GOOD FORESTRY
in the Granite State:

Recommended Voluntary Forest Management Practices for New Hampshire

Presented by The Good Forestry in the Granite State Steering Committee

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Good Forestry in the Granite State fulfills State Law (RSA 227-I:4) requiring the New Hampshire Dept. of Resources and Economic Development, Division of Forests and Lands to provide educational tools identifying recommended voluntary forest management practices. The mission of the division is to "protect and promote the values provided by trees and forests." The division "executes all matters pertaining to forestry, forest management, and forest land within the jurisdiction of the state..." Primary responsibilities of the agency include managing state-owned reservations and forests, preventing and controlling forest fires, monitoring and protecting forest health, enforcing forest protection laws, and gathering statistics and information.

Bennett, Karen P. editor. 2010. *Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire (second edition)*. University of New Hampshire Cooperative Extension, Durham, N.H.

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Good Forestry in the Granite State Steering Committee

Will Abbott, Society for the Protection of N.H. Forests, committee vice-chair
Karen Bennett, University of New Hampshire Cooperative Extension, project manager
Bob Bradbury, LandVest, Inc.
Emily Brunkhurst, N.H. Fish and Game Dept.
Philip Bryce, Fountains America, committee chair
Susan Cox, USDA Forest Service, NA State and Private Forestry
Ken Desmarais, N.H. Division of Forests and Lands
Kristina Ferrare, University of New Hampshire Cooperative Extension
Will Guinn, N.H. Division of Forests and Lands
Geoff Jones, N.H. Association of Conservation Commissions and Loveland Forestry
Don Kent, N.H. Natural Heritage Bureau, Division of Forests and Lands
Bill Leak, USDA Forest Service, Northern Research Station
Rick Lessard, N.H. Timber Harvesting Council
Linda Magoon, N.H. Dept. of Environmental Services, Water Division
Chris Mattrick, USDA Forest Service, White Mountain National Forest
Dave Publicover, Appalachian Mountain Club
Brad Simpkins, N.H. Division of Forests and Lands
Will Staats, N.H. Fish and Game Dept.
Jasen Stock, N.H. Timberland Owners Association
Matt Tarr, University of New Hampshire Cooperative Extension
Dave Tellman, Tree Farmer
Dick Weyrick, Granite State Division of the Society of American Foresters
Mariko Yamasaki, USDA Forest Service, Northern Research Station
Mark Zankel, The Nature Conservancy, N.H. Chapter

Technical Teams

Phil Auger, University of New Hampshire Cooperative Extension
Doug Bechtel, The Nature Conservancy, N.H. Chapter
Pete Bowman, N.H. Natural Heritage Bureau, Division of Forests and Lands
Charles Bridges, N.H. Fish and Game Dept.
Jack Bronnenberg, Bronnenberg Logging and Trucking, LLC
Sara Cairns, N.H. Natural Heritage Bureau, Division of Forests and Lands
Emma Carcagno, University of New Hampshire Cooperative Extension
Melissa Coppola, N.H. Natural Heritage Bureau, Division of Forests and Lands
Doug Cygan, N.H. Dept. of Agriculture
Dave Falkenham, University of New Hampshire Cooperative Extension
Peter Farrell, New England Forestry Consultants
Andrew Fast, University of New Hampshire Cooperative Extension
Carol Foss, N.H. Audubon
Chuck Hersey, University of New Hampshire Cooperative Extension

Linda Heath, USDA Forest Service, Northern Research Station
Joseph Homer, Natural Resources Conservation Service
Ben Kimball, N.H. Natural Heritage Bureau, Division of Forests and Lands
John Lanier, Wildlife Management Institute
Kyle Lombard, N.H. Division of Forests and Lands
Jeff Lougee, The Nature Conservancy, N.H. Chapter
John Magee, N.H. Fish and Game Dept.
William Nichols, N.H. Natural Heritage Bureau, Division of Forests and Lands
Roger Monthey, USDA Forest Service, NA State and Private Forestry
Charlie Moreno, Moreno Forestry Associates
Steve Roberge, University of New Hampshire Cooperative Extension
Don Quigley, University of New Hampshire Thompson School of Applied Science
Bob Spoerl, N.H. Division of Forests and Lands
Dennis Souto, USDA Forest Service, NA State and Private Forestry
Sarah Smith, University of New Hampshire Cooperative Extension
Dan Stepanauskas, Northern Forest Resources
Tanya Tellman, Tree Farmer
Jessica Veasey, University of New Hampshire
Steven Weber, N.H. Fish and Game Dept.

