

A Working Forest - A Dynamic Landscape

The Forest Discovery Trail A Curriculum for Grades 9 through 12

Including correlations with state standards for NH and ME,
lesson plans, and worksheets

Welcome to the Forest Discovery Trail



A working forest in miniature

This 1.5-mile trail will open your eyes to the inner workings of a managed forest. When you reach the end, you will have a better understanding of how all the parts of this ecosystem are interdependent.

Managing the Forest

Resource managers must meet people's needs for wood, water, wildlife, clean air, and recreation while maintaining a healthy, changing, and productive forest ecosystem. We call this a working forest.



Many examples of how the White Mountain National Forest is managed as part of an ever-changing landscape - including tree harvesting - can be seen here.

Self-guided tour

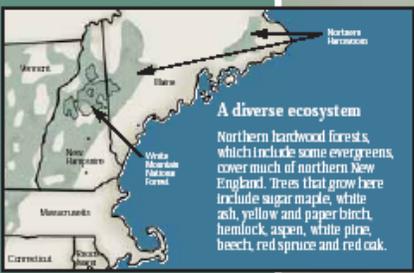


A Working Partnership

The construction of the Forest Discovery Trail was made possible by an innovative partnership among the U.S. Department of Agriculture Forest Service, the National Forest Foundation, and other generous sponsors.

This ongoing educational program is made possible through the support of the Society of American Foresters, the North Country Resource Conservation and Development District, and the USDA Forest Service.

Where is the Northern Hardwood Ecosystem?



A diverse ecosystem

Northern hardwood forests, which include some evergreens, cover much of northern New England. Trees that grow here include sugar maple, white ash, yellow and paper birch, hemlock, aspen, white pine, beech, red spruce and red oak.

Map Legend

- Forest Discovery Trail
- Interpretation point

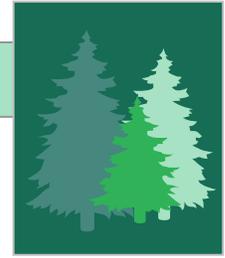
Scale: 0 50 100 feet

White Mountain National Forest

Developed and produced in cooperation with
North Country Resource Conservation & Development



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Acknowledgements

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Partners

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North Country Resource Development & Conservation Area Council
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Curriculum Development

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Project Partners: North Country Resource Conservation & Development Area Council
Sponsors: US Forest Service, Granite State Chapter, Society of American Foresters, National Forest Foundation
Curriculum Development: Alexandra Murphy

**United States Department of Agriculture
Forest Service**



Motto: *Caring for the Land and Serving People*

Mission: to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations.

The Forest Service's mission includes:

- Promoting the health, productivity, diversity, and beauty of forests.
- Listening to people and responding to their diverse needs in making decisions.
- Protecting and managing the National Forests for sustainability and multiple-use.
- Helping states and communities to wisely use the forests to promote rural economic development and a quality rural environment.
- Developing and providing scientific and technical knowledge aimed at improving our capability to protect, manage, and use forests and rangelands.

Forest Discovery Trail Curriculum for Grades 9-12



INTRODUCTION

To many residents of New Hampshire and Maine, working forests are sources of jobs and forest products, and serve as an anchor for the region’s culture and heritage. To others, the forest provides cherished opportunities for recreation, including camping, snow sports, fishing, and hiking. To some people, the sights and sounds of logging operations are contrary to their idea of the “northern forest.” The Forest Service, working with dedicated partners, created the Forest Discovery Trail to help close this gap of perception and to build understanding for the intricacies of managing a working forest – a forest that provides jobs and forest products as well as recreation opportunities, clean water, air and healthy habitats for fish and wildlife.

Although students depend on forest products in every facet of their lives, few understand the journey from forest community to storefront, and the myriad management decisions required to facilitate that journey. The Forest Discovery Trail—a 1.5 mile trail punctuated with interpretive panels—teaches them about the complexity of managing a forest well and maintaining its health while extracting materials for our own use.

Purpose of the Forest Discovery Trail

- To describe the northern forest ecosystem, including scientific, economic, and social components.
- To develop understanding of the multiple use mission of the White Mountain National Forest in local, regional, and national contexts.
- To display a microcosm of a “working forest” and a sample of the strategies utilized by resource managers to meet a wide array of often-competing objectives.

Purpose of the *Forest Discovery Trail Curriculum*

- To increase students’ understanding of forest ecology and management.
- To increase students’ understanding of the surrounding National Forests, and of the management objectives and practices affecting them.
- To increase students’ understanding of the methods resource managers use to manage a forest.
- To provide pre-visit, on-site, and follow-up activities and resources for exploring the Forest Discovery Trail and the standards and frameworks it addresses within your classroom curriculum.

How to Make the Most of the Forest Discovery Trail

- Contact the White Mountain National Forest, Conservation Education Program Leader. Resource managers may be able to help you with your planning, visit your classroom, and/or accompany you on your trip to the Discovery Trail
- Review the curriculum, its exercises, and standards correlations.
- Take this curriculum with you to the trail. Enjoy!

Introduction to the Curriculum

The *Forest Discovery Trail Curriculum* will help you guide students through these three forest management steps, offering pre-visit, on-site, and follow-up activities and related teaching resources. The curriculum also provides supplementary teacher's materials and student worksheets, and offers learning standards correlations for all activities. As you move along the trail, the curriculum includes a copy of each panel followed by its respective curriculum and activities.

The Forest Discovery Trail introduces three key steps in forest management.

1. ***Researching forest ecology***

Before creating a management plan and carrying out forest management, resource managers must first know what they are managing. Managers study the forest to understand the natural processes at work on the land, in the air and water, assess the area's biodiversity, and map natural communities, cover types, and natural features.

2. ***Establishing management objectives***

Once resource managers have mapped and inventoried the forest lands they manage, they then begin the task of setting management priorities for those lands. The National Forest follows a multiple-use mandate that stipulates that they manage for a wide range of objectives, including conservation of forest health, habitat improvement and protection, timber harvest and productivity, a variety of recreation opportunities, aesthetics, and harvest of non-timber forest products.



3. ***Determining management strategies***

Once resource managers determine the management objectives for a given forest, they choose the management strategies that will help them reach those objectives. Forest management is both art as well as a science, balancing people's needs and those of the ecosystem. Forests are managed for a variety of objectives; sometimes these objectives can be achieved simultaneously and sometimes objectives are mutually exclusive. There are innumerable management options that will achieve a desired objective— the resource manager will balance all of these to determine the most appropriate course of management.

Learning Standards

The *Forest Discovery Trail Curriculum* is aligned with state learning standards for New Hampshire and Maine. In the following section, you will find a chart correlating curriculum activities with state learning standards.

Correlations to New Hampshire and Maine Learning Standards, *Forest Discovery Trail Curriculum, Grades 9-12*

Activity		New Hampshire				Maine					
		Language Arts	Social Studies	Science	Mathematics	Language Arts	Science & Tech.	Economics	Geography	Visual & Performing Arts	Mathematics
Pre-visit											
	Wood Wise		5, 9	4c			B	A			
	Graphing Forestland Ownership		10, 11, 15	2c			J		A		
	Mapping in the Third Dimension		10, 15	2b, 6d			J		A		
On-Site						Physical Education A					
	Panel 2: Getting Acclimated			1a, 3a			J				
	Panel 3: Layers of Life			1a, 3a			B				
	Panel 4: Mimicking Nature worksheet	2		1a, 3a, 3b, 4c		E	B, J				
	Panel 5: Mimicking Nature worksheet	2		1a, 3a, 3b, 4c		E	B, J				
	Panel 6: Written Down in Wood worksheet			1a, 3a	4c		B, J				F
	Panel 8: Clearcut Ecology	2		1a, 3a			B, J				
	Panel 10: How Much Wood? Worksheet			1a, 2a, 2b, 6d	4a, 4c	E	J				E, F
	Panel 12: Mimicking Nature worksheet	2		1a, 3a, 3b, 4c		E	B, J				
Follow-up											
	Bringing Forestry Home		5, 9					A			
	Creating a School Grounds Management Plan	2, 6	9,10, 15	1a, 2a, 4c		E, H	B, J, L		A		
	Social Trade-Off's	3, 7	5, 9, 12	3a, 4c			B	A		A	
	Logs of Straw: Dendrochronology		17	2b, 3b, 6a, 6d			J, B, M				
	Calculating Cords of Firewood per Acre				1a, 4c, 5a						B, F, C

Recommended Supplemental Resources

There is a wealth of excellent teaching material related to (or adaptable to) the Northern Forest. Below, you'll find our recommendations of appropriate resources that will help you and your students deepen your study of forestry concepts.

Forestry-Related Curricula

- **Project Learning Tree.** Project Learning Tree (PLT) is a nationwide program of the American Forest Foundation and the Council for Environmental Education. PLT provides both elementary and secondary curriculum materials focused on forests and forest issues. These materials are free of charge to teachers who take a low-cost, one-day training course. *We highly recommend taking part in this training program to access the excellent materials PLT provides.* PLT offers several manuals with excellent forest-related activities specifically geared to high school students. Contact your state's PLT coordinator to find out about up-coming workshops.
New Hampshire PLT: 603-226-0160, info@nhplt.org.
Maine PLT: 207-626-7990, meplt@zwi.net.

PLT coordinators in New Hampshire and Maine have created supplemental materials that provide forest information specific to those states. *The Educator's Guide to New Hampshire Forests* is a series of fact sheets designed to help educators teach about New Hampshire's forests.

We have enclosed *The Educator's Guide to New Hampshire Forests* in this curriculum packet. Though introductory in nature, they provide some good, basic information about New Hampshire forests. These materials are also available on-line at <http://www.nhplt.org/guide.html>.

You can also download the supplementary PLT materials for Maine forests, *Maine Forest Facts*, at www.maintreefoundation.org/programs/plt.html.

- **Great Northern Forest: From Science to Stewardship.** Created by the Fairbanks Museum and Planetarium in St. Johnsbury, Vermont, this excellent resource is designed for middle school students, but gives detailed information, activities, and resource recommendations for 36 subjects related to the Northern Forest that you may find useful for your high school students. Available on-line at www.fairbanksmuseum.org/education_teachers.cfm.
- **Northern Woodlands Magazine.** *Northern Woodlands* offers a program for middle and high school teachers: Northern Woodlands Goes to School. Free copies of the magazine—accompanied by a teacher's guide with activities, resources, and standards correlations—are available for use in the classroom. www.northernwoodlands.com.

Books

- *The Field Guide to the Wildlife Habitats of the Eastern United States*, by Janine Benyus.

- *Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools*, by Mark K. Mitchell and William B. Stapp. Reviewed by the National Association of Science Teachers as “THE reference for those working with community water monitoring projects.”
- *The Life of the Forest*, by Jack McCormick.
- *Reading the Forested Landscape*, by Tom Wessels.
- *Shrub Identification Book*, by George W. Symonds and A.W. Merwin, 1980.
- *Tracking & the Art of Seeing*, by Paul Rezendes. Excellent resource for information about mammal behavior and signs.
- *Tree Identification Book*, by George W. Symonds and Stephen V. Chelminski, 1972.
- *Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont*, by Elizabeth H. Thompson and Eric R. Sorenson. University Press of New England, 2000.
- *Working With Your Woodland*, by Mollie Beattie, Charles Thompson, and Lynn Levine. University Press of New England, 1983. Excellent resource for information about resource management written for the general public.

