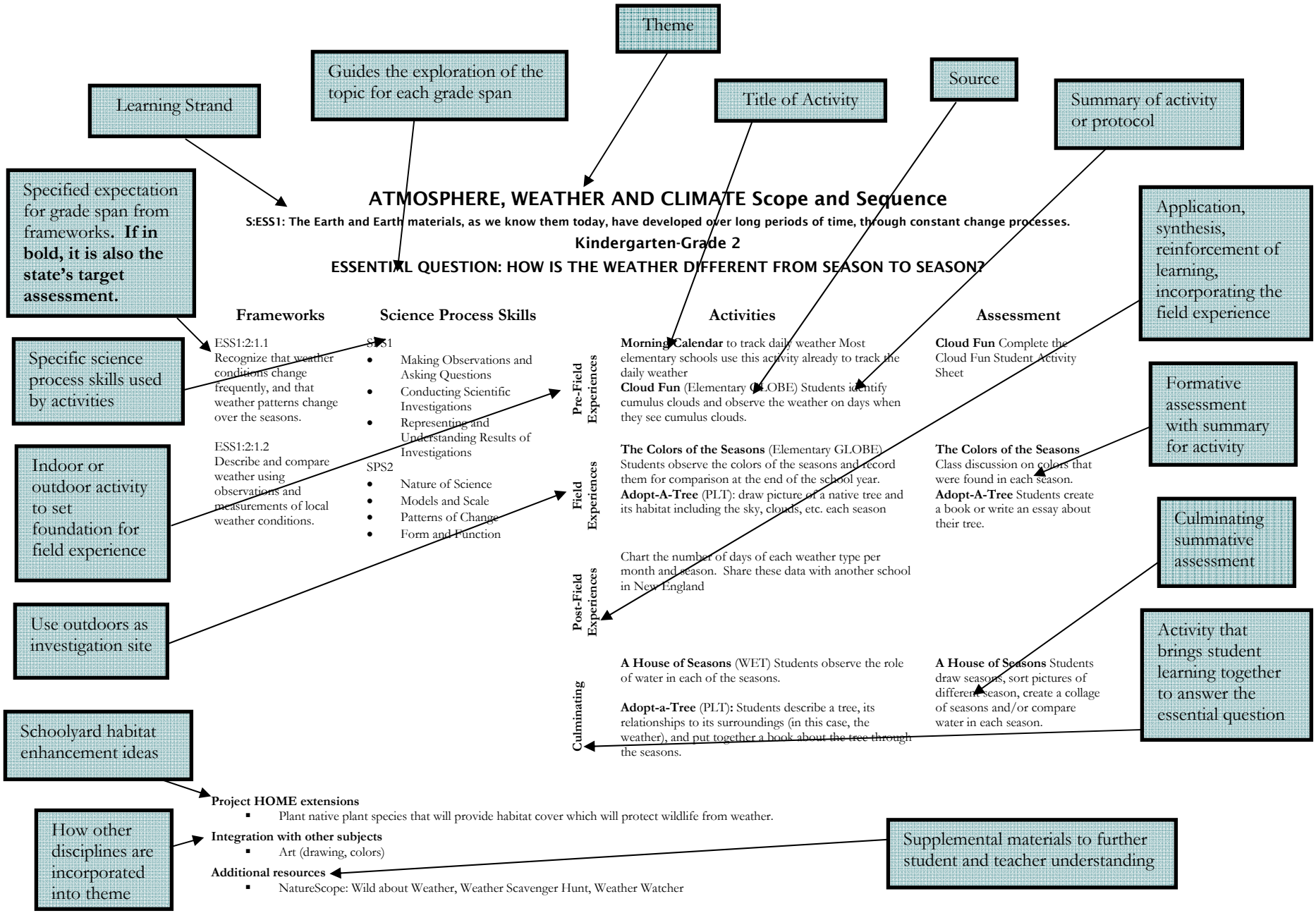
The second chart (see page 9) offers a thematic scope and sequence for each grade level span found in the science frameworks: K-2, 3-4, 5-6, 7-8, and 9-12. In each grade span's scope and sequence chart, an **essential question** is identified to guide exploration of the topic. The first column of each chart is a list of the specific **expectations for that grade span** and theme. The second column is a list of the **science process skills** that are addressed through completion of all of the activities. The third activity column is divided into four rows for **pre-field, field, and post-field experiences, and culminating activities**. This includes activities from the NHEET programs, data collecting protocols from GLOBE, and other recommended activities to complete the experience. The final column includes both **formative and summative assessments** that correspond to the activities where appropriate. The formatting enables teachers to see what specific science frameworks indicators and science process skills are addressed, the activities and programs used and in what order to assure a clear development of a topic, and what assessment pieces are already present or suggested.

Following the flow charts for each grade level span are Project HOME extensions, designed to inspire teachers and their students to enhance their **schoolyard habitat** for wildlife. Also listed are suggestions for how **other disciplines** may be integrated into investigating the essential question. Finally, **additional resources** and supplemental materials are listed to support further teacher and student understanding of the theme.

How to Read the Grade Level Expectations Flow Charts



How to Read the Scope and Sequence Charts



Grade Level Expectations for ATMOSPHERE, WEATHER AND CLIMATE

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.

Explain how winds and ocean currents are created on the Earth's surface. (ESS1:11:1.1)

Explain how heat and energy transfer in and out of the atmosphere; and provide examples of how it is related to weather and climate. (ESS1:11:1.2)

Describe how Earth's atmospheric composition has changed from the formation of the Earth through current time. (ESS1:11:1.3)

Explain how Earth's features can affect wind and weather patterns by causing air to rise and increasing precipitation. (ESS1:11:1.4)

9-12 WHAT ARE THE RELATIONSHIPS AMONG ATMOSPHERE, WEATHER AND CLIMATE?

Identify and describe the processes of the water cycle and explain their effects on climatic patterns. (ESS1:8:1.1)

Identify and describe the impact certain factors have on the Earth's climate, including changes in the oceans' temperature, changes in the composition of the atmosphere, and geological shifts due to events such as volcanic eruptions and glacial movements. (ESS1:8:1.2)

7-8 HOW IS YOUR CLIMATE INFLUENCED BY THE PROCESSES OF THE WATER CYCLE?

Describe and make predictions about local and regional weather conditions using observation and data collection methods. (ESS1:6:1.1)

Explain the composition and structure of the Earth's atmosphere. (ESS1:6:1.3)

Describe how clouds affect weather and climate, including precipitation, reflecting light from the sun, and retaining heat energy emitted from the Earth's surface. (ESS1:6:1.5)

Identify weather patterns by tracking weather related events, such as hurricanes. (ESS1:6:1.2)

Describe weather in terms of temperature, wind speed and direction, precipitation, and cloud cover. (ESS1:6:1.4)

5-6 WHAT ARE THE KEY CHARACTERISTICS OF WEATHER IN YOUR TOWN?

Explain how water exists in the atmosphere in different forms and describe how it changes from one form to another through various processes such as freezing, condensation, precipitation and evaporation. (ESS1:4:1.1)

Based on data collected from daily weather observations, describe weather changes or weather patterns. (ESS1:4:1.3)

Explain that air surrounds the Earth, it takes up space, and it moves around as wind. (ESS1:4:1.2)

Explain how the use of scientific tools helps to extend senses and gather data about weather (i.e., weather/wind vane– direction; wind sock– wind intensity; anemometer– speed; thermometer– temperature; meter sticks/rulers– snow depth; rain gauges– rain amount in inches). (ESS1:4:1.4)

3-4 HOW DOES NATURE PROVIDE EVIDENCE THAT WINTER IN CHANGING INTO SPRING?

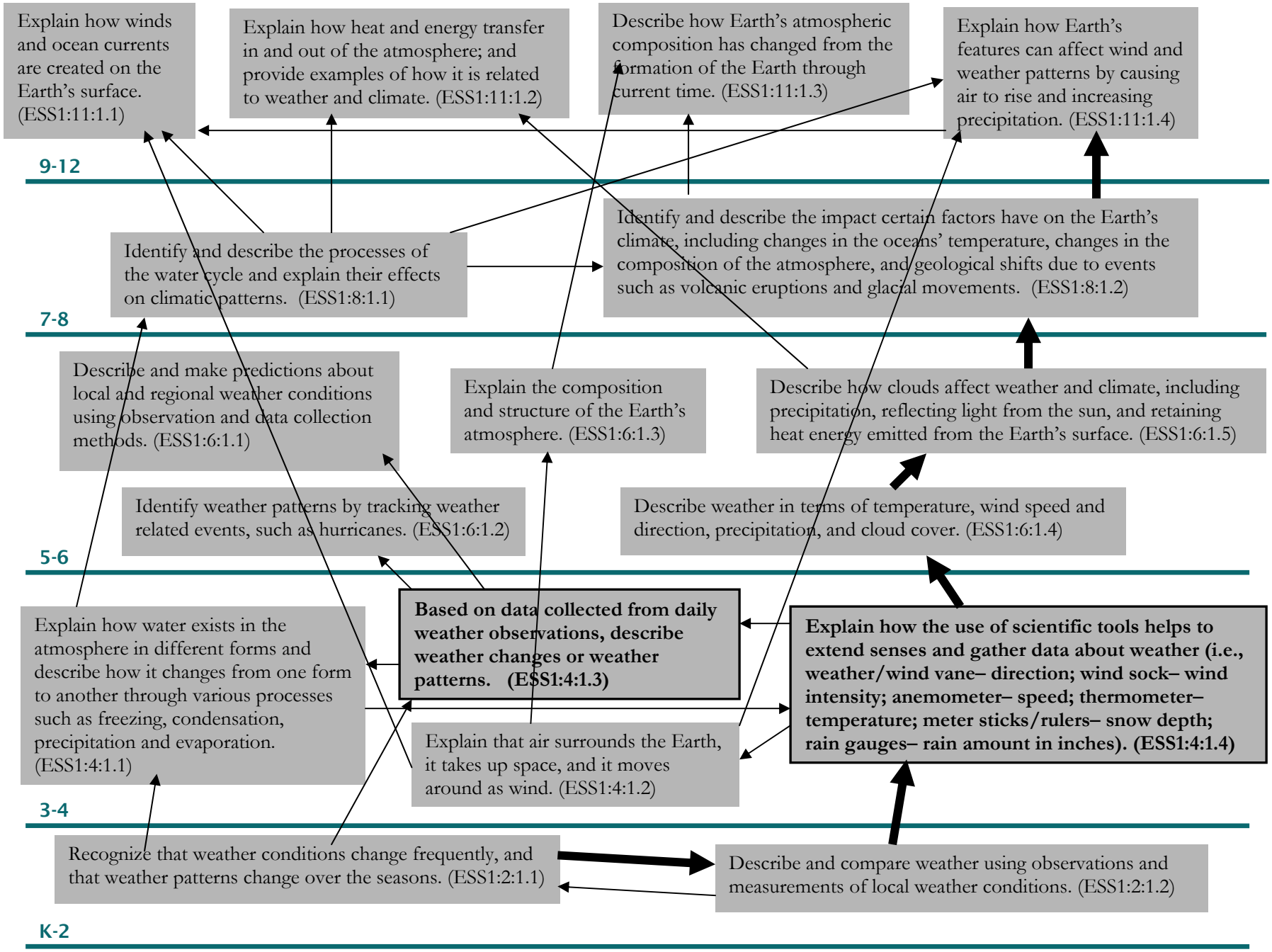
Recognize that weather conditions change frequently, and that weather patterns change over the seasons. (ESS1:2:1.1)

Describe and compare weather using observations and measurements of local weather conditions. (ESS1:2:1.2)

K-2 HOW IS THE WEATHER DIFFERENT FROM SEASON TO SEASON?

Grade Level Expectations for ATMOSPHERE, WEATHER AND CLIMATE

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.



Atmosphere, Weather and Climate Scope and Sequence

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.

Kindergarten – Grade 2

ESSENTIAL QUESTION: HOW IS THE WEATHER DIFFERENT FROM SEASON TO SEASON?

Frameworks	Science Process Skills	Activities		Assessment
ESS1:2:1.1 Recognize that weather conditions change frequently, and that weather patterns change over the seasons. ESS1:2:1.2 Describe and compare weather using observations and measurements of local weather conditions.	SPS1 • Making Observations and Asking Questions • Conducting Scientific Investigations • Representing and Understanding Results of Investigations SPS2 • Nature of Science • Models and Scale • Patterns of Change • Form and Function SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Problem Identification, Formulation, and Solution • Interpersonal and Collaborative Skills • Self Direction • Accountability and Adaptability • Social Responsibility	Pre-Field Experiences	**Morning Calendar** to track daily weather. Most elementary schools use this activity already to track the daily weather. **Cloud Fun** (Elementary GLOBE). Students identify cumulus clouds and observe the weather on days when they see cumulus clouds.	**Cloud Fun.** Complete the Cloud Fun Student Activity Sheet.
		Field Experiences	**The Colors of the Seasons** (Elementary GLOBE). Students observe the colors of the seasons and record them for comparison at the end of the school year. **Adopt-A-Tree** (PLT). Students draw picture of a native tree and its habitat including the sky, clouds, etc. each season.	**The Colors of the Seasons.** Class discussion on colors that were found in each season. **Adopt-A-Tree.** Students create a book or write an essay about their tree.
		Post-Field Experience	Students chart the number of days of each weather type per month and season. Share these data with another school in New England.	
		Culminating	**A House of Seasons** (WET). Students observe the role of water in each of the seasons. **Adopt-a-Tree** (PLT). Students "adopt" a tree, deepening their awareness of individual trees over time.	**A House of Seasons.** Students draw seasons, sort pictures of different season, create a collage of seasons and/or compare water in each season. **Adopt-a-Tree** (PLT). Students describe a tree, its relationships to its surroundings (in this case, the weather), and put together a book about the tree through the seasons.

Project HOME extensions

- Plant native plant species that will provide habitat cover which will protect wildlife from weather.

Integration with other subjects

- Art (drawing, colors) and Math (graphing, counting)

Additional resources

- NatureScope's *Wild about Weather*, "Weather Scavenger Hunt" and "Weather Watcher" (National Wildlife Federation)

Atmosphere, Weather and Climate Scope and Sequence

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.

Grades 3 – 4

ESSENTIAL QUESTION: HOW DOES NATURE PROVIDE EVIDENCE THAT WINTER IS CHANGING TO SPRING?