Additional review was provided by Dan Cyr, Bay State Forestry Services; Ann Davis, landowner; and Ed Witt, Madison Lumber Mill.

Forest Sustainability Standards Work Team (authored the first edition)

Phil Auger, Philip Bryce, Chip Chapman, J.B. Cullen, Gary Donovan, Bob Eckert, Steve Fay, Carol Foss, Susan Francher, Geoff Jones, Eric Kingsley, John Lanier, Bill Leak, Don Merski, Tom Miner, Frank Mitchell, Steve Morton, Dave Publicover, Mike Seeger, Jamie Sayen, Tammara Van Ryn, Scot Williamson, Mariko Yamasaki

Project administration

Will Abbott, Society for the Protection of N.H. Forests, committee vice-chair
Karen Bennett, University of New Hampshire Cooperative Extension, project manager
Philip Bryce, Fountains America, committee chair
Kristina Ferrare, University of New Hampshire Cooperative Extension
Brad Simpkins, Director, N.H. Division of Forests and Lands and State Forester

Illustrations

Unless noted, all illustrations by Ingeborg V. Seaboyer, http://www.derryareaartists.com/

Editing and layout

Peg Boyles and Holly Young, University of New Hampshire Cooperative Extension
Jane Harper, University of New Hampshire

Northeast Utilities Foundation

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A Message from the State Forester

Thank you for reading the revised *Good Forestry in the Granite State*. If this is your first time using this document, I hope you find the information valuable, providing you with useful guidance as you identify and implement your forest management objectives. This revision expands and builds upon the principles and practices conveyed in the original.

The purpose of *Good Forestry in the Granite State* continues to be providing the educational tools needed to manage ecologically sensitive and unique natural features of forest land. These recommended practices, or educational tools, are intended to be voluntary, even though RSA 227-I:4 requires the production of this document:

> **Recommended Forest Management Practices. –** *The director (division of forests and lands) shall coordinate an effort to produce educational tools that identify recommended voluntary forest management practices for sites or practices which are ecologically sensitive due to soils, wildlife habitat, and other unique natural features such as high elevations, steep slopes, deer wintering areas, riparian zones, sensitive soils, and clearcutting.*

This revision incorporates new approaches to forest management and advances in science and technology developed over the past decade, while remaining a practical guide for a diverse audience. *Good Forestry in the Granite State* isn't intended to be an all-inclusive document on forest management, but a foundation. Users are encouraged to supplement their knowledge through literature review or discussions with resource professionals.

Just as this publication has a diverse audience, it has many suitable applications. For example, many conservation easements reference *Good Forestry*. Forest management practices on conservation easements held by the N.H. Division of Forests and Lands are conducted in accordance with, or guided by, goal-specific recommendations in *Good Forestry*. Timber harvesting operations on state-owned lands are conducted in accordance with this document. *Good Forestry* serves as a reference for harvesting biomass, as well as all other forest products on both private and public forest lands.

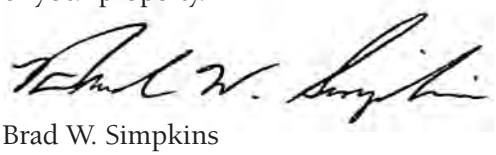
As a voluntary guide to forest management in New Hampshire, *Good Forestry in the Granite State* is not intended for use by local governments or state agencies to regulate or restrict timber harvesting practices. Recommendations in one chapter may conflict with those of another chapter. This isn't a mistake, but rather by design, in recognition of the different objectives and goals selected by the landowner in consultation with natural resource professionals relative to a given situation on a particular piece of property. Site-specific characteristics may require modifying some recommendations. Attempts to adopt *Good Forestry in the Granite State* for land-use regulation, in part or in its entirety, don't align with the intent and spirit of the law establishing the document (RSA 227-I:4). The State, through the Division of Forests and Lands, takes a primary role in the regulation of timber harvesting in New Hampshire (RSA 227-J). The State Legislature made clear the importance of practicing forestry through what is known as the "Right to Harvest" law (RSA 672:1):

> *Forestry, when practiced in accordance with accepted silvicultural practices, constitutes a beneficial and desirable use of New Hampshire's forest resource…the State of New Hampshire has declared that it is in the public interest to encourage preservation of open space by conserving forest and*

other natural resources. Therefore, forestry activities, including the harvest and transport of forest products, shall not be unreasonably limited by use of municipal planning and zoning powers or by the unreasonable interpretation of such powers.