Organizations

- **The American Forest and Paper Association.** Information about recycling and sustainable forestry, www.afandpa.org
- **Environmental Protection Agency.** <http://www.epa.gov/owow/monitoring/vol.html>. The EPA hosts webpages on volunteer water-quality monitoring, including how-to manuals and a national directory of environmental monitoring programs, listed by state.
- **New Hampshire Timberland Owners Association.** Nonprofit organization of forest owners and users working together to promote better resource management and a healthy wood products industry. (603) 224-9699, www.nhtoa.org.
- **NH Division of Forest and Lands.** Information about resource management. 603-271-2214, www.nhdf.org.
- **NH Fish and Game.** 603-271-3122, www.wildlife.state.nh.us.
- **Society for the Protection of NH Forests.** Statewide forest conservation group. 603/224-9945, www.spnhf.org.
- **UNH Cooperative Extension Service.** Visit their website, www.ceinfo.unh.edu, for a listing of the extension office in your area.

Audio-Visual Resources

- The New Hampshire Department of Fish and Wildlife offers an extensive audio-visual lending library, including such videos as *Biodiversity of New Hampshire*, which gives an overview of New Hampshire’s diverse natural resources, and reasons why we should maintain habitat diversity. Visit their website, http://www.wildlife.state.nh.us/Education/ed_audio_visual.htm

Before you visit the Forest Discovery Trail:

PRE-VISIT INFORMATION AND ACTIVITIES



For additional assistance in planning your trip to the Forest Discovery Trail, please contact the Conservation Education Program Leader, White Mountain National Forest, at (603) 528-8707 or at cclong@fs.fed.us. Resource specialists or forest interpreters may be available to accompany your group.

Students will learn most from the Forest Discovery Trail if they become familiar with some basic forest management concepts before visiting the trail.

Key concepts to introduce

- We use and depend on forest products every day.
- Forestland in the United States is owned and managed by a variety of public and private entities. The USDA Forest Service manages public lands for multiple uses and sustainability.
- Resource managers manage forestlands by researching forest ecology, establishing management objectives, and determining and carrying out management strategies.

Introductory activities for students

1. Wood Wise

We use myriad forest products throughout each day, often unconsciously. Among the Project Learning Tree fact sheets included in this curriculum packet, you'll find one entitled, *How Do We Benefit From Our Forests?* This fact sheet lists many forest benefits. The Project Learning Tree High School activity, *What's a Forest to You?* lists even more, including many products students may never have associated with trees, from baseballs to shampoo.

Ask students to consider how they benefit from forests and brainstorm answers. Discuss their answers as a class, and fill in benefits that they may have overlooked. Have them keep a journal for a day, in which they list all the forest-derived products they use during the day. Where did those wood products come from?

PLT *What's a Forest to You?* (PLT Secondary Module, *Focus on Forests*)

Great Northern Forest: From Science to Stewardship curriculum.

Out of Wood. Teaches about wood use among Eastern Woodland Indians, early settlers, and present-day inhabitants. http://www.fairbanksmuseum.org/education_northernforest.cfm.

2. Graphing forestland ownership

Maine has the highest percentage of forest land of any state in the country. New Hampshire has the second highest. Ask students who they think owns the forest land in their state. The *Who Owns NH's Forests?* fact sheet, included this curriculum packet, offers an overview of New Hampshire's land ownership distribution. Maine teachers can download a similar fact sheet for their state from Maine PLT's website, www.maintreefoundation.org/programs/plt.html.

National Forests account for 10% of New Hampshire's forest lands. National Forests are owned by all US citizens and are managed by the United States Forest Service. The Forest Discovery Trail is on land managed by the U.S. Forest Service and was created to teach the public about how the Forest Service manages these publicly held forest lands.

The University of New Hampshire hosts a website that allows you to view detailed maps of New Hampshire, whether you're interested in seeing an overview of the whole state or the details of a specific parcel. The maps show land ownership distribution, and also allows you to view aerial orthophoto and topographical overlays. You'll find this exceptional tool at http://granitweb.sr.unh.edu/clv_phase1/viewer.jsp. The site requires a high-speed internet connection to generate maps.

PLT *Who Owns America's Forests?* (secondary module, *Focus on Forests*). You'll find excellent background information on forestland ownership in the U.S..

Balancing America's Forests (secondary module, *Focus on Forests*). This activity helps students understand the various agencies that manage public lands and their differing management objectives.

Have students convert the voluminous (and highly compelling) land ownership statistics they will encounter in PLT materials (or on the internet) into a pie or bar graphs, both for your state's and for the US as a whole. Be sure to include ownership by private individuals, private industry, public agencies (local, country, state, and federal), and non-profit organizations. Students can use standard spreadsheet and graphing software programs to generate these graphs and interpret this information.

In New Hampshire and Maine, private, non-industrial forestland parcels have steadily decreased in size over the past decades, as state population increases and forest holdings are subdivided. An important result of this is fragmentation of resource management and fragmentation of forest habitat. *Northern Woodlands* magazine has published many articles on this subject. To request back issues of the magazine and to enroll in their *Northern Woodlands Goes to School* program, in which you receive free copies of the magazine for your students, along with a teacher's curriculum guide, contact them at 802-439-6292 or visit their website at www.northernwoodlands.org.

3. What resource managers do and why they do it

As outlined in the introduction to the curriculum, sustainable forest management requires three key steps. Your students can remember the steps with the acronym **RED** (**R**esearch forest ecology, **E**stablish management objectives, **D**etermine and implement management strategies).

Researching forest ecology

Before creating a management plan and carrying out forest management, resource managers must first know what they are managing. They study the forest to understand the natural processes at work on the land, in the air and water, assess the area's biodiversity, and map natural communities, cover types, and natural features. That way, they can make management choices that maintain the forest's health while meeting a wide variety of other social and resource objectives.

Establishing management objectives

Once resource managers have mapped and inventoried the forest lands they manage, they then begin the task of setting management priorities for those lands. The National Forest follows a multiple-use mandate that stipulates that they manage for a wide range of objectives, including conservation of forest health, habitat improvement and protection, timber production, and recreation.

Determining and implementing management strategies

Once resource managers determine the management objectives for a given forest, they then choose the management strategies that will help them reach those objectives. It is very important for students to realize that forestry is an art as well as a science. Forests are managed for a variety objectives; sometimes these objectives can be achieved simultaneously and sometimes objectives are mutually exclusive. There are innumerable management options that will achieve a desired objective—the resource manager will balance all of these to determine the most appropriate course of management. While this concept will be covered in depth at the Forest Discovery Trail, you can introduce this idea through the activities below.

The following activity helps give students a hands-on introduction to the resource management planning process:

School Grounds Management Planning

1. Research ecology and map the school grounds.

Have students work together in small groups to develop a habitat map of your school grounds. Contact your local planning commission for a topographic map of the school site. If they have GIS mapping capabilities, they may be able to overlay an aerial photo of the area).

Have students walk the grounds and delimit different habitats on the map—mowed lawn, open meadow, shrubs, wetlands, stream or river corridors, forest. Invite a forest ecologist to help you identify the natural communities present on the schoolgrounds, through soil analysis and identification of indicator plant species. If your school has CAD, GIS, or GPS technology, you can map landscape features digitally.

Background information on mapping (*Maps and Mapping*) and a mapping lesson plan (*Mapping the Third Dimension*) are included in the front pocket of this curriculum packet.

2. **Determine management priorities.**

Each group should decide upon and defend its management priorities for the school grounds. Some examples include recreation (playing fields, walking trails) animal habitat, clean water, beauty, and/or wood for a school building project. They can then brainstorm ways to manage the grounds to meet these goals. How will the group plan for and accommodate changes needed in the future (i.e. a larger computer lab, a new classroom wing, additional parking?)

Discuss as a group how these priorities can conflict with one another. For example, creating larger playing fields may require cutting down trees at the edge of their woodland, decreasing forest animal habitat. Increasing meadow habitat might require allowing portions of mowed lawn to grow up, decreasing playing field size.

How does the group set priorities if not everyone can agree? What are the economic and social effects of these management decisions? Resource managers try to find the optimal balance that best satisfies management goals.

See *Social Trade-Off's*, in the front pocket of this curriculum packet, for a related lesson plan.

3. **Implement management.**

Have students choose an objective that they might be able to carry out. Perhaps they want to create animal habitat—they might plant native, fruit-bearing shrubs, flowers and trees, or designate a corner of a field to be unmowed, creating meadow habitat. Perhaps they'd like to be able to produce maple syrup from the school's sugar maples. Have them write up a management plan for implementing their ideas to present to school officials.

Additional curricula related to habitat, forest ecology, and biological diversity

PLT *Adopt-a-Forest* (secondary module, *Forest Ecology*)
Cast of Thousands (secondary module, *Forest Ecology*)
Story of Succession (secondary module, *Forest Ecology*)

Additional curricula related to resource management

PLT *Tough Choices* (secondary module, *Focus on Forests*).
Weighing the Options: A Look at Tradeoffs (secondary module, *Focus on Risk*)

At the Forest Discovery Trail:

ORIENTATION INFORMATION



Before beginning your exploration of the Forest Discovery Trail, please share with your students the following trail rules:

Please~

Go lightly and leave no trace of your passing.

Stay with your group.

Respect the plants and animals that call this trail home.

Walk on the trail.

Respect the needs of other forest visitors.

Take home only memories—leave plants, rocks, and other natural objects here for others to enjoy.

Be sure to “Pack it Out!” – there are no trash receptacles along the trail. Please take your trash with you and dispose of it properly.

Remember that the only bathrooms are at the trailhead, near the parking lot.

The trail is gently graded along its 1.5-mile length. While the trail meets standards for wheelchair accessibility, because of environmental conditions (freezing and thawing, sun and shade, leaf litter, ice and snow), the surface material, and the length of the trail, we highly recommend that all wheelchair visitors have capable assistance throughout the duration of their visits.

Materials and Tools to Bring

- Compass
- Measuring tapes and rulers (along the trail, you’ll calculate tree volume. It would be optimal to have one measuring tape and one ruler for each group of 2-3 students, but you can certainly make do with fewer.)
- Calculators (several, if you have them)
- Clip boards or other firm writing surfaces (one for each work group of 2-3 students)
- Pencils
- Handouts: *Mimicking Nature* (3 copies for each group of 2-3 students)
Written Down in Wood (1 copy for each work group)
How Much Wood? (1 copy for each work group)
- Water quality monitoring tools, if you would like to test stream water quality along the trail. You’ll have the opportunity to do so at Panel #9. New Hampshire Department of Fish and Game, through its Watershed Education Program, offers teaching curricula to help students test water quality and identify macro invertebrates. For more information about the program, call 603-271-0456. Also, see the Supplemental Resources section on page 6 for references to the excellent guide, *Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools*.

Key Concepts

- Disturbance, in a variety of scales and from a variety of sources, is part of the forest ecosystem.
- Forestry is an art, as well as a biological, economic, and social science, so there is no single “right” way to manage a forest.
- We use forest products every day, and these products come from forests like this one.

Panel 1:

Welcome to the Forest Discovery Trail



A working forest in miniature

This 1.5-mile trail will open your eyes to the inner workings of a managed forest. When you reach the end, you will have a better understanding of how all the parts of this ecosystem are interdependent.

Managing the Forest

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Many examples of how the White Mountain National Forest is managed as part of an ever-changing landscape – including tree harvesting – can be seen here.