Frameworks	Science Process Skills	Activities		Assessment
ESS1:4:1.1 Explain how water exists in the atmosphere in different forms and describe how it changes from one form to another through various processes such as freezing, condensation, precipitation and evaporation. ESS1:4:1.2 Explain that air surrounds the Earth, it takes up space, and it moves around as wind. ESS1:4:1.3 Based on data collected from daily weather observations, describe weather changes or weather patterns. **ESS1:4:1.4** **Explain how the use of scientific tools helps to extend senses and gather data about weather (i.e., weather/wind vane– direction; wind sock– wind intensity; anemometer– speed; thermometer– temperature; meter sticks/rulers– snow depth; rain gauges– rain amount in inches).**	SPS1 • Making Observations and Asking Questions • Designing Scientific Investigations • Conducting Scientific Investigations • Representing and Understanding Results of Investigations • Evaluating Scientific Explanations SPS2 • Nature of Science • Patterns of Change SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Problem Identification, Formulation, and Solution • Interpersonal and Collaborative Skills • Self Direction	**Pre-Field Experiences**	**Morning Calendar** to track daily weather, see K-2. **Poetic Precipitation** (WET). Students create poems about precipitation and how it makes them feel. **Observing, Describing, and Identifying Clouds**, without contrails (GLOBE). Students observe clouds using a common vocabulary and then compare it to the scientific vocabulary. **Learning to Look, Looking to See** (WILD). Students practice their observation skills in the environment.	**Poetic Precipitation.** Students diagram cloud formation and write or analyze poems about weather. **Observing, Describing, and Identifying Clouds.** Students create a personal cloud booklet. **Learning to Look, Looking to See.** Students draw pictures of people they know to see how well they observe, then create a report about an insect they observe.
		Field Experiences	**Cloud Watch** (GLOBE). Students explore the connections between clouds, cloud cover and weather. Use weather, clouds, temperature, trees, other plants and animals to **investigate the essential question**. Pairs of students use one of the signs of winter changing into spring to investigate. Carried out from February to May.	**Cloud Watch**. Based on their data collection, students test if they can predict the weather based on the clouds.
		Post-Field Experiences	Morning calendar including **Cloud Protocol** and **Clouds 1-Measurement Data Sheet** (GLOBE). Create a monthly, average or daily line graph.	**Investigation Assessment Activity for Atmosphere, Primary** (GLOBE)**.**
		Culminating	Students present findings about essential question investigation in formal presentations to class, other grade level, administration, school board, etc.	

Project HOME extensions

- Plant sunflowers or other plants that follow the sun.
- Build/install a weather station.
- Use the school flagpole as a sundial.

Integration with other subjects

- Art (poem, drawing)
- Literacy (poetry)
- Math (measurement, graphing)

Additional resources

- GLOBE Assessment Activity: *www.globe.gov/fsl/educorn/assessment/atmosphere/atmosPSinvest.html*
- Below Zero: supplemental winter activity guide from Project WILD (NH Fish & Game Department)

Atmosphere, Weather and Climate Scope and Sequence

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.

Grades 5 – 6

ESSENTIAL QUESTION: WHAT ARE THE KEY CHARACTERISTICS OF WEATHER IN YOUR TOWN?

Frameworks	Science Process Skills	Activities		Assessment
ESS1:6:1.1 Describe and make predictions about local and regional weather conditions using observation and data collection methods. ESS1:6:1.2 Identify weather patterns by tracking weather related events, such as hurricanes. ESS1:6:1.3 Explain the composition and structure of the Earth's atmosphere. ESS1:6:1.4 Describe weather in terms of temperature, wind speed and direction, precipitation, and cloud cover. ESS1:6:1.5 Describe how clouds affect weather and climate, including precipitation, reflecting light from the sun, and retaining heat energy emitted from the Earth's surface.	SPS1 • Making Observations and Asking Questions • Conducting Scientific Investigations • Representing and Understanding Results of Investigations SPS2 • Nature of Science • Models and Scale • Patterns of Change SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Problem Identification, Formulation, and Solution • Interpersonal and Collaborative Skills • Self Direction • Accountability and Adaptability	**Pre-Field Experiences**	**Observing, Describing, and Identifying Clouds**, with contrails (GLOBE). Students observe clouds using a common vocabulary and then compare it to the scientific vocabulary. **Estimating Cloud Cover** (GLOBE). Students practice estimating cloud cover using torn pieces of paper glued on a contrasting background. **Observing Visibility and Sky Color** (GLOBE). Students become aware of changes in visibility and sky color due to particles suspended in the air. When a local precipitation event happens, **Nature Rules** (WET). Students create a newspaper report about a precipitation event.	**Observing, Describing, and Identifying Clouds.** Students create a personal cloud booklet. **Estimating Cloud Cover.** Class discussion on accuracy of predictions. **Observing Visibility and Sky Color.** Questions on correlations between sky color and weather. Summary chart. **Nature Rules.** Students write and critique stories on photos, draw a disaster scene and discuss "Nature Rules."
		Field Experiences	Daily • **Soil and Air Temperature** (GLOBE) • **Cloud Protocol** (GLOBE) • **Precipitation Protocols** (GLOBE)	**Investigation Assessment Activity for Atmosphere, Elementary** and **Protocol Checklists for Students** (GLOBE).
		Post-Field Experiences	Analyze data for patterns and relationships.	
		Culminating		

Project HOME extensions

- Using the collected weather data, determine what species of plants would be best suited to your school site if you were to carry out a habitat enhancement project.

Integration with other subjects

- Art (drawing)
- Math (estimating, measurement)
- Writing (newspaper report)

Additional resources

- GLOBE Assessment Activity URL: *www.globe.gov/fsl/educorn/assessment/atmosphere/atmosESinvest.html*
- GLOBE Protocol Check List URL: *www.globe.gov/fsl/educorn/assessment/atmosphere/atmospherehome.html*
- Winter Weather and White-tailed Deer: Winter Severity Index (NH Fish & Game Department)

Atmosphere, Weather and Climate Scope and Sequence

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.

Grades 7 – 8

ESSENTIAL QUESTION: HOW IS YOUR CLIMATE INFLUENCED BY THE PROCESSES OF THE WATER CYCLE?

Frameworks	Science Process Skills	Activities		Assessment
ESS1:8:1.1 Identify and describe the processes of the water cycle and explain their effects on climatic patterns. ESS1:8:1.2 Identify and describe the impact certain factors have on the Earth's climate, including changes in the oceans' temperature, changes in the composition of the atmosphere, and geological shifts due to events such as volcanic eruptions and glacial movements.	SPS1 • Making Observations and Asking Questions • Conducting Scientific Investigations • Representing and Understanding Results of Investigations SPS2 • Systems and Energy • Models and Scale • Patterns of Change SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Problem Identification, Formulation, and Solution • Creativity and Intellectual Curiosity • Interpersonal and Collaborative Skills • Self Direction • Accountability and Adaptability	Pre-Field Experiences	**Water Wonders** Part A (PLT). Students simulate the path of water in the water cycle and discuss its importance to living things. **Water Models** (WET). Students create models of the water cycle and demonstrate how water cycles in various ecosystems.	**Water Wonders** (PLT). Students revise their definition of the water cycle with what they have learned. **Water Models** (WET). Students describe how the world shares water.
		Filed Experiences	Daily • **Relative Humidity Protocol** (GLOBE). • **Surface Temperature Protocol** (GLOBE). • **Air Temperature** (GLOBE). • **Water Temperature Protocol** (GLOBE). • **Soil Temperature** (GLOBE). Monthly **Gravimetric Soil Moisture** (GLOBE). **High/Low Temperature Site Inventory Card** (HOME, Ch. 4). Students identify the areas of the highest and lowest temperatures on the school site.	**Investigation Assessment Activity for Atmosphere, Middle School** (GLOBE). **Atmosphere Protocol Checklists for Students** (GLOBE). **Soil Protocol Checklists for Students** (GLOBE).
		Post-Field Experiences	**Piece It Together** (WET). Students analyze and plot global temperature and precipitation to determine climate patterns. **Water Wonders** Part B (PLT). Students conduct a simple experiment to determine what effect plants have on watersheds and water quality.	**Piece It Together** (WET). Students identify three global climates, compare the sun's angles, match characters to their climates and describe how people adapt to climate. **Water Wonders** (PLT). Students compare water crossing bare soil and water crossing through a forest floor.
		Cumulating	After collecting months of data and comparing it to previous years' of data, students carry out **data analysis to determine climatic patterns**.	

Project HOME extensions

- In groups of four students, ask groups to design a hypothetical or conceptual habitat enhancement project for a site where the ground has no slope.
- Once completed, students then modify their project for a site with sloped ground.

Integrations with other subjects

- Writing (story)
- Math (graphing)
- Geography (comparing various ecosystems, climate patterns)

Additional resources

- GLOBE Assessment Activity URL: *www.globe.gov/fsl/educorn/assessment/atmosphere/atmosMSinvest.html*
- GLOBE Protocol Check List URL: *www.globe.gov/fsl/educorn/assessment/atmosphere/atmospherehome.html*
- GLOBE Protocol Check List URL: *www.globe.gov/fsl/educorn/assessment/soils/soilshome.html*

Atmosphere, Weather and Climate Scope and Sequence

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.

Grades 9 – 12

ESSENTIAL QUESTION: WHAT ARE THE RELATIONSHIPS AMONG ATMOSPHERE, WEATHER AND CLIMATE?

Frameworks	Science Process Skills		Activities	Assessment
ESS1:11:1.1 Explain how winds and ocean currents are created on the Earth's surface. ESS1:11:1.2 Explain how heat and energy transfer in and out of the atmosphere; and provide examples of how it is related to weather and climate. ESS1:11:1.3 Describe how Earth's atmospheric composition has changed from the formation of the Earth through current time. ESS1:11:1.4 Explain how Earth's features can affect wind and weather patterns by causing air to rise and increasing precipitation.	SPS1 • Making Observations and Asking Questions • Designing Scientific Investigations • Conducting Scientific Investigations • Representing and Understanding Results of Investigations • Evaluating Scientific Explanations SPS2 • Nature of Science • Systems and Energy • Models and Scale • Patterns of Change SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation • Science and Technology, Technological Design and Application SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Problem Identification, Formulation, and Solution • Self Direction • Accountability and Adaptability • Social Responsibility	Pre-Field Experiences	**Rain Reasons** (PLT). Students explore the relationships between water, light and temperature on plant growth, precipitation and geography on plant and animal species. **S5: Seasonal Change on Land and Water** (GLOBE). Students use visualizations on incoming sunlight and surface temperature to support inquiry on the differences in seasonal change in the Northern and Southern Hemispheres. **Learning Activities for the GLOBE Earth System Poster Activity 4** (GLOBE). Students identify patterns in satellite imagery (solar energy, surface temperature, clouds, precipitation, soil moisture and vegetation) and look for them in other columns to determine whether those patterns hold for other kinds of data. **S4: Modeling the Reasons for Seasonal Change** (GLOBE). Students investigate what causes the Earth's seasons, with a focus on the Earth's tilt and its spherical shape. **GC1: Your Regional and Global Connection** (GLOBE). Students trace possible pathways of water and wind currents from their part of the continent to other continents, and identify what the wind and water carry. **Learning to Use Visualizations: An Example with Elevation and Temperature** (GLOBE). Students make sense of elevation and temperature data and explore the relationships between the two variables by using them to compute the lapse rate, the rate at which temperature falls with increasing elevation.	**Rain Reasons.** Evaluate how well students can use maps and understand the relationships they studied. **S5: Seasonal Change on Land and Water.** Use the Activity rubric to assess student learning. **Learning Activities for the GLOBE Earth System Poster Activity 4.** Evaluate student knowledge through class discussion using Guidance Questions. **S4: Modeling the Reasons for Seasonal Change.** Use the Activity rubric to assess student learning. **GC1: Your regional and global connection.** Use the Activity rubric to assess student learning. **Learning to Use Visualizations: An Example with Elevation and Temperature.** Use the Activity rubric to assess student learning.

Frameworks	Science Process Skills	Activities		Assessment
		Field Experiences	Daily • **Water Vapor Protocol** (GLOBE). • **Barometric Pressure Protocol** (GLOBE). • **Relative Humidity Protocol** (GLOBE). • **Precipitation Protocols** (GLOBE). • **Digital Multi-Day Max/Min/Current Air and Soil Temperature Protocol** (GLOBE). • **Aerosols Protocol** (GLOBE). • **Surface Ozone Protocol** (GLOBE).	**Investigation Assessment Activity for Atmosphere, High School** (GLOBE). **Atmosphere Protocol Checklists for Students** (GLOBE). **Soil Protocol Checklists for Students** (GLOBE).
		Post-Field Experiences	**RC1: Defining Regional Boundaries** (GLOBE). Students determine how to identify boundaries of a regional system using Landsat regional data and topographic maps. **RC2: Effects of Inputs and Outputs on a Region** (GLOBE). Students draw an imaginary box over an area on a topographic map and using all the spheres (atmosphere, biosphere, hydrosphere, lithosphere), generate questions about changes to inputs and outputs of the system in their area. **The Global Climate** (PLT). Students use data collected from Mauna Loa to measure changes in CO_2 amounts. Students use the GLOBE climate database to compare their data to another region in the country. Using graphs, students will compare soil and air temperatures. Students view **images of environmental change** using satellite imagery: earthshots.usgs.gov/tableofcontents.	**RC1: Defining regional boundaries.** Use the Activity rubric to assess student learning. **RC2: Effects of inputs and outputs on a region.** Use the Activity rubric to assess student learning. **The Global Climate.** Students write a "minute paper" predicting CO2 levels 20 years from now and the effects of those levels.
		Culminating	**Learning Activities for the GLOBE Earth System Poster Activity 3** (GLOBE). Students explore connections in a typical year. • Explain the relationship between solar energy and average temperature in a month going across the poster. • Determine what amounts of solar energy, cloud cover, and soil moisture characterize the most vegetated regions? • If the cloud amount in NH was reduced by 25%, predict changes for NH. • Explain how the global pattern of solar energy relates to the other data on the poster.	**Learning Activities for the GLOBE Earth System Poster Activity 3.** Evaluate student knowledge through class discussion using Guidance Questions.

Project HOME extensions

- Identify an area of your site with a particular microclimate, then map that site and describe its climate.

Integration with other subjects

- Art (graphic design)
- Math (graphing, slopes)
- Geography (climate, ecosystems, global patterns)
- English (writing)
- Physics (behavior and use of light, energy)
- Chemistry (pH, energy),
- Earth Science (sun-Earth relationships)

Additional resources

- As an alternate to RC1: Mapping Climate Patterns with ArcView GIS 3.x from MOBOT site: *www.mobot.org/education/mapping/mapcr.html.* Students will use a PDF document to guide them through viewing US climate data.
- GLOBE Assessment Activity URL: *www.globe.gov/fsl/educorn/assessment/atmosphere/atmosHSinvest.html*
- GLOBE Protocol Check List URL: *www.globe.gov/fsl/educorn/assessment/atmosphere/atmospherehome.html*
- GLOBE Protocol Check List URL: *www.globe.gov/fsl/educorn/assessment/soils/soilshome.html*

Grade Level Expectations for WATER AND WATERSHEDS

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.

Explain that water quality can be affected positively or negatively by outside sources (ESS1:11:7.1)

9-12 HOW IS WATER QUALITY POSITIVELY OR NEGATIVELY AFFECTED BY OUTSIDE SOURCES?