Managed forests help maintain New Hampshire's rural character. The continued management of working forests for multiple objectives and goals is critically important to the environmental, economic, and social well-being of our state. Our forests provide jobs, forest products, wildlife habitat, clean water and air, recreation, tourism, and an overall higher quality of life to our citizens and visitors. Our forests will play an even bigger role in the future, as we face challenges such as continued development pressure, climate change, and renewable-energy development. New Hampshire's number one forest management goal is keeping forests as forests. To that end, the Division of Forests and Lands, and others as evidenced by their use of *Good Forestry in the Granite State*, support and encourage responsible management of working woodlands and forests.

Our forests and woodlands have played an integral part in our state's history, and undoubtedly will play a vital role well into the future. More than 80 percent of New Hampshire remains forested. Much of the forest land that looks untouched by human activity has, in reality, been managed as working forests for generations. This long history of management is a testament to the established tradition of practicing good forestry in the Granite State. Whatever you decide for your individual goals and objectives on your woodlands, I hope this document provides you the foundation to make wise decisions. Most importantly, I thank you for expressing interest in being a good steward, because a well-managed forest provides many benefits, both tangible and intangible, far beyond the boundaries of your property.



Brad W. Simpkins
Director, N.H. Division of Forests and Lands

December 1, 2010

Using This Manual

A Message From the Good Forestry in the Granite State Steering Committee

The purpose of this guide is to provide landowners and the professionals who work with them practical recommendations and information on a wide variety of forest resources to help them make informed decisions that sustain the forest for today and the future.

Though we give the background needed to support decision-making, this manual doesn't attempt to give a full treatment of all topics. Its focus is operational: What you need to know to harvest trees, build a recreational trail or access road, protect water quality, improve wildlife habitat, or create a plan to guide your activities.

This isn't a regulatory document. It's a voluntary guide, not intended for conversion into town ordinances or state regulations. The recommendations are too intertwined with the notion that on-the-ground implementation is site-specific, requiring professional judgment and landowner input. Conservation commissioners and other town officials can help protect natural resources by disseminating this book, or parts of it, to landowners. It is available free at www.goodforestry.org or for a fee as a cd or book.

As you use this manual, keep the following in mind, especially regarding the recommendations:

- The manual is objective-driven. If you know your objectives, going to the relevant chapters will help you learn more. If you aren't sure of your objectives, we hope this manual helps you develop them. Crafting a vision for your land will help guide what happens on the ground.
- Where recommendations are based on state law, we note the relevant statute. Except for those based on state law, recommendations aren't mandatory, but rather options to consider, suggestions for moving towards a desired outcome as stated in each chapter's objectives. The specifics of what to do, when, where, and how are best based on site conditions, landowner objectives, and many other factors. We give guidance in the form of recommendations, considerations, and background information to help landowners and natural resource professionals use their judgment.
- Best management practices (BMPs) are practices determined by the State as the most effective and practicable means of controlling point and non-point pollution at acceptable levels. These guidelines, some of which have been codified into law, are found in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*, published by the N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. We advise readers to seek the latest version of this publication before harvesting timber. In many cases, following a combination of BMPs and the recommended practices in *Good Forestry in the Granite State* will result in the best outcome.
- It will be impossible to follow all the recommendations in this manual. No woodlot has all the natural resources covered in this book, and even if a resource is present, managing for it may not align with the landowner objectives or be practical to implement, especially on small properties.
- Because recommendations are made to achieve an objective as stated in a given chapter, a recommendation in one chapter may conflict with that in another. A clear understanding by landowners of their own objectives, knowledge of the property, and assistance from a natural resource professional will help resolve conflicts and develop a course of action. Managing even small properties requires balancing competing uses and making trade-offs and compromises.
- This guide doesn't replace the expertise of professionals.

- To make them as clear as possible, most recommendations are devoid of qualifying language such as "when possible," "as appropriate," "if practical." Read all recommendations as if these words were there. A given recommendation may not always be possible, practical, or appropriate. Consider the recommendations in light of landowner objectives and site conditions.
- Recommendations and other considerations are based on professional consensus and the best available science. In certain areas, differences of opinion and scientific uncertainty remain.
- Unless otherwise noted, information in this manual is about New Hampshire forests, wildlife, plants, and other natural resources.
- Some towns have regulations pertaining to forest management; we advise readers to check before harvesting.

Conservation Easements and Good Forestry in the Granite State

Many conservation easements refer to *Good Forestry in the Granite State*. For easement holders, the manual establishes a framework to evaluate forest management practices for consistency with the easement purposes and terms. For landowners, it is a guide to acceptable forest management goals, objectives and practices.