Self-guided tour

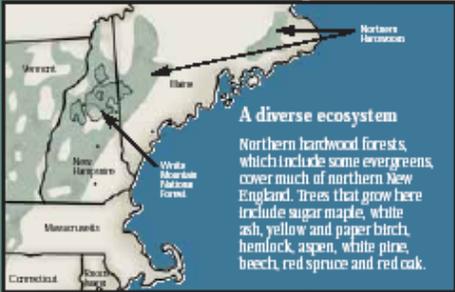


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Where is the Northern Hardwood Ecosystem?



A diverse ecosystem

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Map Legend

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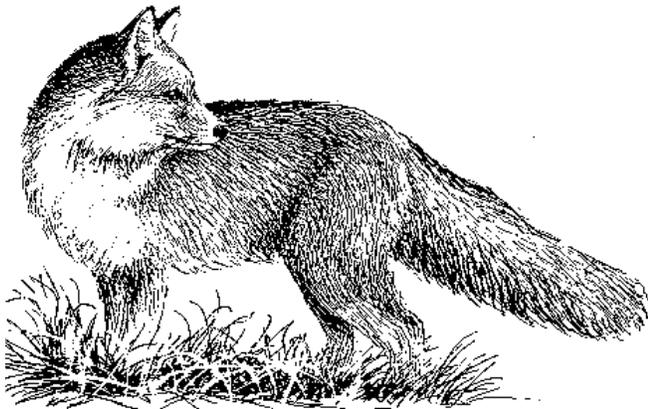
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Panel 1: Welcome to The Forest Discovery Trail

This introductory interpretive panel, which includes a detailed site map, will orient you to the trail. You'll also find a map of the trail in the rear pocket of this curriculum packet.

Before you start out, remind students that, on this trail, they'll be looking at the forest from a resource manager's perspective, noticing things that are important to resource managers, and looking at some of the techniques resource managers have used to manage this forest. Resource managers use these techniques on both publicly-owned and privately-owned forests throughout New England and the rest of the United States.

We encourage your students to carefully explore the forest away from the trail. Please remind them that, while doing so, they should respect the plants and animals that make this forest their home.



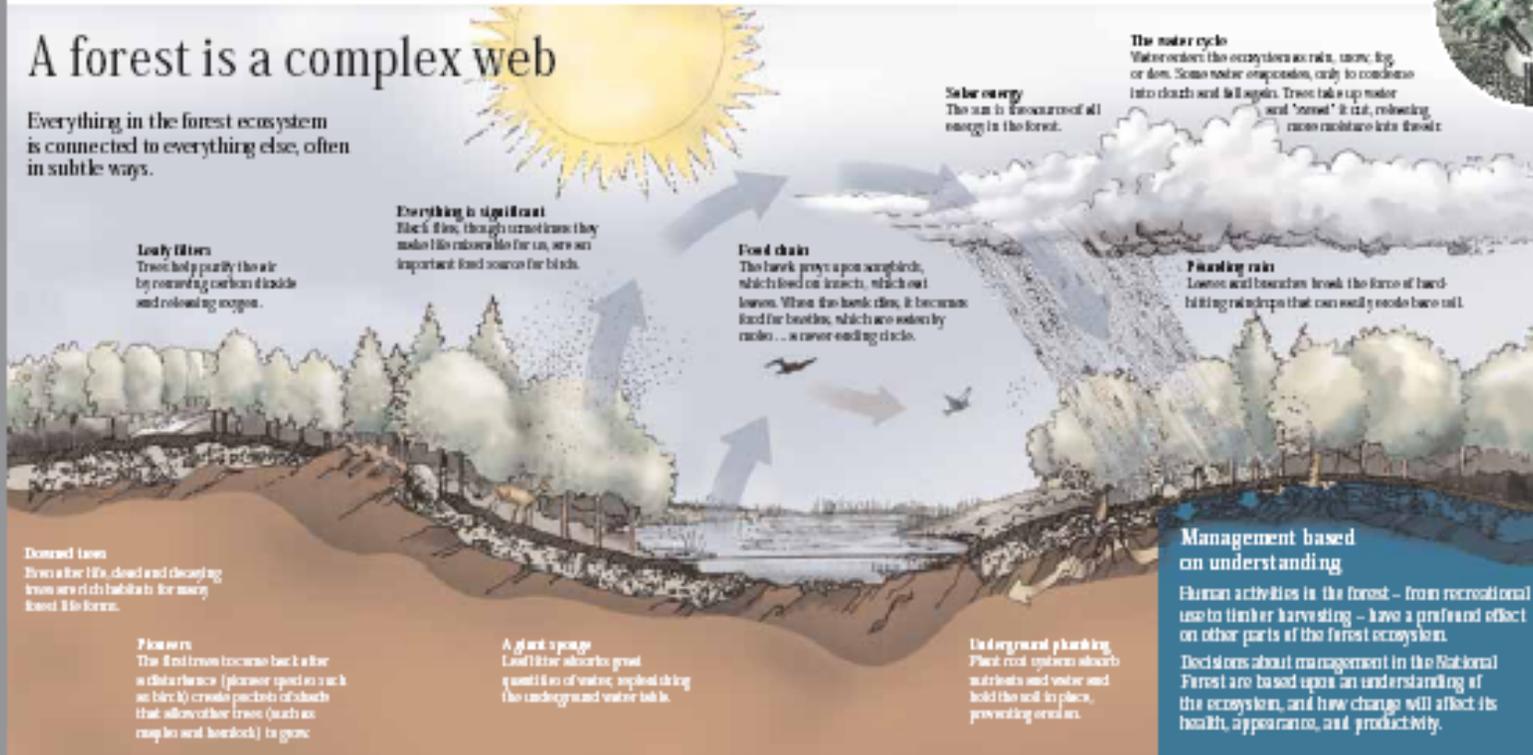
Panel 2:

The web of life: forest ecosystems



A forest is a complex web

Everything in the forest ecosystem is connected to everything else, often in subtle ways.



Leafy filters
Trees help purify the air by removing carbon dioxide and releasing oxygen.

Everything is significant
Even if it's small, though sometimes they make life miserable for us, are an important food source for birds.

Food chains
The hawk preys upon songbirds, which feed on insects, which eat leaves. When the hawk dies, it becomes food for beetles, which are eaten by mice... a never-ending circle.

The water cycle
Water enters the ecosystem as rain, snow, fog, or dew. Some water evaporates, only to condense into clouds and fall again. Trees take up water and "transpire" it out, releasing water moisture into the air.

Solar energy
The sun is the source of all energy in the forest.

Forming rain
Leaves and branches break the force of hard hitting raindrops that can easily needle bare soil.



Change is part of the natural cycle

Disturbances
Small events – a tree hit by lightning, insect outbreaks, or a few trees toppled by high winds – are part of the natural cycle, and create new openings in the forest canopy. These openings allow sunlight and rain to reach plants and the forest floor below.
Larger events – forest fires and massive blowdowns – happen infrequently. When they do, large openings are created that result in dramatic changes.
The forest responds quickly. Berry bushes are the first to take advantage of the increased sunlight. Soon tree and shrub seeds, falling from adjacent trees or lying dormant on the ground, sprout and grow. Before long, the earth is covered with new growth.

Downed trees
Even after life, dead and decaying trees are rich habitats for many forest life forms.

Flowers
The first trees become back after a disturbance (please spot so much as birch) create patches of shade that allow other trees (such as maple and hemlock) to grow.

A plant's pump
Leaf litter absorbs great quantities of water, helping bring the underground water table.

Underground plumbing
Plant root systems absorb nutrients and water and hold the soil in place, preventing erosion.

Management based on understanding
Human activities in the forest – from recreational use to timber harvesting – have a profound effect on other parts of the forest ecosystem.
Decisions about management in the National Forest are based upon an understanding of the ecosystem, and how change will affect its health, appearance, and productivity.



Panel 2: The Web of Life: Forest Ecosystems

A key concept for students at this site is that **the healthy forest community is highly complex**, involving myriad interrelationships among plants and animals and humans. In order to manage it well, resource managers must study the forest community and do their best to understand these interrelationships, then make management choices that respect and reflect this interdependency, so as to keep the pieces of this complex puzzle intact.

Another key idea is that, though complex, **the forest is constantly changing and is very capable of coping with—and is indeed dependant on—change**. The forest deals with change every day, whether the simple change of day to night and season to season, or the larger changes created by windstorms, fire, and timber harvest.

Have students pause at this site to begin to acclimate themselves to the natural environment around them. Help students tune in to where they are. Start big and focus in:

Where in the world are they?

North America, New Hampshire—roughly half way between Equator and North Pole, White Mountains—comprised largely of granite, and so on. All these factors influence the make-up of plants and animals in this forest community. Students should also be able to describe “where they are”, not only in relation to climate, geography and topography, but also in relation to economy—including local, regional, national and world economies—social values, etc. These factors very much influence management decisions that incorporate public opinion.

The forest is on a gentle slope here. Have students use a compass to determine the direction the slope faces. If you do not have a compass, let them roughly orient themselves with the help of the trail map included in this packet. What implications does a south facing slope present? North? How might elevation influence plant, animal and human use.

The slope faces southwest, which means that it soaks up the sun. Thus you can predict that the site is relatively warm and dry.

What kinds of trees survive and thrive in this forest? Are the trees mostly deciduous (hardwood) trees or conifers (cone-bearing)? Have students identify at least 5 tree species, using a tree identification guide as needed(see resource recommendations).

You are standing in a natural community known as sugar maple-beech fine till habitat. As the name implies, the dominant trees in this natural community are sugar maple and American beech, with yellow birch and paper birch occurring in lesser abundance. Sugar maple, beech and yellow birch are major components of several commonly found natural communities in the Northern Forest, so they are especially important ones for students to be able to identify.

Hardwood forest such as this is typical of New England, where shade tolerant (shade-loving) species dominate the mature forest in all but the coldest microhabitats. But natural disturbances

created by windstorms and insect infestation create gaps where shade intolerant (sun loving) species like. aspen, red maple, yellow and paper birch grow.

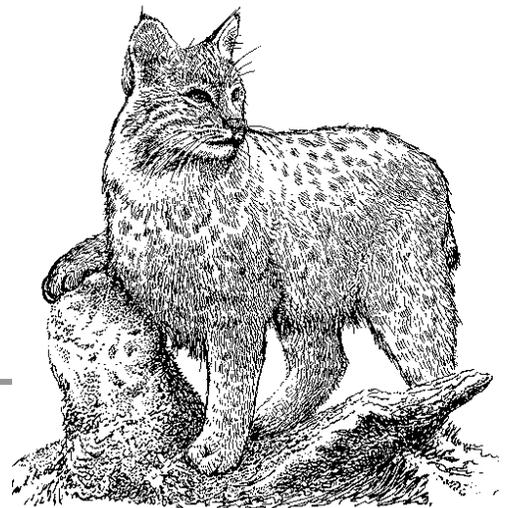
Why does this natural community information matter to resource managers?

Classifying forests in terms of natural communities helps to reveal the long-term possible composition of forests, as a point of reference when compared to the alternative effects generated by forest harvesting. This classification also helps land managers select management practices that work with the land's capacity for growing trees while protecting its health and productivity. If one of a forest manager's objectives for a particular stand is to manage for timber production, then he or she will want to encourage the growth of tree species that grow most vigorously on that site.

How might you expect the forest tree composition to change in a cool ravine, sheltered from the sun, or on a north-facing slope?

You'd find trees better suited to such cool, moist conditions—most likely dominated by softwoods.