Describe how water flows into and through a watershed, falling on the land, collecting in rivers and lakes, soil, and porous layers of rock, until much of it flows back into the ocean. (ESS1:8:7.1)

Identify the physical and chemical properties that make water an essential component of the Earth's system. (ESS1:8:7.2)

Explain the processes that cause cycling of water into and out of the atmosphere and their connections to our planet's weather patterns. (ESS1:8:7.3)

7-8 HOW DOES THE CYCLING OF WATER INTO AND OUT OF THE EARTH'S ATMOSPHERE AFFECT OUR WEATHER?

Explain that water quality has a direct effect on Earth's life forms. (ESS1:6:7.2)

Explain the properties that make water an essential component of the Earth's system, including solvency and its ability to maintain a liquid state at most temperatures. (ESS1:6:7.1)

5-6 HOW DO THE PROPERTIES OF WATER (EG. SOLVENCY, ABILITY TO MAINTAIN A LIQUID STATE) AFFECT LIFE FORMS?

Recognize and describe the Earth's surface as mostly covered by water. (ESS1:4:7.1)

Explain that most of Earth's water is salt water, which is found in the oceans, and that fresh water is found in rivers, lakes, underground sources, and glaciers. (ESS1:4:7.2)

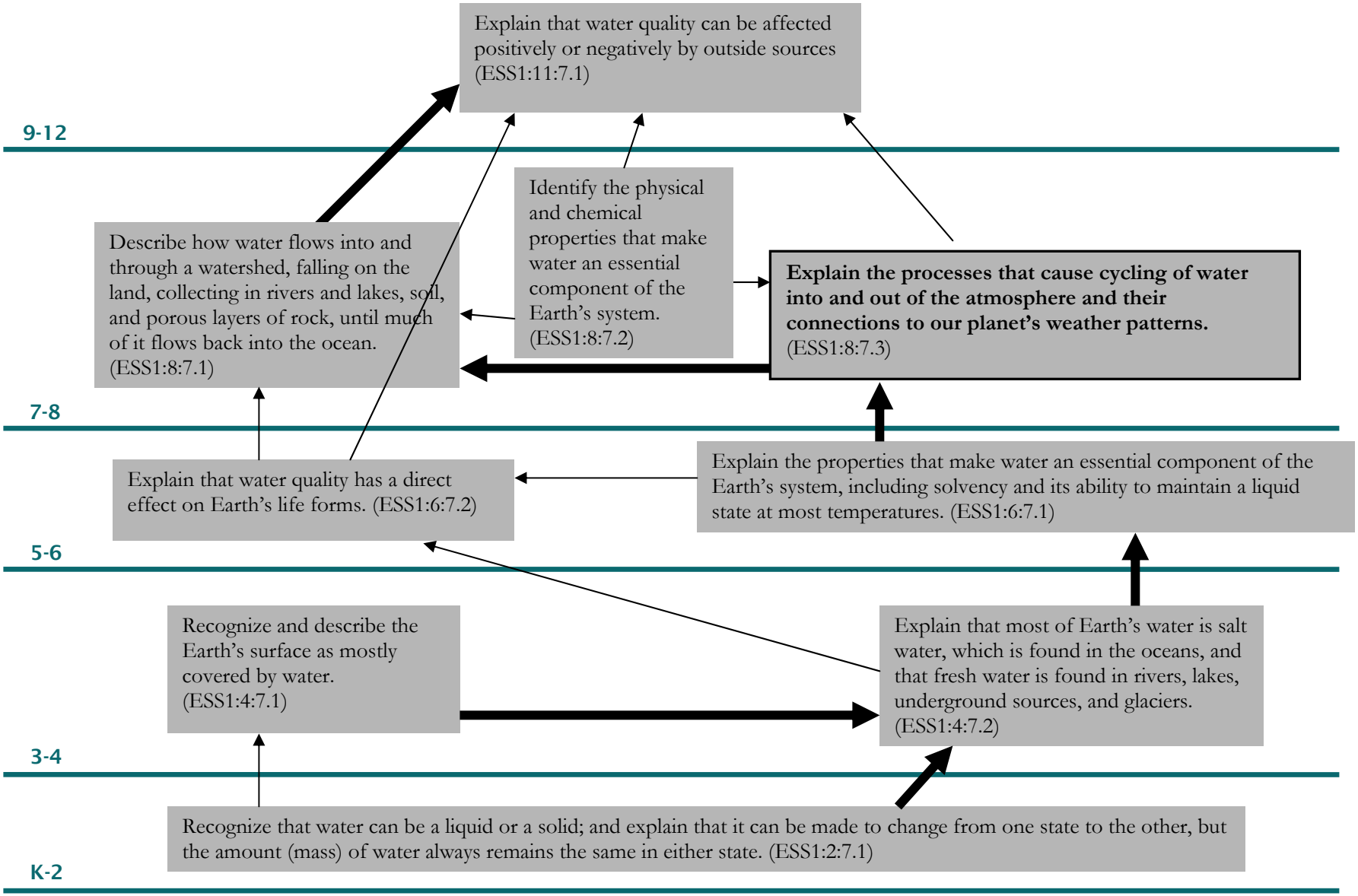
3-4 WHERE IS WATER FOUND ON THE EARTH? WHERE IS SALT WATER FOUND? WHERE IS FRESHWATER FOUND?

Recognize that water can be a liquid or a solid; and explain that it can be made to change from one state to the other, but the amount (mass) of water always remains the same in either state. (ESS1:2:7.1)

K-2 HOW DOES WATER OCCUR AND CHANGE IN OUR ENVIRONMENT?

Grade Level Expectations for WATER AND WATERSHEDS

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.



Water and Watersheds Scope and Sequence

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.

Kindergarten – Grade 2

ESSENTIAL QUESTION: HOW DOES WATER OCCUR AND CHANGE IN OUR ENVIRONMENT?

Frameworks	Science Process Skills	Activities		Assessment
ESS1:2:7.1 Recognize that water can be a liquid or a solid; and explain that it can be made to change from one state to the other, but the amount (mass) of water always remains the same in either state.	SPS1 • Making Observations and Asking Questions • Conducting Scientific Investigations • Representing and Understanding Results of Investigations SPS2 • Nature of Science • Systems and Energy • Models and Scale • Patterns of Change • Form and Function SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation • Science and Technology. Technological Design and Application SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking	Pre-Field Experiences	**Aqua Words** (WILD Aquatic). Students describe a variety of ways and reasons that water is important to people and wildlife. **Thunderstorm Part I** (WET). Students simulate the sounds of a thunderstorm. **Water Match** (WET). Students match up pairs of water picture cards. (Be sure to include snow, ice, and steam. Why are they important and what does water "look like" in pictures?)	**Aqua Words. S**tudents explain how living things use water and its importance by writing a short story or using visual vocabulary techniques. **Thunderstorm, Part I.** Students share thunderstorm stories and match the sounds with the events. **Water Match.** Students describe the states of water and discuss their opinions on pollution.
		Field Experiences	**Wet/Dry Spots Inventory Card** (HOME p. 68). Students inventory the schoolyard for water. Where does water exist on the schoolyard and how is it used? Daily **Precipitation Protocols** (GLOBE). The **maple sugaring process** provides a wonderful field experience to explore changing states of matter, including snow and snow melt, sap as liquid, and evaporation. **To Be a Tree** and **Tree Factory** (PLT) provide good background for students on how water flows through trees.	**Wet/Dry Spots Inventory Card.** Students correctly indicate where water is on a sketch of the schoolyard. **Precipitation Protocols.** Atmosphere Protocol Checklists for Students.
		Post-Field Experiences	**Cold Cash in the Icebox** (WET). Students design iceboxes to keep ice from melting.	**Cold Cash in the Icebox.** Evaluate predictions and design of iceboxes.

Frameworks	Science Process Skills	Activities		Assessment
	• Problem Identification, Formulation, and Solution • Interpersonal and Collaborative Skills • Self Direction	Culminating	Read **Bob the Snowman** by Sylvia Loretan and Jan Lenico. This story explains the process of snow formation while touching delicately on the cycle of life-death-rebirth. Make your own "Bob the Snowman" and take digital images of its changes over time.	Students act out the different states of Bob, and/or write their own story using two states of water (i.e. solid, liquid, or gas).

Project HOME extensions

Integration with other subjects

- Writing, Literacy
- Art (music)
- Math (measuring)
- History (iceboxes)

Additional resources

- Below Zero supplemental activity book (Project WILD)
- GLOBE Protocol Check List URL: *www.globe.gov/fsl/educorn/assessment/atmosphere/atmospherehome.html*

Water and Watersheds Scope and Sequence

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.

Grade 3 – 4

ESSENTIAL QUESTIONS: WHERE IS WATER FOUND ON THE EARTH? WHERE IS SALT WATER FOUND? WHERE IS FRESHWATER FOUND?

Frameworks	Science Process Skills	Activities		Assessment
ESS1:4:7.2 Recognize and describe the Earth's surface as mostly covered by water. ESS1:4:7.2 Explain that most of Earth's water is salt water, which is found in the oceans, and that fresh water is found in rivers, lakes, underground sources, and glaciers.	SPS1 • Making Observations and Asking Questions • Conducting Scientific Investigations • Representing and Understanding Results of Investigations • Evaluating Scientific Explanations SPS2 • Systems and Energy • Models and Scale • Patterns of Change SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Problem Identification, Formulation, and Solution • Interpersonal and Collaborative Skills • Self Direction	Pre-Field Experiences	**Molecules in Motion** (WET). Students simulate molecular movement of water in three states. **Old Water** (WET). Students create a mural that relates events to the age of the Earth, water, and life. **A Drop in the Bucket** (WET). Students estimate and calculate the percent of fresh water. **Incredible Journey** (WET) or **Water Wonders** (PLT). Students simulate water movement through the water cycle.	**Molecules in Motion.** Students write or draw about how water changes to different states. **Old Water.** Students indicate on a time line drawn the appearance of water, life, and humans on Earth. **A Drop in the Bucket.** Students create a commercial about water as a limited resource. **Incredible Journey** or **Water Wonders.** Students write a story about the movement of water through the water cycle.
		Field Experiences	**Grid and Baseline Offset Mapping** (HOME). Students use grid mapping and baseline offset mapping on small and large areas of the schoolyard. **Thunderstorm** Part II (WET). Students create a precipitation map of a mock thunderstorm. **Snow Melt Observation**. Students observe snow melt in small containers. **Stream Sense** (WET). Students use all senses to observe a stream, learning there is a lot more to flowing water. **Rainy Day Hike** (WET). Students collect data about water flowing around their school to introduce the concept of a watershed. Daily **Precipitation Protocols** (GLOBE). **Wet/Dry Spots Inventory Card** (HOME). Students inventory your schoolyard for water. Where does water exist on the schoolyard and how is it used? Visit a weather station**.**	**Grid and Baseline Offset Mapping.** Students create a schoolyard map. **Thunderstorm**. Evaluate how well students can interpret a precipitation map. **Stream Sense.** Students create a mobile that includes things perceived through their senses at the stream site. They also create a sensory guide sheet to educate others about the things someone might see, hear, touch, and smell at a stream. **Rainy Day Hike.** Students create a list of ways the school affects the water running over the schoolyard. **Precipitation Protocols.** Atmosphere Protocol for Students

Frameworks	Science Process Skills	Activities		Assessment
		Post-Field Experiences	**Branching Out** K-2 option (WET). Using branches of trees, students investigate how water flows in a watershed. **Silt: A Dirty Word** (WILD Aquatic). Students explore how sand and silt affect water flow. **Water Concentration** (WET). Students play the game of Concentration and discover how water use practices have evolved. **Every Drop Counts** (WET). Students identify and implement water conservation habits.	**Branching Out.** Students discuss how water flows from smaller streams to, eventually, a larger water body. **Silt: A Dirty Word.** Students chart and discuss the results of the activity and draw pictures of a healthy and polluted (silted) stream. **Water Concentration.** Students write a story concerning the influence of current and past water use practices and methods and identify reasons these practices have evolved. **Every Drop Counts.** Students write or produce a commercial about water conservation.
		Culminating	**Watered Down History** (WILD Aquatic). Students identify organisms associated with a waterway and predict its future. **Water Models** (WET). Students create models of the water cycle in various ecosystems.	**Watered Down History.** Students write a story on how a water body has changed over time and what it will look like in the future. Roleplay the two sides of an issue on building a dam. **Water Models.** Students describe how the world shares water.

Project HOME extensions

- Construct a weather station with a rain gauge.
- Create a rain garden and/or erosion control project.

Integration with other subjects

- Math (estimating)
- Art (music, movement)
- Literacy
- History

Additional resources

- *Puddle Wonders* activity (Project WILD Aquatic)
- Below Zero supplemental activities (Project WILD)
- Great Bay Discovery Center (NH Fish & Game Department)
- Wonders of Wildlife Programs "Pond Ecology and Wetlands" (NH Fish & Game Department)
- GLOBE Protocol Check List URL: *www.globe.gov/fsl/educorn/assessment/atmosphere/atmospherehome.html*

Water and Watersheds Scope and Sequence

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.

Grade 5 – 6

ESSENTIAL QUESTION: HOW DO THE PROPERTIES OF WATER (EG. SOLVENCY, ABILITY TO MAINTAIN A LIQUID STATE) AFFECT LIFE FORMS?

Frameworks	Science Process Skills	Activities		Assessment
ESS1:6:7.1 Explain the properties that make water an essential component of the Earth's system, including solvency and its ability to maintain a liquid state at most temperatures ESS1:6:7.2 Explain that water quality has a direct effect on Earth's life forms.	SPS1 • Making Observations and Asking Questions • Designing Scientific Investigations • Conducting Scientific Investigations • Representing and Understanding Results of Investigations • Evaluating Scientific Explanations SPS2 • Nature of Science • Systems and Energy • Models and Scale • Patterns of Change SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Problem Identification, Formulation, and Solution • Interpersonal and Collaborative Skills • Self Direction • Accountability and Adaptability	Pre-Field Experiences	**Water Detectives** (GLOBE). Students use their senses to identify mystery substances. **Let's Even Things Out** (WET). Students simulate the role water plays in balancing concentrations of solutes through osmosis and diffusion. **What's the Solution?** (WET) .Crime-fighting students investigate water's ability to dissolve substances. **Adventures in Density** (WET). Students explore the relationship between density, heat and salinity. **Macroinvertebrate Mayhem** (WET). Using tag, students learn the effects of environmental stressors. Practice **Freshwater Macroinvertebrates** (GLOBE). **Practicing Your Protocols** (GLOBE). Temperature, Dissolved Oxygen, and Transparency only.	**Water Detectives. Students l**ist substances that might be in water at their Hydrology Site, how they may affect living things there, why instruments are needed to detect them, and how they use their senses. **Let's Even Things Out.** Students simulate, summarize and diagram the process of osmosis and diffusion. **What's the Solution?** Students summarize their results and solve the crime. Students write their own mystery story for friends to solve. **Adventures in Density.** Students describe experiences with water of different densities. **Macroinvertebrate Mayhem.** Students create a matching game where the organisms must be matched to stream conditions. **Practicing Your Protocols.** Hydrology Protocol Checklists for Students.