Although forestry easement language is variable, the following are variations of two commonly used approaches:

(1) "forestry shall be carried out, to the extent practicable, in accordance with the recommended practices contained in *Good Forestry*. …"

(2) "forestry shall be carried out, to the extent reasonably practicable, in accordance with then-current, generally accepted best management practices for the sites, soils, and terrain of the property," and then lists *Good Forestry* as one of several reference publications.

In some cases, easements also include language that provides for future versions of *Good Forestry* (and other documents) as substitutions in place of the version current at the time the easement was executed. For example, in referencing *Good Forestry*, an easement may state: "or similar successor or other publications."

What do these references mean to an easement holder, and what do they mean for a landowner? The Good Forestry Steering Committee and the N.H. Division of Forests and Lands suggests the following guidelines:

(1) Landowners and foresters design and conduct practices in a manner consistent with the background, objectives, considerations, and recommendations presented in *Good Forestry*. To the extent reasonable and practicable, follow the recommendations.

(2) The easement holder should reasonably expect the easement landowner and forester will reflect *Good Forestry* in management planning and practices.

(3) The easement holder shouldn't expect that it will be appropriate or possible for a landowner to adhere to every recommendation. This publication explicitly recognizes that forest management practices on the ground are influenced by landowner goals, local site conditions, and other considerations. It further recognizes that it may not be possible to follow all recommendations, and that some recommendations are based on specific objectives that may conflict with other recommendations based on a different and equally valid objective.

(4) Where forest management practices substantially deviate from, or conflict with, practices recommended in *Good Forestry,* the landowner should provide a rationale for why the management action is a sensible and appropriate practice that accomplishes the general objectives in *Good Forestry*.

(5) In cases where the easement explicitly states that specific recommendations in *Good Forestry* must be followed, the landowner must adhere to the explicitly stated recommendations.

If the easement includes conservation purposes potentially influenced by forestry activities, or specific conservation goals for forest management, then *Good Forestry in the Granite State* may provide helpful guidance in achieving those purposes or goals.

The forest management plan is an important part of the easement compliance process, because it allows landowners to carefully think through and present their intended forest management activities. The management plan allows the easement holder to review the proposed management for consistency with the easement terms, including references to *Good Forestry*. Proposed management that substantially adheres to or differs from *Good Forestry* recommendations can be addressed and reviewed in the plan. Thoughtful discussion between the easement holder and landowner will result in shared goals, objectives and strategies for forest management activities on the property that meet the purposes of the easement.

The actual on-the-ground management rather than the plan determines compliance with the easement terms.

Organization of the Manual

Chapters are grouped in sections by broad topic categories. Each section begins with an **ADDITIONAL READING** that includes the most important documents broadly applicable to multiple chapters in the section.

Each chapter contains background, an objective, considerations, recommended practices, cross references to other chapters, and in most cases, additional information specific to that chapter.

BACKGROUND

The background explains why a certain activity or natural feature is important to forest sustainability.

OBJECTIVE

The objective describes the desired outcome of specific forest management activities.

CONSIDERATIONS

Considerations are factors that can affect implementation of recommended practices. The considerations, along with site conditions and landowner objectives, can help determine if the recommended practices are appropriate. They may describe legal issues that influence how practices are applied, or highlight areas where there isn't complete agreement by professionals.

RECOMMENDED PRACTICES

These are on-the-ground steps landowners and professionals who work with them can take to achieve the chapter objectives. They are designed to meet the chapter objective while factoring in the considerations. When site conditions make it difficult or impractical to implement the practices, managers should take actions consistent with the objective.

CROSS REFERENCES

Cross references lead the reader to additional relevant information within *Good Forestry*.

ADDITIONAL INFORMATION

A short list of documents and websites specific to the chapter topic for those interested in learning more.

In the back of the book you will find the following:

GLOSSARY

A glossary defining technical terms appears at the conclusion of the manual.

APPENDICES

Several appendices provide additional detailed information.

REFERENCES

Organized by chapter, these are the sources from which information for the chapter is drawn. If a reference is listed in the **ADDITIONAL INFORMATION** part of the chapter it isn't repeated in this listing.

GETTING STARTED

Topics in this Section

1.1 First Steps in Forest Management
1.2 Setting Objectives
1.3 Forest Management Planning
1.4 Estate Planning and Land Protection
1.5 Staying Safe Working in the Woods

Additional Reading

Working with Your Woodland: A Landowner's Guide
Mollie Beattie, Charles Thompson, and Lynn Levine
University Press of New England
1993 (second edition)

Positive Impact Forestry
Thom J. McEvoy
Island Press
Washington D.C.
2004

Legal Aspects of Owning and Managing Woodland
Thom J. McEvoy
Island Press
Washington D.C.
1998

Forest Resource Management: A Landowner's Guide to Getting Started
Kristi L. Sullivan, Peter J. Smallidge, James C. Finley, and Michael G. Jacobson
Natural Resource, Agriculture, and Engineering Service
2006

1.1 FIRST STEPS IN FOREST MANAGEMENT

BACKGROUND

The recommended practices in this manual address a variety of forest management goals and objectives. Many of the practices are interrelated, but not all can be applied on every acre. Application of specific practices depends on the site and the landowner's priorities. Successful application of these practices requires a combination of sensible goals, clear objectives, and careful preparation.