An assemblage of plants and animals interacting with one another and with their physical environment is known as a **natural community**. Impress upon students that all forests are not alike. Within the White Mountain National Forest, there are dozens of different natural communities. Changes in slope, elevation, soils, moisture, and exposure to sunlight will alter the composition of plants and animals. *Encourage them to pay careful attention to the forests they pass through, observing with eyes and ears the lay of the land, and the plants and animals that live here.*



What other plants, besides trees, live in this forest?

How about animals—can you see any animal signs?

What can you hear?

Encourage students to pay careful attention to the forest as they pass through, observing with eyes and ears the lay of the land and the plants and animals that live here.

Forests serve an important role in providing clean air through photosynthesis and respiration. This is an example of yet another way that we depend upon the healthy forests around us in ways that are not readily apparent. Air pollution is a challenge of global magnitude. Students can strengthen their awareness of air pollution, its complexities and challenges by learning basic concepts and vocabulary. A summary of air pollution terms, definitions, and word search are included in the handouts in the front pocket of this curriculum packet.

Panel 3:

The forest: where change is the only constant



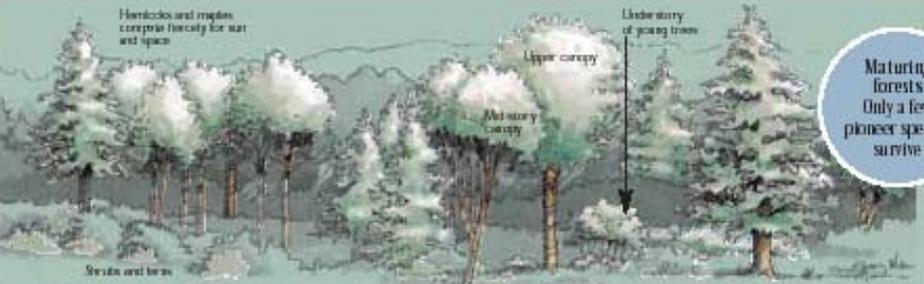
Young forests
Sunlight sparks a cycle of growth

The first to move back in

After a major disturbance, the first trees to gain a foothold are the quick growing pioneer species – such as aspen, pin cherry, and white birch. This initial flush of growth provides a cool shady environment favored by the next generation.

Forest Architecture

As you walk through the Forest Discovery Trail, note the various layers and niches: shrubs and ferns under foot, the understory of young trees, the mid-story canopy overhead, and the upper canopy that reaches the sky. Each of these places is home to different plant and animal species.



Maturing forests
Only a few pioneer species survive

Strong competitors up top

As the forest matures, the shorter-lived pioneers, such as aspen and white birch, will die out. Hardwood species like maples and beech begin an intense competition for sunlight and space. Trees seem to have their own "law of the jungle": shade or be shaded out and die.



Older forests
Less light reaches the forest floor

The cycle continues

As the forest continues to mature, less and less light reaches the forest floor. Eventually, the older, dominant trees start to die, creating openings in the canopy. Shafts of sunlight touch the earth, renewing the cycle of growth.

Panel 3: The Forest: Where change is the only constant

For many students, the idea that forests are many-layered and constantly evolving is very new— isn't a forest just a collection of big trees? New openings continually appear in the forest, and in those openings, seeds of herbaceous plants, shrubs, and trees sprout (exactly which species reproduce depends on such factors as amount of available light, soil moisture, and availability of seeds). Some of these saplings grow into young trees, and on to maturity, until they, too, fall and create an opening. Thus, the forest is filled with plants of many ages, sizes, and species. The following activity helps students notice the many-layered complexity of the forest community.

Activity: Layers of Life

1. Suggest to students that a forest is like an apartment building—it has many “floors,” or layers, and different plants and animals find food, water, and shelter in these layers. Using the list below to guide you, have students point out the forest’s various “floors” in the vicinity of this panel site.
2. Then ask them to name plants and animals that live in this forest. **On which “floor” does each live?**

It's important for students to understand that most plants and animals live on different levels at different times in their lives. A maple seed, for example, starts out on the first floor and, as it grows, moves up through the floors until it reaches the sixth floor. White pines may poke out onto the seventh floor.

A bear lives much of its life on the first floor, where it roots for grubs, tubers, and insects, but eats grass and herbaceous plants from the second floor, forages for berries on the third floor, and climbs to the fifth and sixth floors to eat beech nuts, black cherries, mountain ash berries, and acorns. It depends for its winter hibernation on hollows created by upturned root balls and downed logs of fallen trees. This information is critical for resource managers, who are trying to maintain the forest community's health. To maintain or improve bear habitat, for example, resource managers need to consider the health of several forest layers.

*Floor one: **the forest floor, with its absorbent, nutrient-filled humus.** Note that, just like in an apartment building, this “ground floor” is the foundation from which all the other floors grow, which is why it's so important to take good care of forest soils.*

*Floor two: **ferns, flowers, grasses***

*Floor three: **shrubs***

*Floor four: **understory***

*Floor five: **mid-story***

*Floor six: **canopy***



Floor seven: emergent (trees in this layer stick out above the general level of the forest canopy.)

3. As time passes, the trees in each of these forest layers grow. Trees in the under-story grow and join the mid-story and eventually the canopy. Yet a healthy, mature forest does not lose these younger forest layers. **Why?**

The forest is continually changing as trees age and die or as openings form from disturbances like wind, ice, insect damage, and harvesting. In these openings, succession begins anew. Thus the healthy forest maintains a multi-age, multi-layer community.

Water, Water, Everywhere!



Though there is an interpretive panel further along the trail specifically devoted to discussing water, this site, with its description of the water cycle and of the forest's sponge-like properties, is a good place to remind students of the key role forests play in providing clean water. In creating this trail, the Forest Service paid a great deal of attention to water flow, carefully channeling it to avoid erosion that strips soil nutrients and lowers water quality when those sediments enter streams and rivers. Encourage students to notice the flow of water through this forest—they may be surprised to see just how much water trickles through this forest, channeling water through the forest community, much like the blood vessels in a human body channel life-giving blood.

Railroad Remnants

Between Panels 3 and 4, in the woods to our left, have students look for a raised berm running roughly parallel to the trail. This is what remains of the railroad bed used more than a century ago to carry logs from the forests here to local mills. J.E. Henry build this railroad system in 1892. With more than 50 miles of track, this network was the largest of more than twenty such railroad logging systems in the Northeast. Train cars carried the logs to the sawmill and pulp mill in nearby Lincoln, NH.



Historian Bill Gove has written several books on the subject, including one devoted entirely to this particular railroad logging system, J.E. Henry's Logging Railroads. To order the book, contact Bill Gove at 802- 433-9878.

Panel 4:

One, two... tree by tree



Hairy Woodpecker

A process that mimics nature

A forest is a community of individual trees of all ages, sizes, and species. When a single tree dies, it creates room for a few new ones to grow.

In a harvesting method called "single tree selection," foresters maintain the diversity of the forest by taking out individual trees of all ages and sizes – in a way that imitates nature. The forest around you has been harvested using this method.

With this type of harvesting, little additional sunlight reaches the understory and forest floor because so few trees are removed. This favors the regeneration of shade-tolerant trees like sugar maple and beech, while discouraging certain sun-loving trees such as paper birch and white pine.



Nature
Trees die naturally from disease, old age, and other disturbances, leaving small openings in the forest.



Used to protect views
Single tree selection can be the least noticeable of all the harvesting methods used in the White Mountain National Forest. Because the canopy remains largely intact, this method is often used near recreation areas, main travel routes, and other visually sensitive places.



Imitating Nature
Single tree selection harvest creates small openings in the forest.

Winter food
Saplings grow in small woodland openings, providing abundant food for deer during winter months.

Panel 4: One, two...tree by tree

Have students complete the *Mimicking Nature: Forest Management Practices* worksheet to help them explore the ideas mentioned in the interpretive panel and the conditions they see in the forest around them.

Questions and Answers for the *Mimicking Nature* worksheet:

Question #1: What kind of management practice was used at this site?

Single Tree Selection

Question #2: What kind of natural process does it mimic?

This practice mimics the death of individual trees, caused by age, insect infestation, and disease.

Question #3: Look up at the tree canopy. How much sky can you see through the leaves? Draw a sketch of what you see, filling in the leafy canopy and leaving the sky white.

When mature trees are removed from the forest community, the canopy opens up. As you can see, there is still significant canopy cover in this area, because of the selective nature of the harvest. Given more space after such a harvest, the remaining trees will likely increase their growth rate. Measuring canopy cover is one way of determining the density, or crowding, of a forest.

A more common way to determine tree density is to measure what resource managers call “basal area.” The basal area of a single tree is the cross-sectional area of the tree’s bole at 4.5 feet above the ground. The basal area of an acre of forest is the sum of the basal areas of all the trees in that acre. When resource managers estimate the number of trees per acre and the basal area of those trees, they know the forest stand’s density and an indication of its timber volume. Single tree selection on this site reduced basal area by less than one-third. The Forest Service performs such light harvests in visually sensitive areas – such as in view of popular roads, scenic vistas, or recreation attractions - and in areas where such light treatment best suits the forest community.

Question #4: In this managed area, is the forest floor shaded or sunlit for most of the day?

Shaded.

What kinds of trees would you expect to grow under these conditions?

Shade-tolerant species, including sugar maple, yellow birch, beech, black cherry, hemlock, white pine, and balsam fir.

Question #5: Sketch the forest layers present in this management area. Be sure to note snags (standing dead trees) and down logs if you see them.

All forest layers are present.

Question #6: How might wildlife benefit from the changes created by the management practice?

This management practice maintains the major components of the forest's existing habitat, so managers would expect little change from current wildlife or plant populations.

Which wildlife species might benefit?

Most animals currently living in the mixed age forest community would do well here. Deer, grouse, rabbits, and moose would find increased browse from the seedlings that would sprout in the small openings created by single tree cutting.



Panel 5:

Fields in the forest: wildlife openings



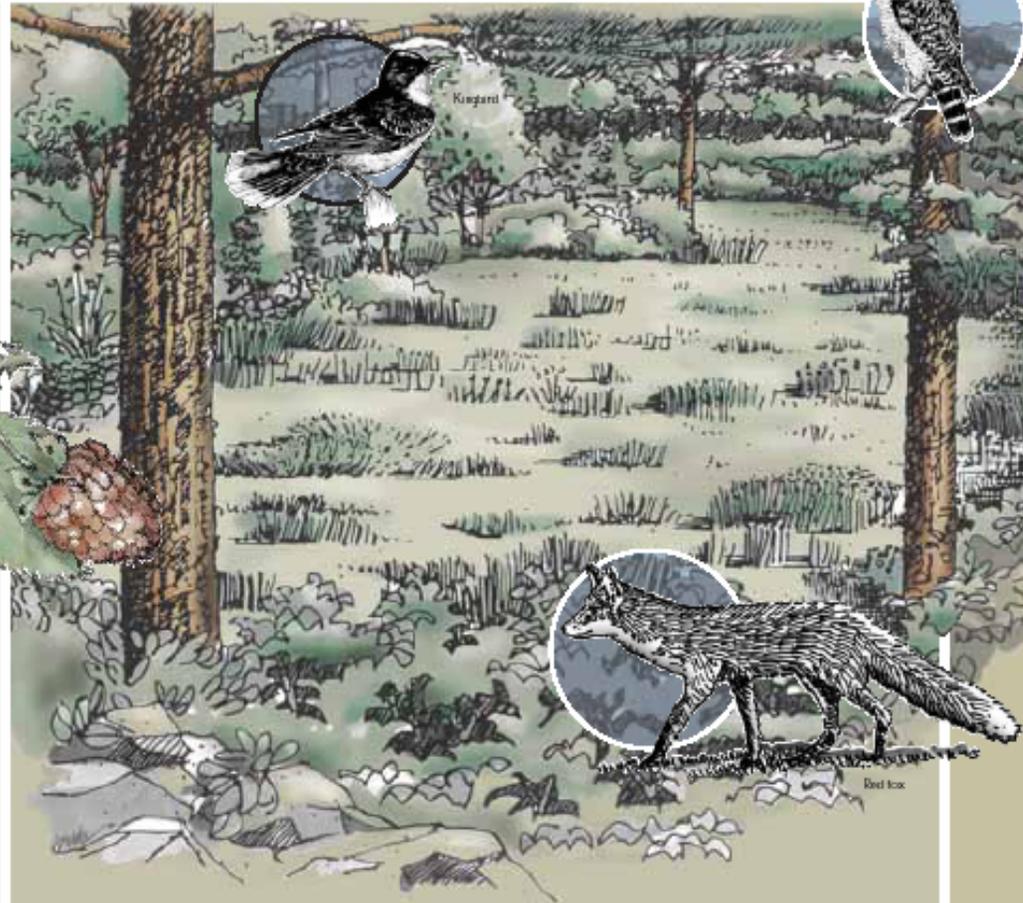
Created meadows

In carefully selected places throughout the forest, one- to six-acre patches of trees are harvested – or abandoned farm fields are kept open – to create special habitats for certain species of wildlife and to open scenic vistas.