Frameworks	Science Process Skills	Activities		Assessment
		Field Experiences	**Dissolved Oxygen Protocol** (GLOBE). **Water Temperature Protocol** (GLOBE). **Water Transparency Protocol** (GLOBE). **Freshwater Macroinvertebrates** (GLOBE).	**Investigation Assessment Activity for Hydrology, Middle School** (GLOBE).
		Post-Field Experiences	**Is There Water On Zork?** (WET). Students describe the characteristics of water and design experiments to identify water. **Water Canaries** (WILD Aquatic). Students identify stream organisms and assess the quality of the water. **Fishy Who's Who** (WILD Aquatic). Students identify local fish species and their value.	**Is There Water On Zork?** Students use the words in the Warm Up to demonstrate their increase in knowledge, then design a poster describing water. **Water Canaries.** Students draw pictures of species found in water bodies and describe the conditions of a water body using the list of organisms that live there. **Fishy Who's Who.** Students list and describe the habitat of five NH fish and why they are important.
		Culminating	**Benthic Bugs & Bio Assessment** (WET *Healthy Water, Healthy People*). Students investigate the relative water quality of a stream by conducting a simulated bio-assessment by sampling aquatic macroinvertebrates (represented by ordinary materials).	**Benthic Bugs & Bio Assessment.** Students determine a stream's water quality using a pollution tolerance index based on a sample of aquatic macroinvertebrates.

Project HOME extensions

- If you have a body of water on your site, conduct a macroinvertebrate study.

Integration with other subjects

- Physical education (tag)
- Math (graphing, calculations)

Additional resources

- Aquatic Resources Watershed Education (NH Fish & Game Department)
- *www.lakes.chebucto.org/ZOOBENTH/BENTHOS/viiefg.cs.umb.edu:8080/efgKeys/html/index.html* (set Data Source to "Streams" and Rendering to "html")
- IWLA Stream Study Homepage *www.people.virginia.edu/~sos-iwla/Stream-Study/StreamStudyHomePage/WhyStudyMacro.HTML*
- *Aquatic Entomology: The Fishermen's and Ecologist's Illustrated Guide to Insects and Their Relatives*, Patrick W. McCafferty, 1998.
- GLOBE Protocol Check List URL: *www.globe.gov/fsl/educorn/assessment/hydrology/hydrologyhome.html,*
- GLOBE Assessment Activity URL: *www.globe.gov/fsl/educorn/assessment/hydrology/hydroMSinvest.html*
- WOW! The Wonders of Wetlands (NH Department of Environmental Services)

Water and Watersheds Scope and Sequence

S:ESS1: The Earth and Earth materials, as we know them today, have developed over long periods of time, through constant change processes.

Grade 7 – 8

ESSENTIAL QUESTION: HOW DOES THE CYCLING OF WATER INTO AND OUT OF THE EARTH'S ATMOSPHERE AFFECT OUR WEATHER?

Frameworks	Science Process Skills	Activities		Assessment
ESS1:8:7.1 Describe how water flows into and through a watershed, falling on the land, collecting in rivers and lakes, soil, and porous layers of rock, until much of it flows back into the ocean. ESS1:8:7.2 Identify the physical and chemical properties that make water an essential component of the Earth's system. **ESS1:8:7.3** **Explain the processes that cause cycling of water into and out of the atmosphere and their connections to our planet's weather patterns.**	SPS1 • Making Observations and Asking Questions • Designing Scientific Investigations • Conducting Scientific Investigations • Representing and Understanding Results of Investigations • Evaluating Scientific Explanations SPS2 • Nature of Science • Systems and Energy • Models and Scale • Patterns of Change SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Problem Identification, Formulation, and Solution • Interpersonal and Collaborative Skills • Self Direction • Accountability and Adaptability	**Pre-Field Experiences**	**Branching Out** (WET). Students build a model watershed to study the flow of water. **Mapping Lesson** using topography maps **Why Do We Study Soil?** (GLOBE). Students learn why soil is important, what forms it and how much there is. **Soil Stories** Part B (PLT). Students carry out a perk test to assess water filtration. **Hangin' Together** (WET). Students mimic the water molecule's special ability to hold onto other water molecules; they also present four properties of water that are critical to life on Earth. **H_2Olympics** (WET). Students investigate adhesion and cohesion. **Water Wonders** (PLT). Students simulate the path of water in the water cycle and discuss its importance to living things then conduct a simple experiment to determine what effect plants have on watersheds and water quality. **Water Walk** (GLOBE). Students observe their hydrology study site to create investigation questions. **Practicing Your Protocols** (GLOBE). pH, Temperature, Dissolved Oxygen and Transparency ONLY.	**Branching Out. Students c**ompare watersheds to other branching patterns, write a story or create a map of your watershed. **Why Do We Study Soil?** Students create a soil story and comment on soil diversity. **Soil Stories** Part B**.** Students write a letter to the homeowners to explain the results of the test. **Hangin' Together.** Students describe how hydrogen bonding occurs in water molecules, and demonstrate, through role playing, hydrogen bonding in solutions. **H_2Olympics.** Students draw a picture of water and identify adhesion and cohesion. **Water Wonders.** Students revise their definition of the water cycle with what they have learned. **Water Walk.** Students create a display about their Hydrology Site. **Practicing Your Protocols.** Hydrology Protocol Checklists for Students.

Frameworks	Science Process Skills	Activities		Assessment
		Field Experiences	**Watershed** (WILD Aquatic). Students describe watershed characteristics and their role. **Where Does Water Run?** (WILD Aquatic). Students investigate the relationship between precipitation, runoff and habitat. **Infiltration Protocol** (GLOBE). Weekly • **pH Protocol** (GLOBE). • **Water Temperature Protocol** (GLOBE). • **Dissolved Oxygen Protocol** (GLOBE). • **Water Transparency Protocol** (GLOBE). **Thirsty Plants** (WET). Students learn about transpiration and plants in the water cycle. **Visit and tour a Weather Station** See **Atmosphere, Weather, and Climate Field Experiences.**	**Watershed.** Students draw a watershed, then describe how they are important and how they can be protected. **Where Does Water Run?** Students describe the relationships explored in this activity, how humans and wildlife affect run-off and vice-versa, and how run-off damage can be limited. **Hydrology Protocol Checklists for Students** (GLOBE). **Investigation Assessment Activity for Hydrology, Middle School** (GLOBE). **Thirsty Plants.** Students write a paragraph on the water cycle without plants.
		Post-Field Experiences	**A Field View of Soil** (GLOBE). Students study the soils on their landscape for variations. **Where are the Frogs?** (WET). Students learn about the effects of acidic water on wildlife. **Piece it Together** (WET). Students plot temperature and precipitation to study climate. **Mapping Lesson** using topography maps.	**A Field View of Soil.** Activity Assessment Questions: Where is the soil typical of your site? Where is an ideal soil moisture site? etc. **Where are the Frogs?** Students create an acid rain collage and identify solutions which have the most H+. **Piece it Together.** Students identify three global climates, compare the sun's angles, match characters to their climates and describe how people adapt to climate.
		Culminating	**Where are the Frogs?** Part III (WET). **Color Me A Watershed** Options I & II (WET). Through the interpretation of maps; students observe how development can affect a watershed.	**Where are the Frogs?** Part III **Color Me A Watershed.** Students compare the land area occupied by farms, towns and natural areas in a watershed during different time period, and how surface runoff is influenced by changes in land use.

Project HOME Extensions

Integration with other subjects

- Math (graphing)
- Geography (mapping, climate, biomes)

Additional resources

- Watershed & Groundwater Models (Project WET, NH Department of Environmental Services)
- Volunteer Lake Assessment Program and Volunteer River Assessment Program (NH Department of Environmental Services)
- Aquatics Resource Watershed Education Program (NH Fish & Game Department)
- GLOBE Protocol Check List URL: *www.globe.gov/fsl/educorn/assessment/hydrology/hydrologyhome.html*
- GLOBE Assessment Activity URL: *www.globe.gov/fsl/educorn/assessment/hydrology/hydroMSinvest.html*
- WOW! The Wonders of Wetlands (NH Department of Environmental Services)

Water And Watersheds Scope And Sequence Chart

S:ESS1: The earth and Earth materials as we know them today, have developed over long periods of time, through constant change processes.

Grades 9-12

ESSENTIAL QUESTION: HOW IS WATER QUALITY POSITIVELY OR NEGATIVELY AFFECTED BY OUTSIDE SOURCES?

Frameworks	Science Process Skills	Activities		Assessment
ESS1:11:7.1 Explain that water quality can be affected positively or negatively by outside sources.	SPS1 • Making Observations and Asking Questions • Designing Scientific Investigations • Conducting Scientific Investigations • Representing and Understanding Results of Investigations • Evaluating Scientific Explanations SPS2 • Nature of Science • Systems and Energy • Patterns of Change SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation • Science and Technology, Technological Design and Application SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Problem Identification, Formulation, and Solution • Creativity and Intellectual Curiosity • Interpersonal and Collaborative Skills • Self Direction • Accountability and Adaptability • Social Responsibility	**Pre-Field Experiences**	Introduction to Water. Review properties and chemistry of water, including pH, using the **GLOBE Hydrology Protocols.** **Color Me A Watershed** Options II & III (WET). Students use maps and observe how development affects a watershed. **The Data Game** (GLOBE). To understand how accuracy and precision in data collection affects outcomes. Teams collect data on water volumes or soil moisture and manipulate data. Other teams see if data are valid. Exercise in reporting data. **The Incredible Journey** (WET). Students play the water cycle game and then use extension for showing the link between the Earth's spheres and a water droplet. **Journey of a Water Droplet** (GLOBE). Using the Earth Systems Poster, students follow connections of the Earths Systems and a water droplet. **Color Me a Watershed** (WET). Students look at interpretive maps and delineate a local watershed from GIS local data. **Model a Catchment Basin** (GLOBE). Students design a catchment basin, using Extension for the 9-12 activity. **Where Does Water Run? Extension** (WILD Aquatic). Students use a map of school grounds and GIS data to plot run off routes and identify drainage patterns. **Great Water Journeys** (WET). **S**tudents use a global map and a set of clue cards to locate some significant water journeys. **The pH Game** (GLOBE). Students learn about acidity levels and what it means to living things. Review **GLOBE Soil Activities.** Assumes soil introduction at middle school. **Just Passing Through** (GLOBE). Students explore the relationship between soils and water. Test pH of water before and after it passes through soil. Advanced: Design experiments to test soil passing through soil under different conditions/factors.	**Color Me A Watershed.** Students compare the land occupied by farms, towns and natural areas in a watershed during different time periods and how surface runoff is influenced by changes in land use. **The Data Game.** Periodically insert erroneous data during data collection and reward students who identify them. Note: Do NOT report erroneous data. **The Incredible Journey.** Students write a story about the movement of water through the water cycle. **Color Me a Watershed.** Students design a plan to minimize runoff. **Model a Catchment Basin.** Students use the model to discuss effects of landscape changes. Predict how what changes would affect the quality of your watershed. Create a clay model of a watershed. **Where Does Water Run? Extension.** Students describe the relationships, how humans and wildlife affect run-off and vice-versa, and how run-off damage can be limited. **Great Water Journeys.** Students present their water journey. Create water trivia cards. **The pH Game.** Students discuss the results of the activity and what factors affect soil pH. **Just Passing Through.** Assess GLOBE Science Notebooks, class participation in discussions and the contribution of questions, hypotheses, observations and conclusions. Students prepare a written report, paper or presentation on their experiment.

Frameworks	Science Process Skills	Activities		Assessment
		Field Experiences	**pH Protocol** (GLOBE). **Alkalinity Protocol** (GLOBE). **Nitrate Protocol** (GLOBE). **Dissolved Oxygen Protocol** (GLOBE). **Electrical Conductivity Protocol** (GLOBE). **Salinity Protocol** (GLOBE). **Water Temperature Protocol** (GLOBE). **Water Transparency Protocol** (GLOBE). **Begin collecting baseline data on local water sources** (eg, river, stream, wetland). Make predictions on quality before testing: Do you think this water quality will be impaired? Why are you choosing this site? **Freshwater Macroinvertebrates,** Extension (GLOBE). Students conduct in-depth water quality monitoring of a water body. Test for physical parameters, macroinvertebrates, and collect baseline data. Enter data into GLOBE data base for the site **Hydrology Protocols** (GLOBE). Students collect water quality data over a period of time (weekly or monthly) throughout the school year on the same water bodies. Follow protocols and record data into the GLOBE database. Document latitude and longitude using a GPS unit. Compare data collected to past years and other locations around New England or the world. In grade 11 and 12, students could map their sites using a GIS program such as ARCVIEW.	**Hydrology Protocol Checklists for Students** (GLOBE). **Investigation Assessment Activity for Hydrology, High School** (GLOBE).
		Post-Field Experiences	**Landfills,** Extension (PLT Municipal Solid Waste module). Using a topographic or satellite image, students choose a landfill site that will not impact surface or groundwater quality using the skills gained on water chemistry, soils, test protocols and watershed data. Explain why this site is the best location and what design will limit leaching.	**Landfills.** Use student created landfill models as a focus of class presentations.
		Culminating	Students use GLOBE or Volunteer River Assessment data from DES and satellite imagery from 2 sites along a major river in NH to analyze and compare data from both sites. Determine which water quality parameters might be affected by manmade or natural characteristics on the landscape. Hypothesize what single variable might be affecting the water quality.	

Project HOME extensions

Integration with other subjects

- Geography (watershed mapping, global connections)
- History (industrialization)
- Chemistry (water testing)
- Biology (interaction of water and living things)
- Physics (satellite imagery)
- Earth Science (soil and water interactions)
- Math (graphing, calculations)

Additional resources

- Aquatic Resources Watershed Education Program (NH Fish & Game Department)
- Volunteer Lake Assessment Program URL: *www.des.nh.gov/wmb/vlap* (NH Department of Environmental Services)
- Volunteer River Assessment Program URL: *www.des.nh.gov/wmb/vrap* (NH Department of Environmental Services)
- Watershed Management, UNH Cooperative Extension
- GLOBE Protocol Check List URL: *www.globe.gov/fsl/educorn/assessment/hydrology/hydrologyhome.html*
- GLOBE Assessment Activity URL: *www.globe.gov/fsl/educorn/assessment/hydrology/hydroHSinvest.html*

Grade Level Expectations for HABITATS AND ECOSYSTEMS

S:LS2: Energy flows and matter recycles through an ecosystem.