A fruitful bounty

In meadows, the snow melts earlier in the spring, providing lush new growth for wildlife impoverished after a long winter. In late summer, the openings produce an abundance of wild berries – a favorite of the black bear. With the arrival of fall, seed-eating birds seek out these places like roadside diners during their fall migration.



Keeping the fields open for wildlife

Forest openings are carpeted with grasses and shrubs that are used by many animals for food and shelter. The fields may be mowed or burned every few years to keep them open.

Living at the edge

Wildlife openings also create edges where the forest meets the fields. These habitat junctions support a highly diverse wildlife population, and are favored by predators in search of prey.

Panel 5: Fields in the Forest

Students will quickly note that the management practices at this site have created far different habitat from that at the last site. Have students compare the two sites by completing a new *Mimicking Nature: Forest Management Practices* worksheet at this site—either in writing or simply by discussing aloud as a group.

Questions and Answers for the Mimicking Nature worksheet:

Question #1: What kind of management practice was used at this site?

Permanent Forest Opening

Question #2: What kind of natural process does it mimic?

This practice mimics disturbance caused by a windstorm, lightning strike or insect attack. What human process does this mimic? Invite students to reflect on the early settlement of New England. What were the major industries? How might they have appeared on the landscape? Farming and sheep operations have maintained permanent openings on the New England landscape for more than 100 years.

Question #3: Look up at the tree canopy. How much sky can you see through the leaves?

The canopy has been completely removed in the harvest area at this site.

Question #4: In this managed area, is the forest floor shaded or sunlit for most of the day?

Sunlit.

How do you think soil moisture and temperature compare with the surrounding forest?

Because the opening receives more sun than the surrounding forest, the site is likely drier and soil temperature higher on sunny summer days and likely colder and windier in the winter.

What kinds of trees would you expect to grow under these conditions?

Shade-intolerant species (including pin cherry, aspen, poplar, paper birch) are likely to pioneer the sunny hillside portion of this small opening. As you can see, pin cherry saplings already thickly cover the hillside. Because the opening is relatively small, it is still shaded during much of the day by the trees around the edge. This partial shade will encourage saplings that tolerate moderate amounts of shade, including softwoods like white pine.

This area will remain open, however, because the Forest Service plans to maintain this opening using fire or mechanical clearing, thereby creating a permanent opening.

Question #5: Sketch the forest layers present in this management area. Be sure to note snags (standing dead trees) and downed logs if you see them.

In much of the opening, only the soil, grass, and shrub layers are present. But encourage students to explore the opening's edges, where it meets the surrounding forest. Here, a transition zone provides important hiding cover for wildlife venturing out into the open area to forage, a phenomenon known as the "edge effect."

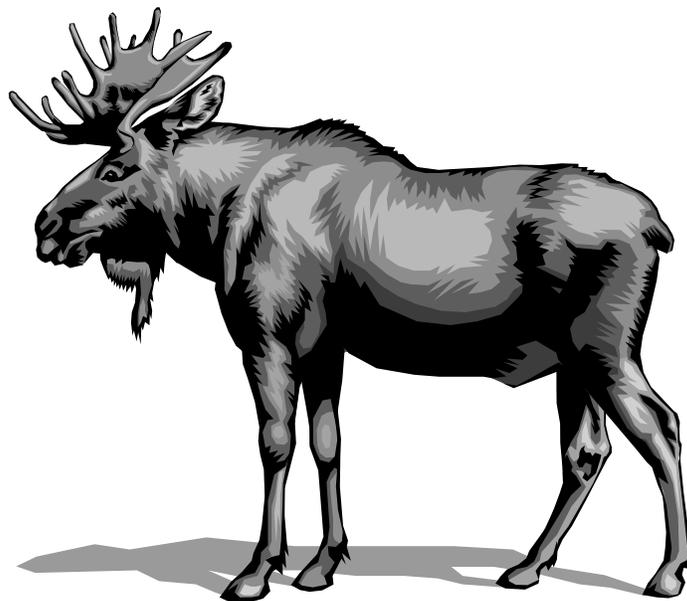
Question #6: How might wildlife benefit from the changes created by the management practice?

This management practice created a sunny opening, in which grasses, berry bushes and hardwood saplings thrive. This creates food sources different from those available in the mature hardwood forest. Moreover, any edge between two habitats—in this case, forest and field—is especially diverse because, in addition to animals that require forest habitat and those that require field habitat, the area attracts those that make use of both habitats (like bluebirds, which nest in tree holes at the forest edge of such a clearing, but forage for insects in the opening itself.) Note that the opening will change as natural succession of forest plant species occurs—as the field gives way to young forest, animals that need field habitat (like bluebirds) be replaced by forest-dwelling animals.



Which wildlife species might benefit?

Different plant species thrive in open areas, particularly berry bushes and grasses. These are important food sources for wildlife. Deer, grouse, rabbits, rodents, and moose would find browse material here. *Animals that feed upon meadow insects, like bluebirds and swallows, and animals that feed on small mammals attracted to the meadow—like red-tailed hawk, fox, weasel, owl.*



Panel 6:

The sheltering woods



Learning from nature

Natural disturbances are rarely uniform in the changes they inflict on the landscape. After a windstorm or devastating fire, it is not uncommon to find a few strong trees standing. The open spaces between them encourage new growth.



Nature's survivors
The forest around you has been harvested by the shelterwood cutting method, which imitates a natural pattern of disturbance and survival.

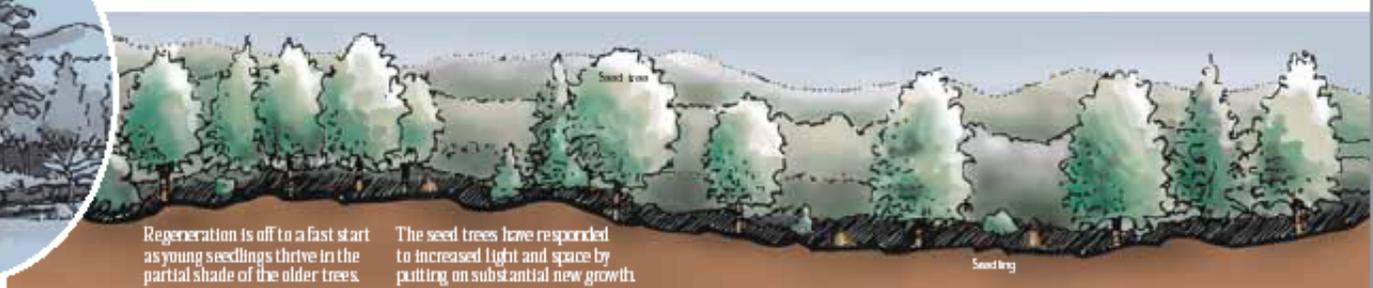
Why use the shelterwood method?

Shelterwood cutting provides a good environment for regrowth of species like red oak, sugar maple, yellow birch, and hemlock, which need shade to become established. This practice also provides a soft visual transition from cut to uncut forests.



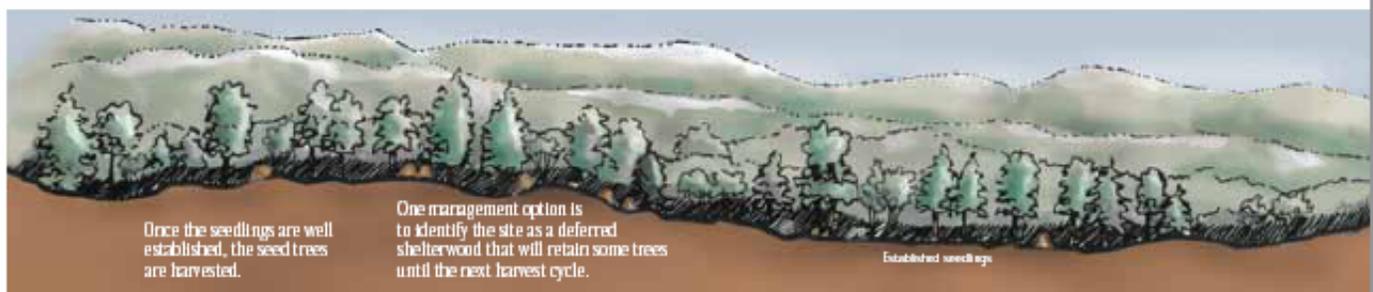
Shelterwood cutting takes a two- or three-step approach to regenerating new stands of trees.

High quality trees that will provide seeds for new growth are kept. These are called "seed trees." Lower quality trees are removed.



Regeneration is off to a fast start as young seedlings thrive in the partial shade of the older trees.

The seed trees have responded to increased light and space by putting on substantial new growth.



Once the seedlings are well established, the seed trees are harvested.

One management option is to identify the site as a deferred shelterwood that will retain some trees until the next harvest cycle.

Panel 6. The sheltering woods...a nursery for trees

As the panel suggests, one good reason for performing a shelterwood cut is to promote vigorous growth among the trees that remain after the initial cut. By the time the remaining trees are cut 10-15 years later, they have added substantially to their girth, increasing their timber value.

Examining tree rings gives students the opportunity to “see” a tree’s growth over its life from seedling to felled tree. Every growth season, a tree adds a new layer of wood to its trunk. Each ring has two parts: a wide, light part (early wood) and a narrow, dark part (late wood). The early wood grows during the wet, spring growing season. During the transition from the drier summer to fall and winter, growth slows and the late wood forms. The rings provide clues about the climate, of the area over time and evidence of disturbance to and around the tree, such as fires and floods, earthquakes, drought, etc..

By examining a cut stump, students can not only determine a tree’s age, but can also hypothesize about events in the tree’s life and changing growing conditions throughout its life. Students can do so by completing the *Written Down in Wood: The Story of Tree Rings* worksheet, included in this curriculum packet. Alternately, *Logs of Straw, Dendrochronology* is a lesson plan to help students understand the story of tree rings and correlate the information revealed there to regional and world climatic and social history.

Questions and Answers about *Written Down in Wood: The Story of Tree Rings* worksheet:

While many of the questions on the worksheet simply require direct observations, some require a little mathematics, as discussed below.

Question #3. How many years does it take for your tree to increase one inch in diameter?

Because a tree expands its girth all around its circumference, its diameter, which transects any given growth ring twice, will increase each year by twice the thickness of that year’s growth ring. Thus, the answer to this question will be one-half the average rings/inch. If their tree had an average of 10 rings per inch, it would take 5 years for the tree to increase one inch in diameter.

Question #5. When the first phase of a shelterwood harvest is complete, the remaining trees have much more light and access to water and nutrients. If you were to examine their growth rings in the years following the shelterwood cut, what would you be likely to see?

More widely spaced rings, indicating faster growth.

Question #6. Tree math BONUS question: Let’s say that a 12-inch sugar maple was left on a shelterwood harvest site after the first cutting phase. The maple then grew vigorously, at a rate of 5 growth rings per inch, until it was harvested 15 years later during the second phase of the shelterwood harvest. What was its diameter at the time it was cut?

18 inches

Panel 7:



Patches of sunlight spark new growth

A flush of new growth

Every time nature creates an opening, sunlight hitting the forest floor sparks a flush of new growth. Over time, a patchwork effect is created by groups of trees of various ages.

Natural openings caused by severe windstorms

Group cuts renew the forest

Resource managers design group selections to imitate nature by harvesting small groups of trees – usually in "bites" of less than half an acre – to allow sunlight to reach the forest floor.

Small group harvest
Small group selection imitates natural processes

Twenty years later

With time, these small-harvested areas grow back. The hillside soon becomes an unbroken landscape of forest with a natural appearance

A forest of many species and ages
A true mosaic of older and younger growth make up the forest here, including den trees and snags



Planning for a true forest mosaic

Resource managers deliberately use this method to create a multi-layered composition of different-aged trees that includes many species. Shade-loving sugar maple and beech thrive not far from sun-loving birch and white ash. This biologically and visually diverse environment, a true forest mosaic, provides a rich habitat for birds and mammals – from forest floor to canopy.

Panel 7: Patches of sunlight spark new growth

You and your students are standing in another small group selection harvest site. Such a harvest imitates a forest dynamic typical for the northern hardwood forest, in which small-scale disturbances, spread lightly across the landscape, create a mosaic of openings, at various successional stages, throughout the forest. This multi-aged, multi-layered patchwork supports a diversity of wildlife species.

Panel 8:

A fresh start



Setting the stage for a new forest

Large-scale disturbances in the forest, including windstorms, fires, or clearcut harvest, initiate the cycle of growth. A burst of new sunlight hitting the forest floor allows a new generation of trees to take hold. This site was clearcut in 1895 and again in 2001.

The green reserves

Resource managers design clearcuts that leave only scattered clumps of standing trees, including those that contain nesting cavities or provide perches for hawks and owls that like to hunt in the new growth.

Where cuts are visible from roads or trails, forest managers design the shape and edges to appear as natural as possible.

Used with care

Clearcuts of 5 to 30 acres in size are used to imitate large-scale natural disturbances. Clearcuts are used under certain conditions to:

- Create temporary openings
- Encourage pioneer species such as pin cherry or white birch
- Renew a forest by improving the health and quality of trees
- Establish a rich balance of new growth, middle-aged, and older forests across the landscape

How big is an acre?
An acre is 43,560 square feet, or the equivalent of a square approximately 208 feet on each side. It is easy to remember that an acre is about the same size as a football field. There are 640 acres in a square mile.

Is replanting necessary?

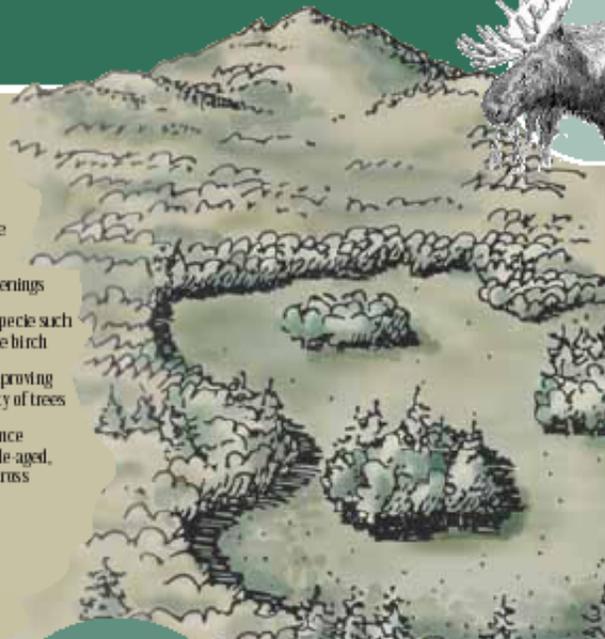
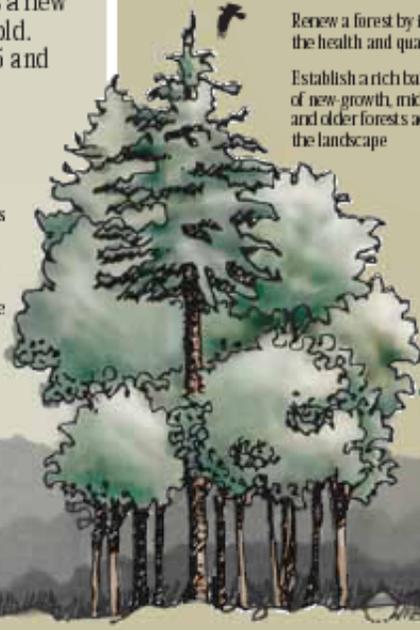
Following a blowdown, forest fire, or a clearcut, an acre of forestland in the White Mountains will naturally spring back to life, producing up to 20,000 seedlings per acre. This works out to one new tree every 18 inches in all directions, so replanting is rarely needed.

Wildlife's response

The first flush of new growth offers a welcome food supply for moose, bear, and deer. Low brush also makes a home for migratory songbirds and attracts grouse and woodcock, which raise their young in the protective cover of brambles and berries. Resource managers often leave trees in clearcuts to provide for wildlife needs. Can you spot the trees left for bears in this clearcut?



Moose



Bear

Panel 8: A fresh start

This forest was cut in 1895 and then again in 2001.

How old were the oldest trees in the forest when the forest was cut in 2001?

106 years old

Each management practice you've see so far has involved clearing trees in varying configurations and numbers. At a few of the sites, you've seen small group selections in which all trees in the treatment area were removed, as they have been in this clearcut. It is the size of the area treated that determines whether it's considered a group selection or a clearcut. The Forest Service defines a clearcut as a clearing of at least 10 acres. This harvest area approximately 5 acres; it gives a sense of how a clearcut area looks and feels.

Why might resource managers create a clearcut rather than several small group selections?

A clearcut not only generates a larger volume of timber, but also encourages regeneration of different species than a small group selection. Shade-intolerant species (aspen, white birch) will grow in this wide-open clearcut, whereas the small group selection area will regenerate in shade-tolerant species, because of the shading provided by the remaining trees.

As can be the case with major natural disturbances like hurricanes and wildfires, clearcutting this area returned it to an early *successional* stage. If students are not familiar with the idea of forest succession, this site is a good place to discuss it. The Project Learning Tree *How Old is Our Forest?* fact sheet, included in this curriculum packet, give a good introduction to New Hampshire's forest succession.

Encourage students to leave the trail and find out what's growing in the cleared area.

In what successional stage is this management area now?

They'll see lots of beech saplings sprouting from beech stumps, as well as plenty of pin cherry saplings, grasses and other herbaceous plants.

What kinds of food and shelter might animals find here that they wouldn't find in such abundance in the mature forest?

***Food:** tender sapling buds and shoots, grasses. Blueberries and blackberries also thrive in openings like this.*

***Shelter:** Once saplings and shrubs become established, the clearcut offers low, dense cover for birds and small animals*

Of the management practices you have see so far, which produces the largest volume of timber per acre?

Clearcut

Which produces the lowest volume of timber per acre?

Single Tree Selection

Which abruptly alters the composition of the forest the most?

Clearcut

Which changes it the least?

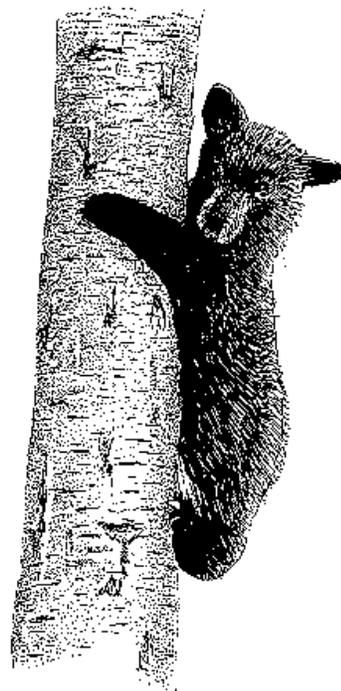
Single Tree Selection

What are other considerations a forest manager weighs related to a clearcut vs. a shelterwood harvest? How would harvesting costs compare? What about road building and maintenance costs? Regeneration costs? How would visual impacts compare? How would these factors be weighed in a highly visible recreation corridor? How would a resource manager accommodate the concerns of an adjacent landowner? Might some neighbors encourage resource management and associated roadbuilding while another neighbor object to harvest's visual impact, the increased road noise, etc.?

These questions point to the continual balancing act resource managers perform when managing for multiple objectives. Each management choice involves tradeoffs, and resource managers try to create the optimal balance that will satisfy often-conflicting management objectives.

Banquet Tree

As the trail curves through the lower part of the clearcut, you'll pass a tall, lone beech on your right. Be sure to take a close look with your students. Ask them to figure out what's so special about this tree. If they don't see anything right away, let them know that the tree is chock full of animal signs. The curved rows of black dots you see up the tree's trunk are the marks left by bear claws as a **black bear** climbed this beech to gather beech nuts in its upper branches.



Calculating forest stand wood volume provides wonderful real-life math applications. See the Calculating Cords of Firewood per Acre worksheet in the rear pocket of this curriculum packet.

Panel 9:

Streambanks and salamanders: the riparian zone

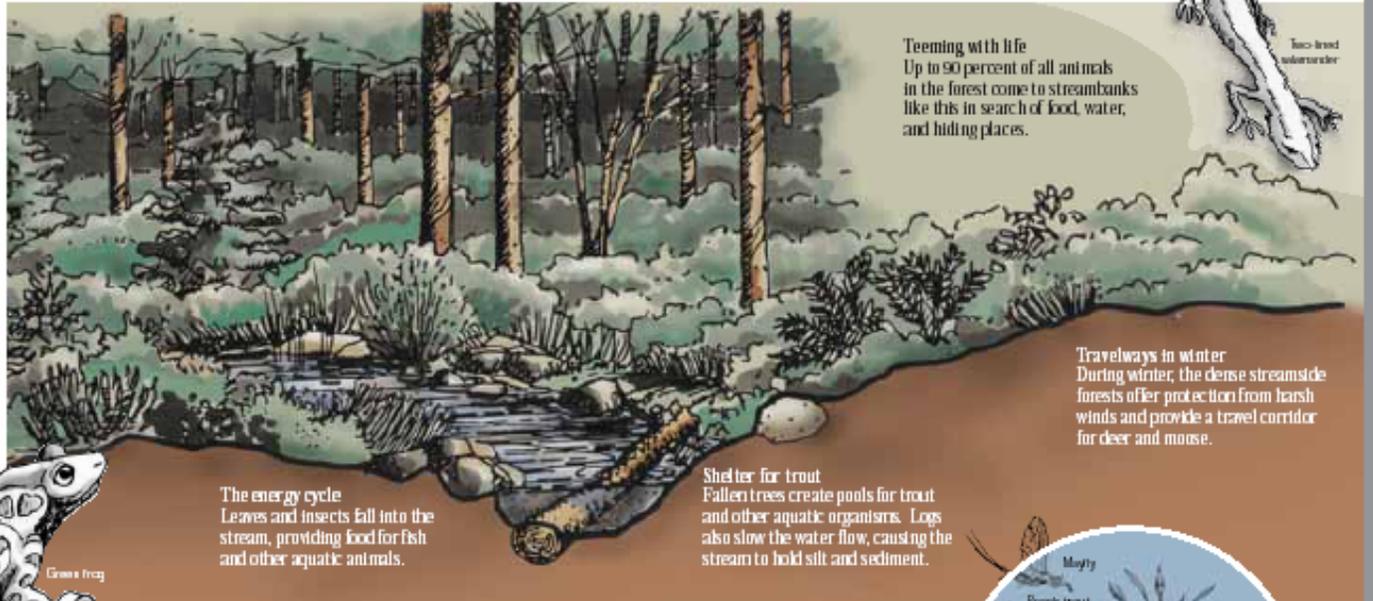


Where the forest meets the stream

The riparian zone is the forest community that exists along the banks of waterways, creating a special habitat for plants and animals of the water and woods.