Focus on Environment

Explain or evaluate potential bias in how evidence is interpreted in reports concerning a particular environmental factor that impacts the biology of humans. (LS2:11:1.6)

Describe how the interrelationships and interdependencies among organisms generate stable ecosystems that fluctuate around a state of rough equilibrium for hundreds or thousands of years. (LS2:11:1.2)

Analyze and describe how environmental disturbances, such as climate changes, natural events, human activity and the introduction of invasive species, can affect the flow of energy or matter in an ecosystem. (LS2:11:1.4)

Explain how the amount of life an environment can sustain is restricted by the availability of matter and energy, and the ability of the ecosystem to recycle materials. (LS2:11:1.1)

Using data from a specific ecosystem, explain relationships or make predictions about how environmental disturbance (human impact or natural events) affects the flow of energy or cycling of matter in an ecosystem. (LS2:11:1.5)

Identify the factors in an ecosystem that can affect its carrying capacity. (LS2:11:1.3)

9-12 HOW DOES ENVIRONMENTAL DISTURBANCE AFFECT THE FLOW OF ENERGY AND THE CYCLING OF MATTER IN AN ECOSYSTEM?

Explain how changes in environmental conditions can affect the survival of individual organisms and an entire species. (LS2:8:1.1)

Using data and observations, predict outcomes when abiotic/biotic factors are changed in an ecosystem. (LS2:8:1.3)

Explain that in all environments, organisms with similar needs may compete with one another for resources, including food, space, water, air, and shelter, and that in any particular environment the growth and survival of organisms depend on the physical conditions. (LS2:8:1.2)

7-8 WHAT DATA MUST BE COLLECTED IN ORDER TO MAKE DECISIONS ABOUT THE IMPACT CHANGE HAS ON LIVING THINGS?

Identify and describe the factors that influence the number and kinds of organisms an ecosystem can support, including the resources that are available, the differences in temperature, the composition of the soil, any disease, the threat of predators, and competition from other organisms. (LS2:6:1.1)

Explain that most microorganisms do not cause disease and that many are beneficial to the environment. (LS2:6:1.2)

5-6 HOW DOES CHANGE IN ABIOTIC OR BIOTIC FACTORS AFFECT A NATURAL POPULATION OF PLANTS OR ANIMALS THAT LIVE IN AN AREA?

Describe how the nature of an organism's environment, such as the availability of a food source, the quantity and variety of other species present, and the physical characteristics of the environment affect the organism's patterns of behavior. (LS2:4:1.1)

Describe the interaction of living organisms with nonliving things. (LS2:4:1.2)

3-4 WHAT RELATIONSHIP DO LIVING THINGS HAVE WITH NON-LIVING THINGS IN THE ENVIRONMENT WHERE THEY OCCUR?

Recognize that living things can be found almost anyplace in the world; and that specific types of environments are required to support the many different species of plant and animal life. (LS2:2:1.1)

Recognize that animals, including humans, interact with their surroundings using their senses; and that different senses provide different kinds of information. (LS2:2:1.2)

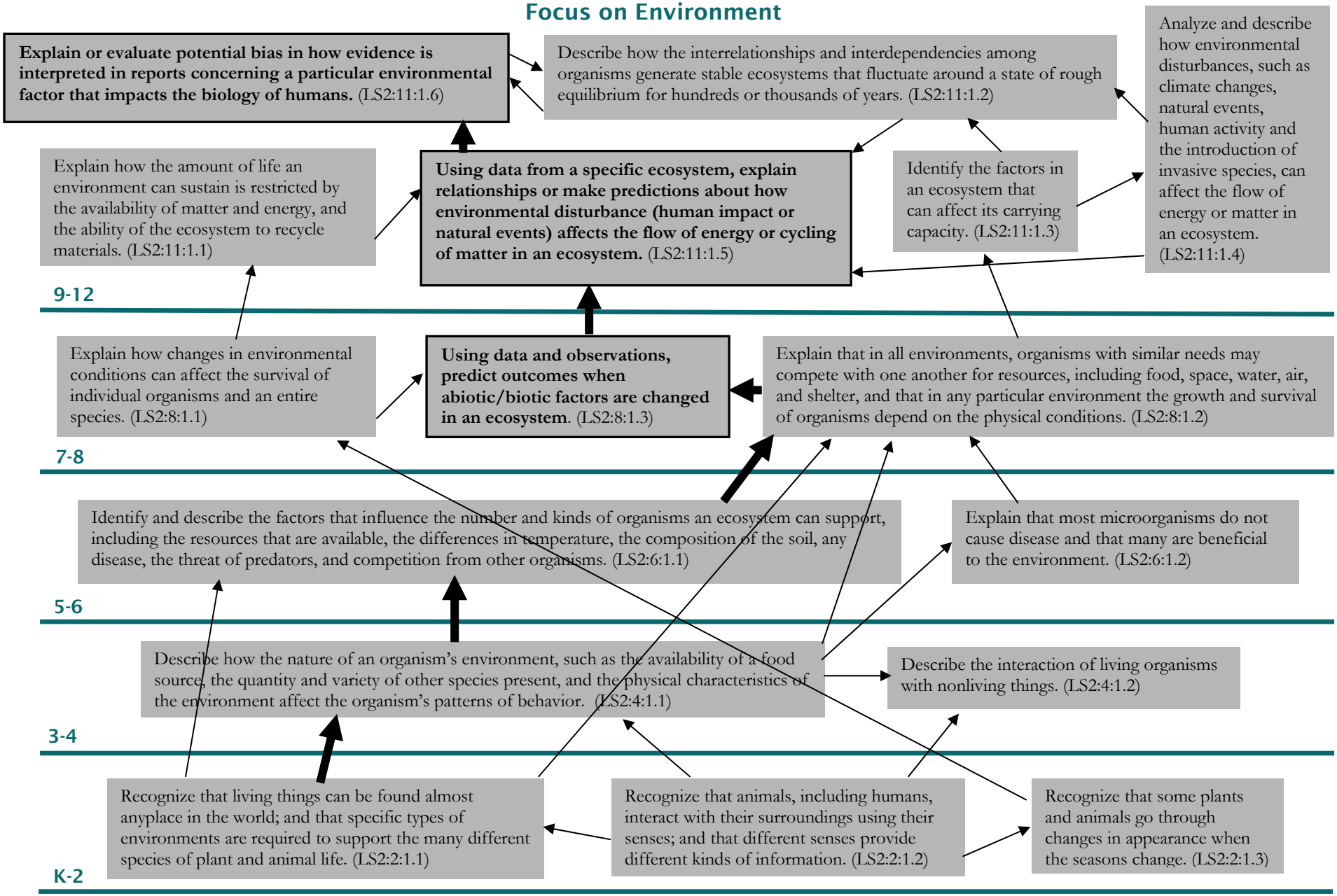
Recognize that some plants and animals go through changes in appearance when the seasons change. (LS2:2:1.3)

K-2 HOW DO PLANTS AND ANIMALS GET THEIR BASIC NEEDS FULFILLED BY THEIR HABITAT?

Grade Level Expectations for HABITATS AND ECOSYSTEMS

S:LS2: Energy flows and matter recycles through an ecosystem.

Focus on Environment



Grade Level Expectations for ECOSYSTEMS AND HABITATS

S:LS2: Energy flows and matter recycles through an ecosystem.

Focus on Flow of Energy

Use examples from local ecosystems to describe the relationships among organisms at the different trophic levels. (LS2:11:2.1)

9-12 HOW DOES ENVIRONMENTAL DISTURBANCE AFFECT THE FLOW OF ENERGY AND CYCLING OF MATTER IN AN ECOSYSTEM?

Explain how food provides energy and materials for growth and repair of body parts. (LS2:8:2.1)

Given a scenario, trace the flow of energy through an ecosystem, beginning with the sun, through organisms in the food web, and into the environment (includes photosynthesis and respiration). (LS2:8:2.2)

7-8 WHAT DATA MUST BE COLLECTED IN ORDER TO MAKE DECISIONS ABOUT THE IMPACT CHANGE HAS ON LIVING THINGS?

Recognize that energy, in the form of heat, is usually a byproduct when one form of energy is converted to another, such as when living organisms transform stored energy to motion. (LS2:6:2.4)

Describe how energy is transferred in an ecosystem through food webs; and explain the roles and relationships between producers, consumers and decomposers. (LS2:6:2.1)

Recognize that one of the most general distinctions among organisms is between plants, which use sunlight to make their own food, and animals, which consume energy-rich foods. (LS2:6:2.2)

Describe the process of photosynthesis and explain that plants can use the food they make immediately or store it for later use. (LS2:6:2.3)

5-6 HOW DOES CHANGE IN ABIOTIC OR BIOTIC FACTORS EFFECT A NATURAL POPULATION OF PLANTS OR ANIMALS THAT CAN LIVE IN AN AREA?

Recognize that energy is needed for all organisms to stay alive and grow or identify where a plant or animal gets its energy. (LS2:4:2.2)

Recognize that the transfer of energy through food is necessary for all living organisms and describe the organization of food webs. (LS2:4:2.1)

3-4 WHAT RELATIONSHIP DO LIVING THINGS HAVE WITH NON-LIVING THINGS IN THE ENVIRONMENT WHERE THEY OCCUR?

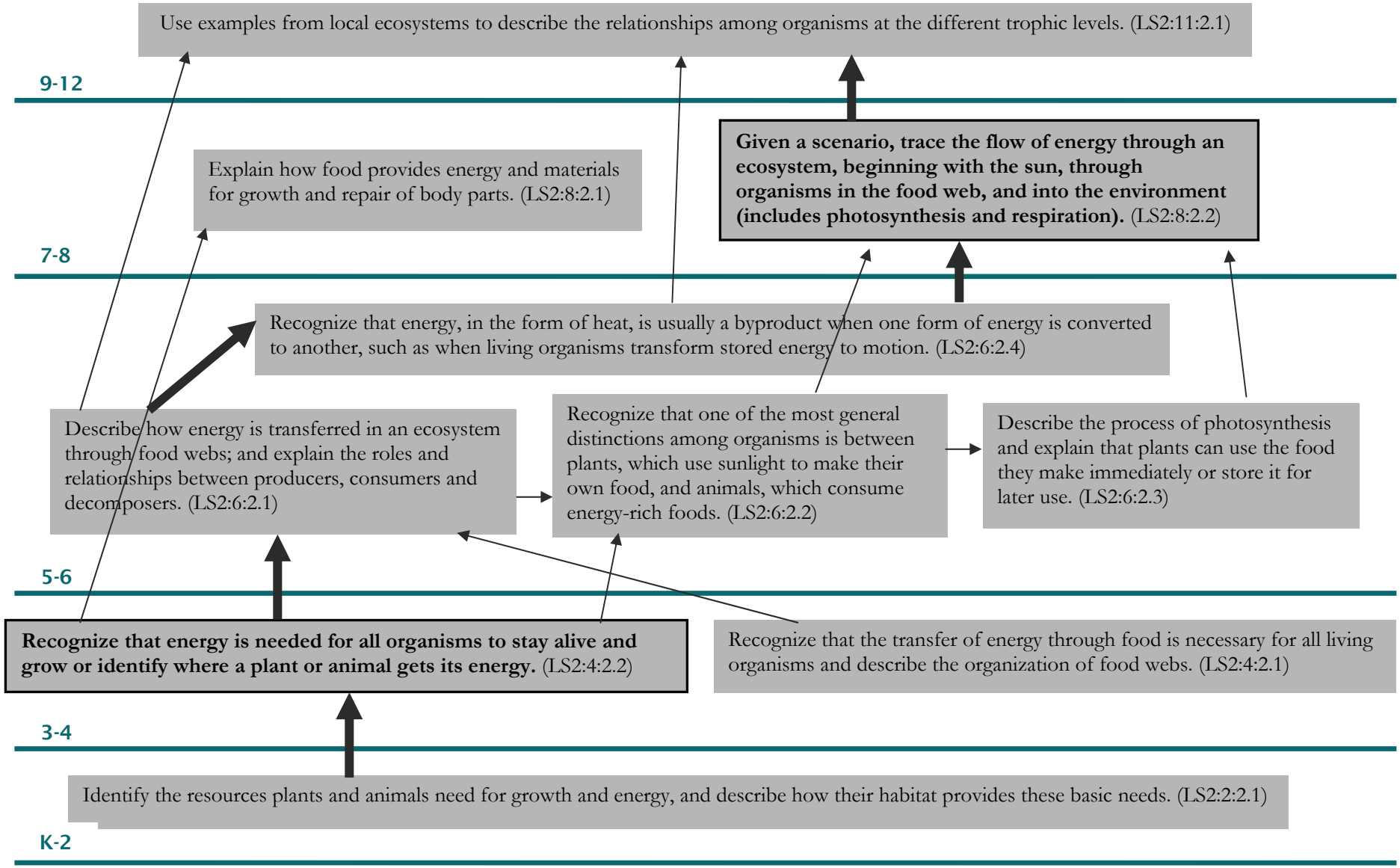
Identify the resources plants and animals need for growth and energy, and describe how their habitat provides these basic needs. (LS2:2:2.1)

K-2 HOW DO PLANTS AND ANIMALS GET THEIR BASIC NEEDS FULFILLED BY THEIR HABITAT?

Grade Level Expectations for ECOSYSTEMS AND HABITATS

S:LS2: Energy flows and matter recycles through an ecosystem.

Focus on Flow of Energy



Grade Level Expectations for ECOSYSTEMS AND HABITATS

S:LS2: Energy flows and matter recycles through an ecosystem.

Focus on Recycling of Materials

Explain that as matter and energy flow through different levels of organization in living systems between living systems and the environment, elements, such as carbon and nitrogen, are recombined in different ways. (LS2:11:3.1)

Trace the cycling of matter (e.g. carbon cycle) and the flow of energy in a living system from its source through its transformation in cellular, biochemical processes (e.g. photosynthesis, cellular respiration, fermentation). (LS2:11:3.2)

9-12 HOW DOES ENVIRONMENTAL DISTURBANCE AFFECT THE FLOW OF ENERGY AND CYCLING OF MATTER IN AN ECOSYSTEM?

Know that all organisms, including humans, are part of, and depend on, two main interconnected global food webs, one which includes microscopic ocean plants and the other which includes land plants. (LS2:8:3.3)

Describe how matter is recycled within ecosystems and explain that the total amount of matter remains the same, though its form and location change. (LS2:8:3.4)

Given an ecosystem, trace how matter cycles among and between organisms and the physical environment (includes water, oxygen, food web, decomposition and recycling, but no carbon cycle nor nitrogen cycle). (LS2:8:3.6)

Identify autotrophs as producers who may use photosynthesis and describe this as the basis of the food web. (LS2:8:3.1)

Explain the process of respiration and differentiate between it and photosynthesis. (LS2:8:3.2)

Identify carbon, hydrogen, oxygen, nitrogen and phosphorus as common elements of living matter. (LS2:8:3.5)

7-8 WHAT DATA MUST BE COLLECTED IN ORDER TO MAKE DECISIONS ABOUT THE IMPACT CHANGE HAS ON LIVING THINGS?