Trees cool the water

The trees along the stream help keep the water cool and clear while providing shade and shelter for cold-water fish, and food for other aquatic organisms.



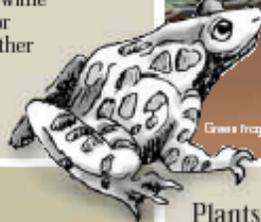
Teeming with life
Up to 90 percent of all animals in the forest come to streambanks like this in search of food, water, and hiding places.

Two-lined salamander

Travelways in winter
During winter, the dense streamside forests offer protection from harsh winds and provide a travel corridor for deer and moose.

The energy cycle
Leaves and insects fall into the stream, providing food for fish and other aquatic animals.

Shelter for trout
Fallen trees create pools for trout and other aquatic organisms. Logs also slow the water flow, causing the stream to hold silt and sediment.



Grass frog

A protected corridor

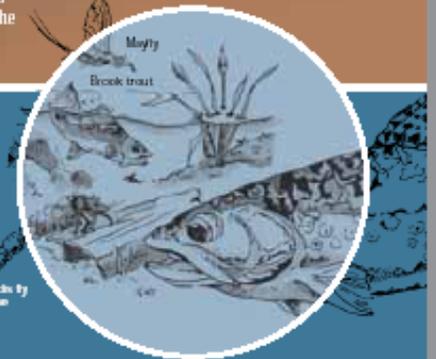
Resource managers understand that the riparian zone is an important niche in the ecosystem. They protect this zone during harvest through the careful location and construction of roads, trails, and bridges.

Plants anchor the soil

Elements that naturally occur in soil, such as phosphorous, are absorbed and used by plants before flowing into the stream. Vegetation anchors the soil in the stream bank, lessening the effects of spring floods and heavy rains.

Canaries of the stream

Some creatures – including trout and caddis fly larvae – can thrive only in clean, clear water. Their presence is often used to gauge the water quality in a stream, much like the canaries once used by coal miners tested air quality in mine shafts.



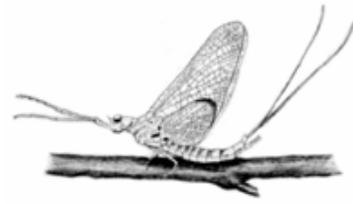
Mayfly

Brook trout

Caddis fly larvae

Panel 9: Streambanks and salamanders: the riparian zone

Streams like this one are for the forest community what arteries are for your body, delivering clear, clean, highly oxygenated water for both aquatic (water-dwelling) and terrestrial (land-dwelling) animals.



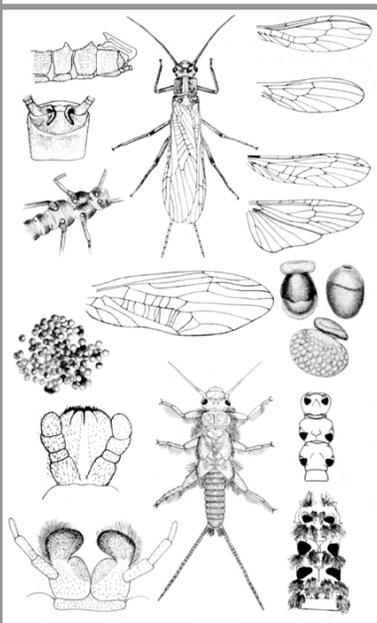
The Forest Service is the largest forest research organization in the world. Their research has provided the scientific basis upon which forest practices have evolved. For example, not long ago, resource managers kept streams like this one free from fallen logs and debris, believing that to be the best management practice for the stream. Now resource managers understand that such debris forms critical habitat for aquatic insects and fish, maintains lower water temperatures critical to many species, and filters and holds sediment, keeping water clear. As a result of this new knowledge, managers will sometimes anchor woody debris in streams to improve habitat.

Resource managers have also learned how important it is to maintain a vegetation **buffer** along riparian corridors like this one. Such a buffer shades the water, protecting aquatic animals from temperature fluctuations. Roots of buffer plants soak up runoff during storms, preventing stream siltation that makes it difficult for aquatic animals to breathe (much like heavy smog makes it hard for people to breathe). These roots also hold the banks in place, so they don't erode during heavy runoff.

Streamside trees also perform the critical job of shading the water, thereby preventing temperature fluctuations that can harm aquatic animals, many of which cannot tolerate the high water temperatures that occur in an unshaded stream.

What would happen if resource managers didn't maintain a healthy buffer on either side of this stream—if they cut trees right up to the stream's edge?

Siltation, fluctuating water temperatures, decreased aquatic animal health, streambank erosion.



Stream Monitoring— How can you tell if a stream is healthy?

An important part of a resource manager's job is to be sure that resource management practices do not degrade water quality. But what constitutes high quality stream water? Some signs of health are easy to see without tools—intact banks with good vegetative buffer, no signs of erosion runoff into stream, clear water. But clear water isn't always healthy water, and a few, simple tests can help determine water quality—measuring particulate matter, bacterial count, dissolved oxygen, and water temperature.

A healthy macroinvertebrate population is another sign of stream health.

Encourage students to explore the stream's edge. By carefully lifting up submerged stones, they may catch a glimpse of aquatic insects. Remind students to be sure to replace stones where they found them.

Panel 10:



Openings in the forest



Gaps form naturally

Small openings in the forest are created when several trees die from windstorms, lightning strikes, or insect attacks. These smaller openings are more common than those resulting from large-scale disturbances such as forest fires.

The openings around you were deliberately created to mimic these natural occurrences. Using a cutting technique called "group selection," trees are taken out in small bunches.



Ten to twenty trees at a time

By harvesting only 10 to 20 trees at a time, the amount of sunlight reaching the floor is limited. If the openings were any larger – allowing more sunlight to hit the forest floor – the more aggressive and faster growing hardwood species would take over.

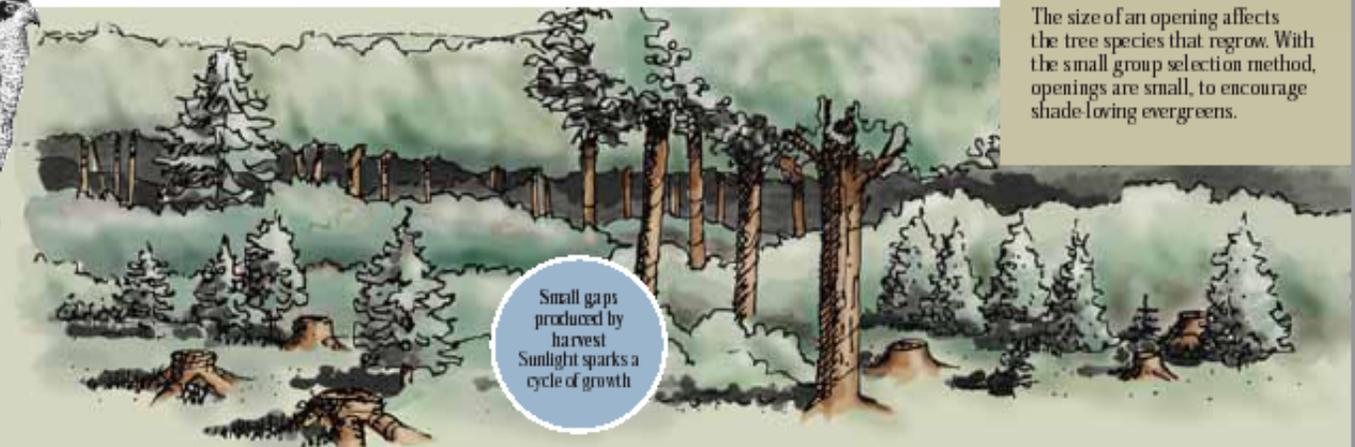


Blowdowns, lightning strikes or disease
Naturally occurring gaps are common in the forest



Planning for conifers

The size of an opening affects the tree species that regrow. With the small group selection method, openings are small, to encourage shade-loving evergreens.



Small gaps produced by harvest
Sunlight sparks a cycle of growth

Panel 10: Openings in the forest

After a resource manager maps and inventories a given forested area, she determines how to best manage the area. It's important for students to understand that forestry is an art as well as a science, and in practicing this art, each resource manager will develop unique management recommendations for the forest, based on rigorous scientific research, forest standards, and best management practices as well as, in the case of public lands, public needs and values.

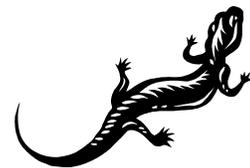
As discussed earlier, a resource manager can determine the approximate volume of timber in a forest stand by estimating the number of trees in the stand and calculating the stand's basal area. You and your students can easily conduct another important volume calculation—the volume of timber in individual trees.

Resource managers determine timber volume in a given tree with a special tool known as a scaling stick, or Biltmore stick. But your students can measure timber volume without such specialized tools, simply using a ruler and a measuring tape.

Have students complete the worksheet *How Much Wood? Calculating Tree Volume*, working in groups of two or three. **You may wish to complete the exercise once with all the students together, to be sure they understand how it's done.** This exercise gives students hands-on application of mathematics, and also gives them a sense of what resource managers do and how much lumber a single tree provides.

Scattered Riches

As you and your students walk through the softwood group selection area, notice how resource managers have left the branches of harvested trees scattered in the harvest area. Why might they do this?



Branches return nutrients to the soil and provide cover for small animals.

The interpretive panel explains how such small harvests favor the regeneration of softwoods. What animals might benefit from such regeneration?

Because softwoods retain their foliage in winter, they offer protection from winter snow and wind. Deer, in particular, seek out their shelter.

Questions and Answers for the *How Much Wood?* Worksheet:

Bonus Question: If a 20" diameter tree has one 16-foot log, its volume is 170 board feet. So, if it has two 16-foot logs, the volume should be 340 board feet, right? But if you look at the tree

scale chart on the back of this worksheet, you'll see that, for any given tree diameter, the volume of two 16-foot logs is always less than double that of a single 16-foot log. Why?

Trees are not perfect cylinders; they are conical. Thus, the upper 16-foot log will always be of lesser diameter than the lower 16-foot log.

Forest roads: where do they lead?



As you examine the forest here, notice the corridor that is Forest Road #397. This haul road was last used in 1971 to remove timber from the adjacent forest.

Resource managers plan road systems to accommodate a variety of uses. Sometimes roads are maintained for long-term vehicular use or for hikers, snowmobilers, cross-country skiers, and mountain bikers.

This road, which has been allowed to reforest naturally with young seedlings and saplings, is in a period of non-use, but it may be used in the future if needed.

The White Mountain National Forest
The U. S. Department of Agriculture administers the White Mountain National Forest. The forest is managed for a wide spectrum of resources including wood, water, wildlife habitat, and scenic and recreation opportunities.



Panel 11: Forest roads: Where do they lead?

Ask students to see if they can spot the grown-over forest road near the panel. If the road was last used in 1971, roughly how old are the trees that have sprouted up in it? In managing a forest, resource managers decide where to place roads to access logging sites. They also decide which roads to leave open and intact after the logging operation is complete and which to close. Sometimes, they tear up logging roads with heavy equipment to rehabilitate the roaded area to its pre-logging condition.

What might be some of the management objectives that influence these decisions?

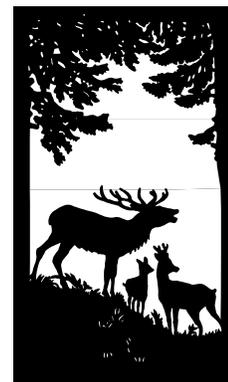
- **Recreation:** *Managers may wish, for example, to increase opportunities for hiking and skiing in an area where they have constructed logging roads, and so choose to leave some of the roads open for those uses. Roads left in place will require maintenance; resource managers must consider these additional costs of keeping forest roads open for recreation objectives.*



- **Logging:** *Managers may plan to harvest the area again in the near future (as with a shelterwood harvest, in which they will return to the site in 10-15 years).*



- **Wildlife Habitat:** *Roads can create a barrier to travel for some animal species, can increase wildlife mortality due to increased hunting pressure, and can increase human disturbance to sensitive wildlife species. Resource managers consider wildlife needs in assessing where they create roads and whether the roads will be temporary or maintained permanently as part of a forest management infrastructure.*



Panel 12:

The old timers: mature hardwood forests



Who lives here?

The forest in front of you is a small example of a mature hardwood forest. These mature forests are important to wildlife species including the pileated woodpecker, scarlet tanager, black bear, and flying squirrel.



Black-throated blue warbler

Neotropical migrants
Some migratory birds that winter in the tropics prefer mature forests where they find abundant food sources.

Mature tree top canopy



Downy Woodpecker

Snags are home to many birds and animals

Often in the mature forest, dead or dying trees called "snags" lie scattered throughout the woods.

Cavities in snags provide home and shelter for over 60 species of birds and animals. While these trees may not be particularly attractive to us, snags often teem with wildlife of many forms and sizes.

A mix of young and old

Seventy-five percent of the White Mountain National Forest is over 80 years old, while only five percent has been growing for less than 20 years. Resource managers use a variety of techniques to balance the mix of young and old forest.

Resource managers wear many hats

Several of the harvesting techniques demonstrated on the Discovery Trail perpetuate and enhance the mature hardwood forest.

In areas formally designated as Wilderness, forests are reserved from harvest, road building, and related activity in order to provide visitors with solitude and an environment not apparently affected by human intervention. This is an example of the wide spectrum of both tangible and intangible objectives resource managers must balance.



Fallen log

A fall food favorite
Deer, bear, and many other animals eat beech nuts to help build up fat reserves for the long winter.

Panel 12: The old timers: the mature hardwoods

At this site, students encounter the idea that managing a forest for its wilderness qualities—that is, choosing to allow natural processes to dominate the landscape—is yet another management strategy the resource manager uses to provide different human benefits such as solitude, a sense of wildness and challenge while maintaining the forest community’s health. Such forests provide important habitat for animal species that require undisturbed, mature forest. Leaving some land areas to predominantly natural processes provides for important human needs as well. People have come to appreciate wildness, challenge, solitude, and vast areas significantly unaffected by human use. This is yet another “demand” on the resource that resource managers must balance with other products and uses of the working forests.

One size doesn’t fit all

It’s important that students understand the complexity of a management objective like “Improving Wildlife Habitat”. While a clearcut is an excellent management choice for improving grouse habitat, since grouse dine heavily on the aspen and birch buds that will soon blanket the cut area, it does not improve habitat for pine marten and barred owls, which prefer mature, undisturbed hardwood forests. Conversely, this mature hardwood forest is less-than-optimal for animals that find food and shelter in early successional or mid-successional forest areas.

Complete another *Mimicking Nature: Forest Management Practices* worksheet, offering students interesting comparisons with earlier management practices.

Questions and Answers for *Mimicking Nature* worksheet:

1. What kind of management practice was used at this site?

Management for wilderness qualities. Like the rest of this hillside, this area was clearcut in the late 1800s. Since then, the northern hardwood forest community has regrown. In this area, resource managers have chosen to allow natural processes to dictate the forest’s composition.

2. What kind of natural process does it mimic?

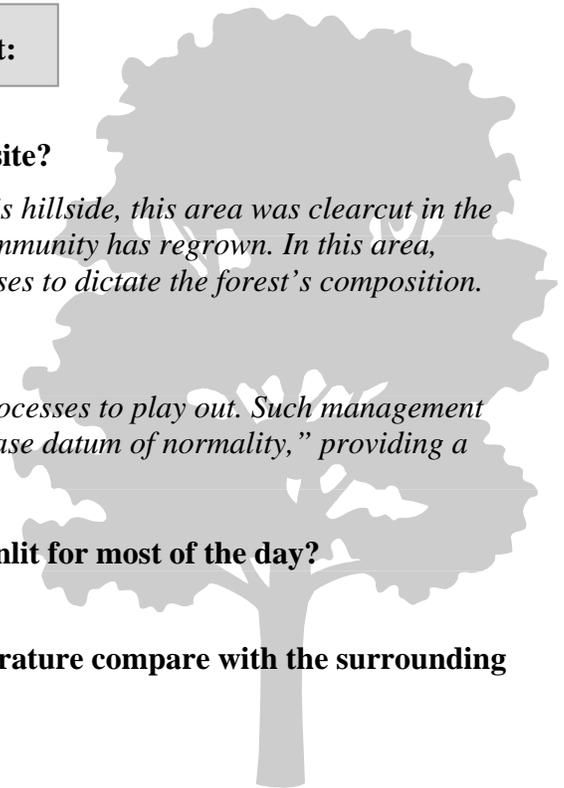
In this area, resource managers are allowing natural processes to play out. Such management creates what ecologist Aldo Leopold referred to as “a base datum of normality,” providing a study tool for resource managers.

3. In this managed area, is the forest floor shaded or sunlit for most of the day?

Shaded

How do you think the area’s soil moisture and temperature compare with the surrounding forest?

Similar.

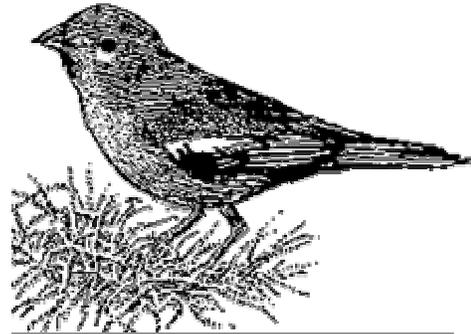


What kinds of trees would you expect to grow under these conditions?

This area will continue to mature into a climax northern hardwood forest community, dominated by sugar maple, beech, and yellow birch. Throughout this area, natural forest disturbances (death of individual trees, insect attacks, blowdowns, etc) will occur periodically, creating openings that return the disturbed site to an earlier forest successional stage.

4. How might animals benefit from the changes created by the management practice? Which animals might benefit?

A variety of animals could live here, including animals that prefer undisturbed forest-interior sites, like pine marten, red-shouldered hawk, barred owl, pileated woodpecker, red-eyed vireo, northern parula, black-and-white warbler, American redstart, prothonotary warbler, ovenbird, hooded warbler, and the scarlet tanager.



Northern parula warbler

Ailing Beeches

At this site, you get a good look at beech bark scale disease, a pathogen caused by an insect and its associated fungus, *Nectria coccinea*. This pathogen causes the cracks and wrinkles you can see on the usually-smooth beech bark, and eventually weakens the trunk so much that it snaps in two.

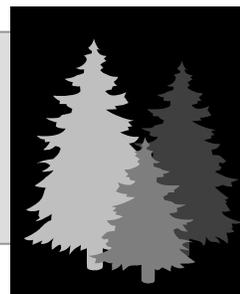
In his book, *Reading the Forested Landscape*, Tom Wessels devotes an entire chapter to this phenomena—a fascinating and beautifully illustrated read for your students.

From this final panel, you and your students will loop back to the parking area.

We hope you have enjoyed the Forest Discovery Trail. Please contact the White Mountain National Forest at (603) 528-8707 or cc_long@fs.fed.us to offer feedback about the trail and curriculum materials or to request additional information.

Please encourage your students to return to The Forest Discovery Trail with their families to enjoy the trail throughout the year.

After your visit to the Forest Discovery Trail: FOLLOW-UP ACTIVITIES



1. As your students learned on the Forest Discovery Trail, resource managers strive to manage the forest in ways that maintain the forest's health while meeting a wide variety of other social and resource objectives. One good way to benefit the human community while maintaining the forest's health is to ensure that every tree removed from the forest contributes the highest possible value to the local community.
 - Have students learn about the value-adding forest products businesses in your community—loggers, sawmill operations, kiln drying facilities, truckers, furniture makers, and so on. Tune in, as well, to the non-timber forest product producers: maple sugarers, wreath and garland makers, people who harvest wild edibles. Your students may be surprised to learn how many people in your community work directly with forest products.
 - Have your students work individually or in groups of two to pick one of the value-adding businesses to study in greater depth. Have them generate questions and interview the business owner to learn what each business does, how it uses forest products, how many people it employs, and so on. Have students creatively display their findings and showcase their displays in your community, at the local library, town hall or bank.
2. Extend your study of tree rings using the *Logs of Straw: Dendrochronology* lesson plan, included in the front pocket of this curriculum packet.
3. Extend your study of tree and stand volume measurements using the *Calculating Cords of Firewood per Acre* lesson plan, included in the front pocket of this curriculum packet.
4. Mapping the Third Dimension allows students to use three dimensional photo imaging to learn about the forest. Stereoscopic photo pairs and instructions are included in the front pocket of the curriculum packet.
5. An Air Quality word search is included in the front pocket of this curriculum packet

Additional follow-up curricula

Now that your students have some hands-on experience with some of the management choices and techniques used by resource managers, they're ready to look at some of the issues and challenges facing resource managers. Use the *Social Trade-off's* lesson plan, included in the front pocket of this curriculum packet.

POST-STUDY EVALUATION QUESTIONS

1. What are the three steps resource managers take in order to decide how to best take care of a particular forest? (Provide sample answers here.)
2. Every forest is made up of many vegetative (plant) layers, beginning with the leaf litter (humus) and extending up to the tops of the tallest trees (canopy). Describe the layers, and name an animal that might live in each layer.
3. How does a resource manager determine the best harvest technique to use in a given forest stand?
4. What is succession? If a forested area is cut using the small group selection method, what are the successional stages it will go through over the next 100 years?
5. Name 3 naturally occurring disturbances that create openings in the forest.
6. Name 10 ways you use trees in your daily life.
7. What is the Forest Service, and what is its purpose?