Define a population as all individuals of a species that exist together at a given place and time and explain that all populations living together in a community, along with the physical factors with which they interact, compose an ecosystem. (LS2:6:3.1)

Using food webs, identify and describe the ways in which organisms interact and depend on one another in an ecosystem. (LS2:6:3.2)

Explain how insects and various other organisms depend on dead plant and animal matter for food and describe how this process contributes to the system. (LS2:6:3.3)

5-6 HOW DOES CHANGE IN ABIOTIC OR BIOTIC FACTORS EFFECT A NATURAL POPULATION OF PLANTS OR ANIMALS THAT CAN LIVE IN AN AREA?

Describe ways plants and animals depend on each other (e.g. shelter, nesting, food). (LS2:4:3.2)

Recognize that plants and animals interact with one another in various ways besides providing food, such as seed dispersal or pollination. (LS2:4:3.1)

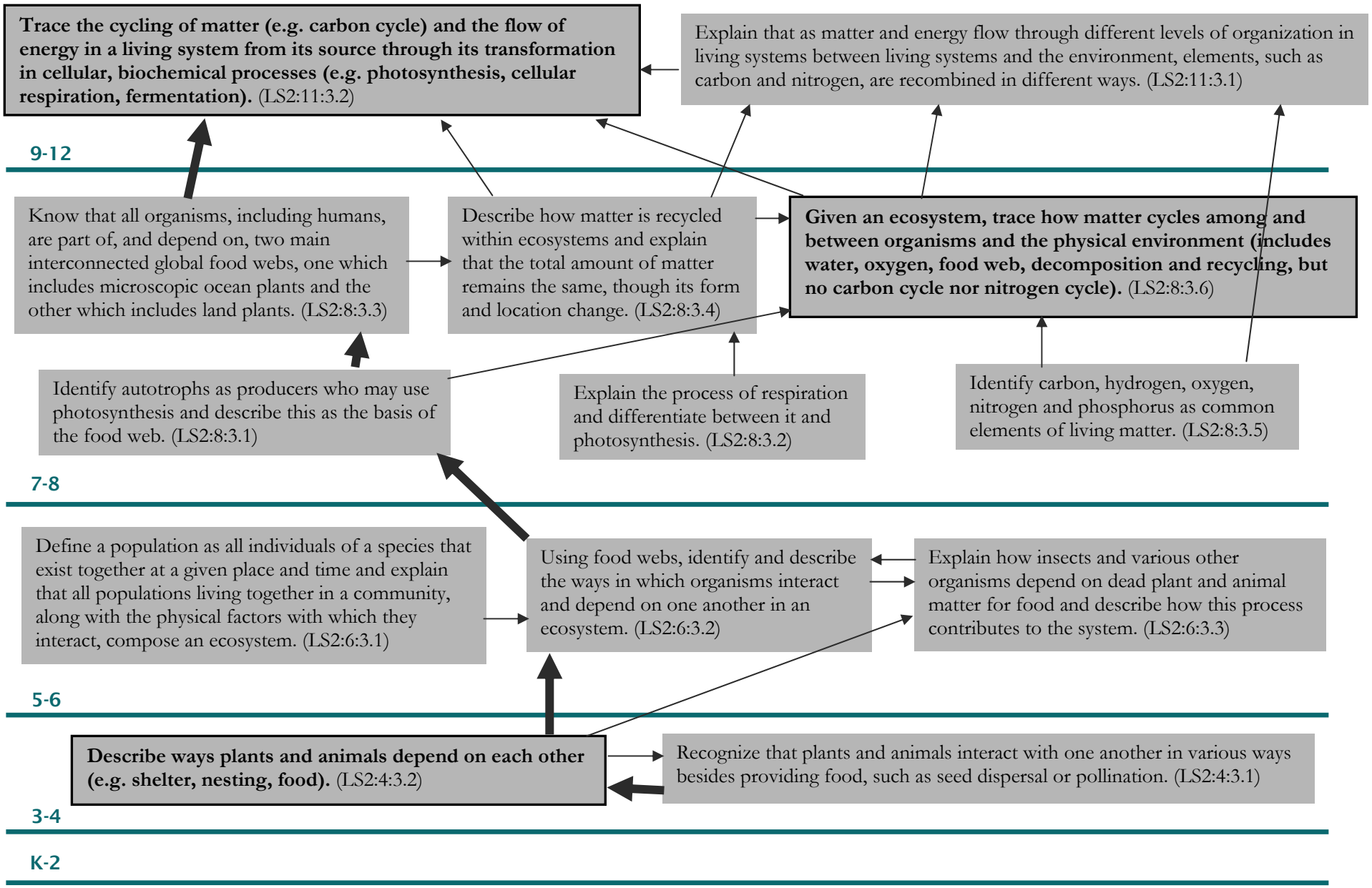
3-4 WHAT RELATIONSHIP DO LIVING THINGS HAVE WITH NON-LIVING THINGS IN THE ENVIRONMENT WHERE THEY OCCUR?

K-2 HOW DO PLANTS AND ANIMALS GET THEIR BASIC NEEDS FULFILLED BY THEIR HABITAT?

Grade Level Expectations for ECOSYSTEMS AND HABITATS

S:LS2: Energy flows and matter recycles through an ecosystem.

Focus on Recycling of Materials



Grade Level Expectations for ECOSYSTEMS AND HABITATS

S:LS3: Groups of organisms show evidence of change over time.

Focus on Change Over Time

Analyze the aspects of environmental protection, such as ecosystem protection, habitat management, species conservation and environmental agencies and regulations, and evaluate and justify the need for public policy in guiding the use and management of the environment. (LS3:11:1.3)

Identify ways humans can impact and alter the stability of ecosystems, such as habitat destruction, pollution, and consumption of resources and describe the potentially irreversible effects these changes can cause. (LS3:11:1.1)

Identify ways of detecting and limiting or reversing environmental damage. (LS3:11:1.2)

9-12 HOW DOES ENVIRONMENTAL DISTURBANCE AFFECT THE FLOW OF ENERGY AND CYCLING OF MATTER IN AN ECOSYSTEM?

Describe the type of impact certain environmental changes, including deforestation, invasive species, increased erosion, and pollution containing toxic substances, could have on local environments. (LS3:8:1.1)

7-8 WHAT DATA MUST BE COLLECTED IN ORDER TO MAKE DECISIONS ABOUT THE IMPACT CHANGE HAS ON LIVING THINGS?

Explain how changes in environmental conditions can affect the survival of individual organisms and the entire species. (LS3:6:1.2)

Provide examples of how all organisms, including humans, impact their environment, and explain how some changes can be detrimental to other organisms. (LS3:6:1.1)

5-6 HOW DOES CHANGE IN ABIOTIC OR BIOTIC FACTORS EFFECT A NATURAL POPULATION OF PLANTS OR ANIMALS THAT CAN LIVE IN AN AREA?

Using information (data or scenario), explain how changes in the environment can cause organisms to respond (e.g. survive there and reproduce, move away, die). (LS3:4:1.3)

Provide examples of how an organism's inherited characteristics can adapt and change over time in response to changes in the environment. (LS3:4:1.2)

Provide examples of how environmental changes can cause different effects on different organisms. (LS3:4:1.1)

3-4 WHAT RELATIONSHIP DO LIVING THINGS HAVE WITH NON-LIVING THINGS IN THE ENVIRONMENT WHERE THEY OCCUR?

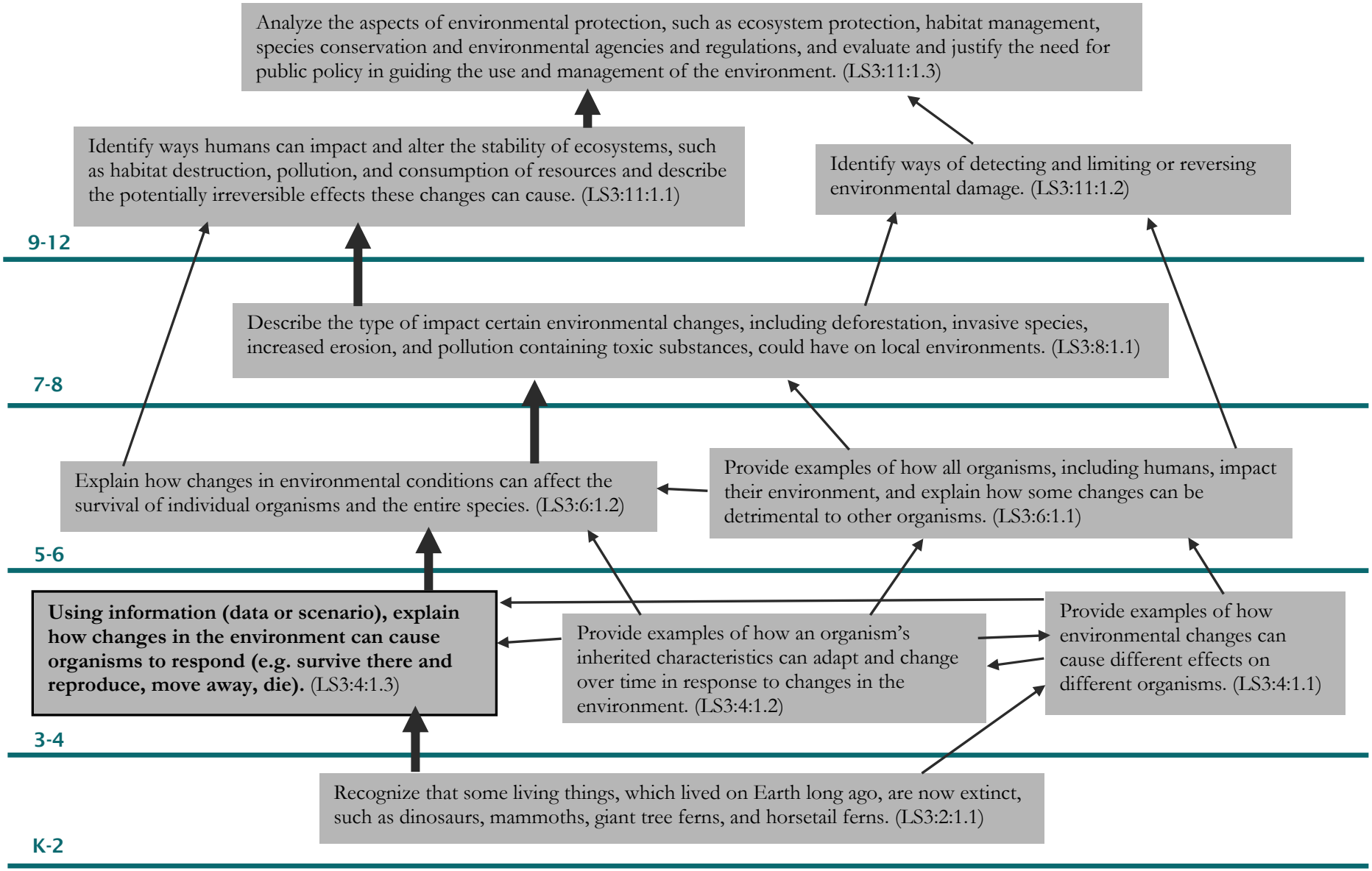
Recognize that some living things, which lived on Earth long ago, are now extinct, such as dinosaurs, mammoths, giant tree ferns, and horsetail ferns. (LS3:2:1.1)

K-2 HOW DO PLANTS AND ANIMALS GET THEIR BASIC NEEDS FULFILLED BY THEIR HABITAT?

Grade Level Expectations for ECOSYSTEMS AND HABITATS

S:LS3: Groups of organisms show evidence of change over time.

Focus on Change Over Time



Ecosystems and Habitats Scope and Sequence

S:LS2: Energy flows and matter recycles through an ecosystem.
S:LS3: Groups of organisms show evidence of change over time.

Kindergarten – Grade 2

ESSENTIAL QUESTION: HOW DO PLANTS AND ANIMALS GET THEIR BASIC NEEDS FULFILLED BY THEIR HABITAT?

Frameworks	Science Process Skills	Activities		Assessment
LS2:2:1.1 Recognize that living things can be found almost anyplace in the world; and that specific types of environments are required to support the many different species of plant and animal life. LS2:2:1.2 Recognize that animals, including humans, interact with their surroundings using their senses; and that different senses provide different kinds of information. LS2:2:1.3 Recognize that some plants and animals go through changes in appearance when the seasons change. LS2: 2:2.1 Identify the resources plants and animals need for growth and energy, and describe how their habitat provides these basic needs. LS3:2:1.1 Recognize that some living things, which lived on Earth long ago, are now extinct, such as dinosaurs, mammoths, giant tree ferns, and horsetail trees.	SPS1 • Making Observations and Asking Questions • Conducting Scientific Investigations • Representing and Understanding Results of Investigations SPS2 • Nature of Science • Systems and Energy • Models and Scale • Patterns of Change • Form and Function SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation • Science and Technology, Technological Design and Application SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Problem Identification, Formulation, and Solution • Interpersonal and Collaborative Skills • Self Direction • Accountability and Adaptability • Social Responsibility	Pre-Field Experiences	**Everybody Needs a Home** (WILD). Students use a floor plan of their house to describe how all animals need a home. **The Beautiful Basics** (WILD). Students identify survival needs. For stream field site: **Are You Me?** (WILD Aquatic). Students match juvenile and adult aquatic animal cards. **Sensory Exploration** (See Observation Skills for Science Fieldwork, page 6).	**Everybody Needs a Home.** Students identify reasons why people need home and animals need shelter; draw a picture of or describe a suitable habitat **The Beautiful Basics.** Students list things animals need for survival; say how human needs differ from animal needs **Are You Me?** Students draw pictures of aquatic animals when young and as adults.
		Field Experiences	**Adopt-A-Tree** (PLT). Students observe one tree and explore its relationships with living and non-living things. **All Year Long** (Elementary GLOBE). Students observe a site throughout the four seasons. Use adopted trees. **Green-Up Protocol** (GLOBE). Use adopted trees. **Trees as Habitats** (PLT). Students describe how trees provide habitats and the relationships between trees, plants and animals. **Site Inventory Cards** (HOME, Ch. 4). Students explore their schoolyard site for evidence of Animal Foods, Most Common Plants, Wet/Dry Spots, Earthworm Analysis, etc. For forest field site: **The Forest of S.T. Shrew** (PLT). Students explore the forest for microhabitats.	**Adopt-A-Tree.** Create books or portfolios of adopted tree; show or describe 5 features of tree and compare to other students' trees. **All Year Long.** Students discuss their observations. **Green-Up Protocol.** Check for understanding using the Questions for Further Investigation. **Trees as Habitats.** Students write an interview with a tree or story from tree's perspective; record observations from visits to neighborhood trees; connect local animals to uses of trees. **Site Inventory Cards.** Students share the evidence they have collected. **The Forest of S.T. Shrew.** Check for understanding using the questions listed under Assessment Opportunity.

Frameworks	Science Process Skills	Activities		Assessment
		Post-Field Experiences	**Green-Up Data Analysis** (GLOBE). Students predict the length of their individual leaf and create a graphical representation of the lengths of the classroom leaves as they grow. **25 Words Inventory Card** (HOME, Ch. 2). Students investigate their school site and list 25 words to describe it.	
		Culminating	**Environmental Exchange Box** (PLT). Students exchange information about their region's ecosystems with another group. **Schoolyard Safari** (PLT). Students look for signs of animals and evidence that the schoolyard provides what they need to survive. For water field sites: **Water Plant Art** (WILD Aquatic). Students identify aquatic plants as important.	**Environmental Exchange Box.** As a class, evaluate the quality of the exchange box and write a thank you note to the partner class. **Schoolyard Safari.** Students write a story, draw a picture, create a diorama or act out the behavior for one of the animals found on the schoolyard. Students can make analogies between their animal and others or jobs. **Water Plant Art.** Students draw two other plants and their associated wildlife.

Project HOME extensions

- Create a simple map or model of the school site
- Plant a garden for hummingbirds and butterflies (see HOME Appendices)

Integration with other subjects

- Art (collages, drawing)
- Writing
- Math (measuring)
- Social Studies (biomes and ecosystems)

Additional resources

- Hands on Nature. Jenepher Lingelbach, ed., Vermont Institute of Natural Science, Woodstock, VT. 2000. ; "Forest Foray" and "Clock Choices"
- *Landowners Guide to Wildlife Inventory,* UNH Cooperative Extension
- Mapmaking with Children: Sense of Place Education for the Elementary Years. Sobel, David. Heinemann, Portsmouth, NH. 1998.
- Nature with Children of All Ages. Sisson, Edith. Phalarope Books. 1990.
- Sharing Nature with Children and Sharing the Joy of Nature, Joseph Cornell. Dawn Publications, Nevada City, CA. 1998.
- Intrigue into the Past – Project Archeology
- Track Kit (NH Fish & Game Department)
- Great Bay Discovery Center (NH Fish & Game Department)
- New England Wildlife, Habitats, Natural History and Distribution. DeGraaf, Richard M. and Mariko Yamasaki. University Press of New England, Hanover, NH. 2001.

Ecosystems and Habitats Scope and Sequence

S:LS2: Energy flows and matter recycles through an ecosystem.
S:LS3: Groups of organisms show evidence of change over time.

Grade 3 – 4

ESSENTIAL QUESTION: WHAT RELATIONSHIP DO LIVING THINGS HAVE WITH NON-LIVING THINGS IN THE ENVIRONMENT WHERE THEY OCCUR?

Frameworks	Science Process Skills	Activities		Assessment
LS2: 4:1.1 Describe how the nature of an organism's environment, such as the availability of a food source, the quantity and variety of other species present, and the physical characteristics of the environment affect the organism's patterns of behavior. LS2: 4:1.2 Describe the interaction of living organisms with nonliving things. LS2: 4:2.1 Recognize that the transfer of energy through food is necessary for all living organisms and describe the organization of food webs. **LS2: 4:2.2** **Recognize that energy is needed for all organisms to stay alive and grow or identify where a plant or animal gets its energy.** *(continued on next page)*	SPS1 • Making Observations and Asking Questions • Designing Scientific Investigations • Conducting Scientific Investigations • Representing and Understanding Results of Investigations • Evaluating Scientific Explanations SPS2 • Nature of Science • Systems and Energy • Models and Scale • Patterns of Change SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Problem Identification, Formulation, and Solution • Interpersonal and Collaborative Skills • Self Direction	Pre-Field Experiences	**What's That, Habitat?** (WILD). Students draw human and animal homes. **Habitat Lap Sit** (WILD). Students physically demonstrate habitat components. **How Plants Grow** (PLT). Students design experiments to see how variables change plant growth. **Air Plants** (PLT). Students study photosynthesis**.** **P2: A Sneak Preview of Budburst** (GLOBE). Students observe budburst happening in the classroom. Students predict when they think budburst will occur. For salt marsh field site: **Marsh Munchers** (WILD Aquatic). Students explore the food web in a salt marsh. For Water Field Site: **Silt: A Dirty Word** (WILD Aquatic). Students describe the effects of silt on water flow.	**What's That, Habitat?** Students describe the basic needs of animals and people. **Habitat Lap Sit.** Students describe the components of habitat and their arrangement, and assess the impact of change on wildlife using the examples given. **How Plants Grow.** Students draw pictures of seedling growth in different conditions. **Air Plants.** Students cut out the pictures from the Student Page and explain the steps of photosynthesis. **P2: A Sneak Preview of Budburst.** Students use their Science Notebooks to discuss their observations. **Marsh Munchers.** Students list marsh predators and prey species, construct a marsh food web. **Silt: A Dirty Word.** Students chart and discuss the results of the activity, draw pictures of a healthy and polluted (silted) stream.

Frameworks	Science Process Skills	Activities		Assessment
LS2:4:3.1 Recognize that plants and animals interact with one another in various ways besides providing food, such as seed dispersal or pollination. **LS2:4:3.2** **Describe ways plants and animals depend on each other (e.g., shelter, nesting, food).** LS3: 4:1.1 Provide examples of how environmental changes can cause different effects on different organisms. LS3: 4:1.2 Provide examples of how an organism's inherited characteristics can adapt and change over time in response to changes in the environment. **LS3: 4:1.3** **Using information (data or scenario), explain how changes in the environment can cause organisms to respond (e.g., survive there and reproduce, move away, die).**		Field Experiences	**Habitrekking** (WILD). Students gather evidence about habitats. **Adopt-A-Tree** (PLT). Students observe one tree and explore its relationships with living and non-living things. **Sunlight and Shades of Green** (PLT). Students study the effects of shade on plant leaves. Use adopted trees. **Site Inventory Cards** (HOME, Ch. 4). Students explore their schoolyard site for evidence of Animal Sign, Agents of Decomposition, Survival Adaptations, etc. For urban field site: **Are Vacant Lots Vacant? K-3 Variation** (PLT). Students describe the plants and animals and their relationships in a vacant lot. For forest field site: **Fallen Log** (PLT). Students study a fallen log for organisms and decomposition. For water field site: **Water Walk** (GLOBE). Students explore their stream site noting factors that contribute to its quality and the living organisms in and around it. For vernal pool/wetland field site: **Life in the Fast Lane** (WET). Students explore temporary wetlands. **Budburst Protocol** (GLOBE). Use adopted trees.	**Habitrekking.** Repeat the investigation for a local environment and summarize the findings. **Adopt-A-Tree.** Students create a book or write an essay about their tree. **Sunlight and Shades of Green.** Students write a recipe for a tree to make food. **Site Inventory Cards** (HOME, Ch. 4). Students discuss and compare their inventory results for different areas of the schoolyard. **Are Vacant Lots Vacant?** K-3 Variation. Students consider improvements to the site and draw pictures of what they think the site will look like if all suggestions were included. **Fallen Log.** Students draw a series of pictures showing what happens to a fallen log. **Water Walk.** Students create a display about their Hydrology Site. **Life in the Fast Lane.** Students discuss the results of the exploration.

Frameworks	Science Process Skills	Activities		Assessment
		Post-Field Experiences	**Web of Life** (PLT). Students study the interaction of plants and animals. **Budburst Data Analysis** (GLOBE). Students compare their predicted budburst date to the actual date. **Earth System Play** (Elementary GLOBE). Students act out a play about Earth interactions. **Site Inventory Worksheet** (HOME, Appendix). Students tally and record the results of their inventory in a Wildlife and Habitat Inventory Form. For salt marsh field site: **Salt Marsh Players** (WET). Students act out animal adaptations to the salt marsh.	**Web of Life.** Students demonstrate a web of life which includes humans. **Earth System Play.** Students write more verses to the Earth System song, create Earth System riddles, or write another play. **Site Inventory Worksheet.** Students discuss what other areas of the schoolyard or features they need to inventory. **Salt Marsh Players.** Students identify marsh living things, write a skit about one, act out their responses to tides and other changes in their environment, and design a costume for a salt marsh organism.
		Culminating	**Picture This!** (PLT). Students create collages of different animals and the different ecosystems they inhabit. **Habitat Enhancement Project** (HOME). Students design and plan a habitat enhancement project to encourage more hummingbirds on the schoolyard site.	**Picture This!** Students create a picture portfolio and explain their choice of pictures. **Habitat Enhancement Project.** Students carry out a habitat enhancement project to encourage more hummingbirds on the schoolyard site.

Project HOME extensions

- Create a map and conduct a site inventory of the school site.
- Study wildlife food lists and native plant lists to assist in creating the hummingbird habitat, bird feeding area or bird watching station.

Integration with other subjects:

- Art (drawing, acting, collages)

Additional resources

- Wonders of Wildlife Programs "Habits and Habitats" and "Endangered Species" (NH Fish & Game Department)
- Track Kit (NH Fish & Game Department)
- Discover WILD Times for Kids (NH Fish & Game Department)
- WILD in NH (NH Fish & Game Department)
- www.wildnewengland.org
- New England Wildlife: Habitat, Natural History and Distribution. DeGraaf, Richard M. and Mariko Yamasaki. University Press of New England, Hanover, NH. 2001.

Ecosystems and Habitats Scope and Sequence

S:LS2: Energy flows and matter recycles through an ecosystem.
S:LS3: Groups of organisms show evidence of change over time.

Grade 5 – 6

ESSENTIAL QUESTION: HOW DOES CHANGE IN EITHER ABIOTIC OR BIOTIC FACTORS AFFECT A NATURAL POPULATION OF PLANTS OR ANIMALS THAT CAN LIVE IN AN AREA?

Frameworks	Science Process Skills	Activities		Assessment
S2: 6:1.1 Identify and describe the factors that influence the number and kinds of organisms an ecosystem can support, including the resources that are available, the differences in temperature, the composition of the soil, any disease, the threat of predators, and competition from other organisms. LS2: 6:1.2 Explain that most microorganisms do not cause disease and that many are beneficial to the environment. LS2: 6:2.1 Describe how energy is transferred in an ecosystem through food webs; and explain the roles and relationships between producers, consumers and decomposers. LS2: 6:2.2 Recognize that one of the most general distinctions among organisms is between plants, which use sunlight to make their own food, and animals, which consume energy-rich foods. *(continued on next page)*	SPS1 • Making Observations and Asking Questions • Conducting Scientific Investigations • Representing and Understanding Results of Investigations SPS2 • Systems and Energy • Models and Scale • Patterns of Change SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation SPS4 • Communication Skills • Critical Thinking and Systems Thinking • Interpersonal and Collaborative Skills • Accountability and Adaptability • Social Responsibility	Pre-Field Experiences	**Microtrek Treasure Hunt** (WILD). Students recognize that wildlife is all around. **Oh Deer!** (WILD). Students study the essential components and concepts of habitats and look at fluctuating population size. **How Many Bears Can Live in This Forest?** (WILD). Students explore the concept of limiting factors. **Tree Factory** (PLT). Students become familiar with the parts of a tree. **Every Tree For Itself** (PLT). Students describe how varying amounts of light, water and nutrients affect a tree's growth. **Who Fits Here?** (WILD). Students match living things to their environment. **What's for Dinner?** (WILD). Students see the connection from plants to animals.	**Microtrek Treasure Hunt.** Students discuss evidence that wildlife is present and create a chart of the results of the treasure hunt. **Oh Deer!** Students identify the components of habitat and define limiting factors. Examine graphs of population size and answer questions from the activity. **How Many Bears Can Live in This Forest?** Students define limiting factors and describe their effects on animal population. **Tree Factory.** Students create and label a model of a tree using art supplies or use the Student Page to use as a talking book. **Every Tree For Itself.** Students graph the results of the activity. **Who Fits Here?** Students describe the ecosystem of an anima and the importance of adaptation. Design a game for younger students on wildlife adaptations. **What's for Dinner?** Students create a food chain and identify the source of all animal food.

Frameworks	Science Process Skills	Activities		Assessment
LS2: 6:2.3 Describe the process of photosynthesis and explain that plants can use the food they make immediately or store it for later use. LS2: 6:2.4 Recognize that energy, in the form of heat, is usually a byproduct when one form of energy is converted to another, such as when living organisms transform stored energy to motion. LS2: 6:3.1 Define a population as all individuals of a species that exist together at a given place and time; and explain that all populations living together in a community, along with the physical factors with which they interact, compose an ecosystem. LS2: 6:3.2 Using food webs, identify and describe the ways in which organisms interact and depend on one another in an ecosystem. LS2: 6:3.3 Explain how insects and various other organisms depend on dead plant and animal matter for food; and describe how this process contributes to the system. LS3: 6:1.1 Provide examples of how all organisms, including humans, impact their environment; and explain how some changes can be detrimental to other organisms. LS3: 6:1.2 Explain how changes in environmental conditions can affect the survival of individual organisms and the entire species.		Field Experiences	**Site Seeing: Beginning Level** (GLOBE). Students sketch their study site and determine boundaries of a system. **Field, Forest and Stream** (PLT). Students explore three different environments and study their abiotic and biotic components. **Edge of Home** (WILD Aquatic). Students explore the transition zone between habitats. **Trees in Trouble** (PLT). Students take a closer look at trees for signs of damage. **LC1: Connecting the parts of the study site** (GLOBE). Students make connections between the Earth System spheres. **Map and Inventory** (HOME). Students map and inventory the schoolyard site over time. **Wildlife Census** (HOME). Students conduct a wildlife census of the schoolyard site over time using a grid system. **Site Inventory Cards** (HOME, Ch. 4). Students use inventory cards High/Low Temperature, Surface Rocks, Animal Foods and Agents of Decomposition to collect data about their schoolyard site. **Baseline/Offset and Grid Mapping** (HOME, Ch. 4). Students map different areas and aspects of the schoolyard.	**Site Seeing: Beginning Level.** Students answer the discussion questions in the activity. **Field, Forest and Stream.** Students chart the relationships between the elements/components. **Edge of Home.** Students write about ecotones. Choose an animal and describe its interactions with several different ecosystems. **Trees in Trouble.** Students draw and discuss healthy and unhealthy trees. **LC1: Connecting the parts of the study site.**

Frameworks	Science Process Skills	Activities		Assessment
		Post-Field Experiences	**Tree Cookies** (PLT). Students use tree cookies to look for damage or stress. **Rain Reasons** (PLT). Students explore the relationships between water, light and temperature on plant growth and precipitation and geography on plant and animal species. **Changing the Land** (WILD). Students learn about fragmentation, detecting change in aerial photographs, and the considerations for land-use planning.	**Tree Cookies.** After hearing a story about a tree, students draw what the tree cookie would look like. **Rain Reasons.** Evaluate how well students can use maps and understand the relationships they studied. **Changing the Land.** Students analyze aerial photos from the past and present for change. Role-play being part of a land-use planning committee.
		Culminating	**Improving Wildlife Habitat in the Community** (WILD). Students use their knowledge of habitat to improve an area for wildlife. **Enhancement Plan Worksheet** (HOME, Appendix J). Students use their knowledge of the schoolyard site to develop an enhancement plan for wildlife.	**Improving Wildlife Habitat in the Community.** Students describe the importance and value positions of land-use planning. **Enhancement Plan Worksheet.** Students demonstrate how the enhancement plan for wildlife relates to the inventory results.

Project HOME extensions

Integration with other subjects

- Art (drawing)
- Social Studies (ecosystems, biomes)

Additional resources

- Wonders of Wildlife Program "Habits and Habitats" (NH Fish & Game Department)
- Furbearer Curriculum Kit (NH Fish & Game Department)
- Discover WILD Times for Kids (NH Fish & Game Department)
- WILD in NH (NH Fish & Game Department)
- www.wildnewengland.org
- New England Wildlife, Habitat, Natural History and Distribution. DeGraaf, Richard M. and Mariko Yamasaki. University Press of New England, Hanover, NH. 2001.
- Outdoor Inquiries: Taking Science Investigations Outside the Classroom. Patricia McGlashan and Kristen Gasser, et al., Heinemann, Portsmouth, NH. 2007.

Ecosystems and Habitats Scope and Sequence

S:LS2: Energy flows and matter recycles through an ecosystem.
S:LS3: Groups of organisms show evidence of change over time.

Grade 7 – 8

ESSENTIAL QUESTION: WHAT DATA MUST BE COLLECTED IN ORDER TO MAKE DECISIONS ABOUT THE IMPACT CHANGE HAS ON LIVING THINGS?

Frameworks	Science Process Skills	Activities		Assessment
LS2: 8:1.1 Explain how changes in environmental conditions can affect the survival of individual organisms and an entire species. LS2: 8:1.2 Explain that in all environments, organisms with similar needs may compete with one another for resources, including food, space, water, air, and shelter, and that in any particular environment the growth and survival of organisms depend on the physical conditions. **LS2: 8:1.3** **Using data and observations, predict outcomes when abiotic/biotic factors are changed in an ecosystem.** LS2: 8:2.1 Explain how food provides energy and materials for growth and repair of body parts. **LS2: 8:2.2** **Given a scenario, trace the flow of energy through an ecosystem, beginning with the sun, through organisms in the food web, and into the environment (includes photosynthesis and respiration).**	SPS1 • Making Observations and Asking Questions • Conducting Scientific Investigations • Representing and Understanding Results of Investigations SPS2 • Nature of Science • Patterns of Change SPS3 • Collaboration in Scientific Endeavors • Common Environmental Issues, Natural Resources Management and Conservation SPS4 • Information and Media Literacy • Communication Skills • Interpersonal and Collaborative Skills • Self Direction	Pre-Field Experience	**Soil: The Great Decomposer** (GLOBE). Students observe decomposition under various conditions. **P5: Investigating Leaf Pigments** (GLOBE). Students compare the leaf pigments in the fall and spring. **Why Do We Study Soil?** (GLOBE). Students explore the nature of soil, how it is formed and how much of it there is. **Soil Stories** (PLT). Students explain how the components of soil influence its ecosystem and human use. **Overlay Maps** (HOME, Appendix B). Students collect the necessary maps to study different aspects of the site.	**Soil: The Great Decomposer.** Vary the activity and use earthworms or different soils, record the results. **P5: Investigating Leaf Pigments.** Students use Science Logs to document activity observations and answers to questions. Use Activity Science Skills checklist to document progress. Students explore other material. Use the Activity rubric to assess student learning. **Why Do We Study Soil?** Students create a soil story and comment on soil diversity. **Soil Stories.** Students write a letter to the homeowners to explain the results of the test. **Overlay Maps.** Students assemble the maps to scale and correlate data.

Frameworks	Science Process Skills	Activities		Assessment
		Field Experience	**World Travelers** (WILD). Students map and report on native and non-native species. **Site Seeing: Intermediate Level** (GLOBE). Students collect a series of abiotic observations for different land cover types. **Fallen Log** (PLT). Students study a fallen log for organisms and decomposition. **Green-Down Protocol** (GLOBE). **Overlay Mapping the Schoolyard** (HOME, Ch. 3). Students actively participate in mapping the schoolyard site creating overlays of different aspects of the site. **Wildlife Census** (HOME, Ch 4-5). Students determine if a specific area would host a specific species.	**World Travelers.** Students answer a series of Evaluation questions on non-native vs. native species. Describe how to identify plants. **Site Seeing: Intermediate Level.** Students re-visit the same sites in different seasons to compare and contrast. Construct a terrarium using the data collected. **Fallen Log.** Students draw a series of pictures showing what happens to a fallen log. **Green-Down Protocol.** Students discuss the Questions for Further Investigation.
		Post-Field Experience	**Migration Barriers** (WILD). Students study deer migration and what impact humans can have. **Green-Down Data Analysis** (GLOBE). Students create color charts of their leaves changing colors. If possible, use several leaves of different species. **Checks and Balances** (WILD). Students design a wildlife management plan using best practices. **Invasive Species** (PLT). Students learn what invasive species are, why they are problematic and how to prevent their spread.	**Migration Barriers.** Students define migration, discuss human interference with migration and how to decrease that interference. **Checks and Balances.** Students describe factors that influence population and wildlife/human management. **Invasive Species.** Use students' presentations to evaluate their understanding of invasives, oral communications skills, problem solving ability and creative messaging.
		Culminating	**400 Acre Wood** (PLT). Students design a land management plan using best practices as they see them.	**400 Acre Wood.** Students role-play presenting their plans while a committee decides which proposal is the most appropriate.

Project HOME extensions

Integration with other subjects

- Art (color)
- History (soil forming factors, invasive species, human impact)

Additional resources

- Wonders of Wildlife Program "Endangered Species" (NH Fish & Game Department)
- Winter Severity Index (NH Fish & Game Department)
- Project Osprey Curriculum Unit (NH Fish & Game Department)
- NH Wildlife Action Plan. *www.state.nh.us/wildlife/wildlife_plan.htm.*

Ecosystems and Habitats Scope and Sequence

S:LS2: Energy flows and matter recycles through an ecosystem.
S:LS3: Groups of organisms show evidence of change over time.

Grade 9 – 12

ESSENTIAL QUESTION: HOW DOES ENVIRONMENTAL DISTURBANCE AFFECT THE FLOW OF ENERGY AND THE CYCLING OF MATTER IN AN ECOSYSTEM?

Frameworks	Science Process Skills	Activities		Assessment
LS2: 11:1.1 Explain how the amount of life an environment can sustain is restricted by the availability of matter and energy, and the ability of the ecosystem to recycle materials. LS2: 11:1.2 Describe how the interrelationships and interdependencies among organisms generate stable ecosystems that fluctuate around a state of rough equilibrium for hundreds or thousands of years. LS2: 11:1.3 Identify the factors in an ecosystem that can affect its carrying capacity. LS2: 11:1.4 Analyze and describe how environmental disturbances, such as climate changes, natural events, human activity and the introduction of invasive species, can affect the flow of energy or matter in an ecosystem. **LS2: 11:1.5** **Using data from a specific ecosystem, explain relationships or make predictions about how environmental disturbance (human impact or natural events) affects the flow of energy or cycling of matter in an ecosystem.** *(continued on next page)*	SPS1 • Making Observations and Asking Questions • Conducting Scientific Investigations • Representing and Understanding Results of Investigations • Evaluating Scientific Explanations SPS2 • Nature of Science • Systems and Energy • Patterns of Change SPS3 • Common Environmental Issues, Natural Resources Management and Conservation • Science and Technology, Technological Design and Application SPS4 • Information and Media Literacy • Communication Skills • Critical Thinking and Systems Thinking • Self Direction	Pre-Field Experiences	**Bottleneck Genes** (WILD). Students simulate the gene-pool analysis of the black-footed ferrets. **Carrying Capacity** (WILD). Herds of students test the limits of a food supply. **Story of Succession** Part A (PLT, Forest Ecology module). Students study a succession story and create pictures to go along with it.	**Bottleneck Genes.** Students research a local threatened species and consider how genetic diversity is a challenge for zoos. **Carrying Capacity.** Using a scenario, students explain the increase and collapse of a population. **Story of Succession** Part A. Working in teams, students use transparent overlays and colored markers to create a sequence of pictures to show succession and explain it to their peers.

Frameworks	Science Process Skills	Activities		Assessment
LS2: 11:1.6 **Explain or evaluate potential bias in how evidence is interpreted in reports concerning a particular environmental factor that impacts the biology of humans.** LS2: 11:2.1 Use examples from local ecosystems to describe the relationships among organisms at the different trophic levels. LS2: 11:3.1 Explain that as matter and energy flow through different levels of organization in living systems and between living systems and the environment, elements, such as carbon and nitrogen, are recombined in different ways. **LS2: 11:3.2** **Trace the cycling of matter (e.g., carbon cycle) and the flow of energy in a living system from its source through its transformation in cellular, biochemical processes (e.g., photosynthesis, cellular respiration, fermentation).** LS3: 11:1.1 Identify ways humans can impact and alter the stability of ecosystems, such as habitat destruction, pollution, and consumption of resources; and describe the potentially irreversible effects these changes can cause. LS3: 11:1.2 Identify ways of detecting, and limiting or reversing environmental damage. LS3: 11:1.3 Analyze the aspects of environmental protection, such as ecosystem protection, habitat management, species conservation and environmental agencies and regulations; and evaluate and justify the need for public policy in guiding the use and management of the environment.		Field Experiences	**Mapping the Schoolyard** (HOME). Students actively participate in mapping the schoolyard site. **Fire Ecologies** (WILD). Students conduct a field investigation on burn sites. **Bird Song Survey** (WILD). Students investigate an area and use bird-counting techniques. **Wildlife Census** (HOME). Students determine if a specific area would host a specific species. **Adopt a Forest** (PLT, Forest Ecology module). Students develop a scientific protocol to explore ecological relationships and biological and structural diversity of an adopted forest. **Cast of Thousands** (PLT, Forest Ecology module). Students take scientific measurements, examine interrelationships among organisms, and determine the extent of human impact on their adopted forest. **Story of Succession** Part B (PLT, Forest Ecology module). Students observe a local site over time to monitor succession. **Story of Succession** Part C (PLT, Forest Ecology module). Students observe stages of succession at their adopted forest and compare these with two other sites (from Parts A and B of activity). **Biometry Protocols** (GLOBE). Students collect ground and canopy cover measurements, identify the dominant species and measure the tree heights and circumference of five representative trees.	**Mapping the Schoolyard.** Students accurately depict the schoolyard. **Fire Ecologies.** Students describe the importance of fire in forests and grasslands and species that thrive when fire is present. Design a PR campaign to describe the value of fire to ecosystems. **Bird Song Survey.** Students summarize results, design a butterfly survey, and use "visual vocabulary." **Adopt a Forest.** Students prepare a report on what they learned about their adopted forest, prompted by a series of questions. **Cast of Thousands.** Students apply the knowledge they gained by answering the questions on page 37 and use forest measurements to graph various factors. **Story of Succession** Parts B and C**.** Students describe and analyze stages of succession at three sites. **Biometry Protocols.** Students use the data they collected to classify the land cover in the study site using the *Land Cover Sample Site Protocol (GLOBE).*

Frameworks	Science Process Skills	Activities		Assessment
		Post-Field Experiences	**The Glass Menagerie** (WILD Aquatic). Students observe and describe changes in physical characteristics of several different experimental aquatic habitats that they create. **Green Space** (PLT, The Places We Live module). Students investigate relationships between the human and natural environment. **RC2: Effects of Inputs and Outputs on a Region** (GLOBE.) Students draw an imaginary box on a topographic map and using all the spheres (atmosphere, biosphere, hydrosphere, lithosphere), generate questions about changes to inputs and outputs of the system in their area. **Far Reaching Decisions** (PLT, The Places We Live module). Students explore how the choices we make about the foods we eat, the products we purchase, the energy we use and the communities we develop affect distant communities.	**The Glass Menagerie.** Students match the list of characteristics in the Evaluation with the type of lake. **Green Space.** Students develop their own action plans for contributing to the protection of green space. **RC2: Effects of inputs and outputs on a region.** Use the Activity rubric to assess student learning. **Far Reaching Decisions.** Students write a detailed account from the perspective of a consumer product or a resource, tracing its path and experiences from points A to Z.
		Culminating	Students choose an abiotic factor change that would affect the wildlife of an area and describe its potential impact. Students make predictions about energy flow if a disturbance occurs within a specific system. Students develop strategies for how they would increase the diversity or amount of a species in a specific area. **Land Cover Sample Site Protocol (GLOBE)**. Students use the data collected in the *Biometry Protocols (GLOBE)* to classify the land cover in the study site.	

Project HOME extensions

Integration with other subjects

- Chemistry (nitrogen cycle)
- Biology (genetics)
- Art (drawing)
- Social Studies (mapping, ecosystems, human impact)
- Music (bird songs)

Additional resources

- NH Wildlife Action Plan URL *www.Wildnh.com/Wildlife/wildlife_plan.htm,* (NH Fish & Game Department)

Appendix

New Hampshire Education and Environment Team Contact Information

NH GLOBE Program
www.globe.gov
Jennifer Bourgeault, Coordinator
North Country Education Services GLOBE Partnership
69 High Street
Stratham, NH 03885
(603) 778-6305
unhglobejen@comcast.net

NH Project Learning Tree
www.nhplt.org
Erin Hollingsworth, Education Coordinator
54 Portsmouth Street
Concord, NH 03301
(603) 226-0160
info@nhplt.org

NH Project WET
www.des.nh.gov/wet
Alicia Carlson, State Coordinator
NH Department of Environmental Services
29 Hazen Drive, P.O. Box 95
Concord, NH 03301
(603) 271-4071
Alicia.Carlson@des.nh.gov

NH Project WILD
www.wildnh.com/Education/project_WILD.htm
Mary Goodyear, Wildlife Educator
NH Fish and Game Department
11 Hazen Drive, Concord, NH 03301
603-271-3211 or (603) 846-5108
mgoody@ncia.net

Project HOME
www.wildnh.com/Education/ed_project_HOME.htm
Marilyn Wyzga, Wildlife Educator
NH Fish and Game Department
11 Hazen Drive, Concord, NH 03301
(603) 271-1197
marilyn.wyzga@wildlife.nh.gov

USDA Forest Service Conservation Education

State & Private Forestry, Northeastern Area
Susan Cox, Conservation Education Coordinator
Durham Field Office
USDA Forest Service
271 Mast Rd
Durham NH 03824
603 868-7706
smcox@fs.fed.us

White Mountain National Forest
Clare Long, Conservation Education Specialist
719 Main Street
Laconia, NH 03246
(603) 528-8707
cclong@fs.fed.us