Forest land can serve landowners as both a financial investment and a way to leave a legacy. The key to protecting your investment and legacy is working with a team of professionals: foresters, loggers, and other natural resource professionals, as well as financial and legal advisers.

OBJECTIVE

Using *Good Forestry in the Granite State* and considering basic business practices will help landowners achieve their goals and objectives.

CONSIDERATIONS

- Knowing your boundaries protects you from your neighbor mistakenly cutting your trees and protects your neighbor from you making such an error. Foresters are allowed to establish new interior boundaries and to re-mark known boundary lines to carry out forest management. Foresters also can research deeds and help determine if a survey is required. Only licensed land surveyors are allowed to establish boundaries common to another owner, when the corners or lines aren't known (RSA 310-A:74). Some foresters also are licensed land surveyors. More information is available from the N.H. Land Surveyors Board.
- Current use assessment (RSA 79-A) is a tax strategy aimed at making it easier for landowners to keep their land undeveloped. Instead of taxing land at its real-estate market value, land in current use is taxed on its income-producing capability as a woodlot or a farm, not as a potential site for houses or commercial development.

  Current use is voluntary. Parcels must be at least 10 undeveloped acres or meet an annual minimum income level. Forest land categories include (1) white pine, (2) hardwood and (3) all other types. Assessments are made within ranges established by the State. Assessments within the ranges are determined by the local assessor based on the severity of the terrain, accessibility of the forest products, and the ability of the site to grow trees. Certified Tree Farms or land with a management plan prepared by a licensed forester can qualify as "forest land with documented stewardship," which further lowers the assessment.

  Though current use doesn't require that land stay open to the public, an additional recreation adjustment is available for landowners who allow hunting, fishing, snowshoeing, hiking, skiing, and nature observation. Once land is accepted, there are no buy-out provisions and the current use status stays with the land until the land is changed to a nonqualifying use. At the time of change in use, there is a land-use-change tax due, which is 10 percent of the full and true value (not the current use value) of the changed portion as assessed by the town. *The Current Use Criteria Booklet*, a good source of information revised annually, is available from the N.H. Dept. of Revenue Administration or your UNH Cooperative Extension county forester.

1.1: First Steps in Forest Management

- An important component of management is setting clear short- and long-term goals and objectives that are realistic and based on the forest's current condition and its potential capability. Good management requires an understanding of what resources exist on your property. Knowing as much as possible about the property and its history can save time and money when developing and implementing a management plan. It's also important to consider a piece of land in relation to its surroundings, especially if managing for wildlife is important to you.
- Careful planning is much more likely to bring results that adhere to the recommendations in this publication. Planning may be as simple as setting goals and objectives and accumulating inventory information, or as detailed as a written management plan prepared by a licensed forester. The more care and preparation taken before timber harvesting begins, the better the results (1.3 Forest Management Planning).
- New Hampshire has a well-established network of public and private organizations to help guide private forest landowners.
- County extension foresters employed by UNH Cooperative Extension (UNHCE) can answer landowner questions. The N.H. Natural Heritage Bureau and N.H. Fish and Game are good sources of information about plants, wildlife and habitats. Other natural resource professionals (e.g. wetland scientists, wildlife biologists) can help identify special habitats.
- State law (RSA 310-A:98-117) requires all foresters offering services for compensation to private landowners be licensed. Licensed foresters are available to assist with an array of management activities. They can plan roads and trails, manage wildlife habitat, write management plans including for current use, and plan and supervise timber harvests. Services typically involved with a timber sale include marking trees, estimating harvest volumes, filing necessary permits, contracting with loggers, supervising harvesting, handling finances, and marketing wood products. UNHCE can provide a list of licensed foresters.
- Selling timber is a complicated matter that involves knowing about markets, tree values, future tree potential, ground conditions, laws, and silviculture. You have many options when selling timber. One option is to hire a forester to act as your agent in a timber sale; another is to sell directly to a buyer. A forester who acts as your agent provides you with a work order or some other agreement specifying the type and cost of the services to be performed. Foresters may be paid by the hour or as a percentage of the standing timber or log-sale receipts. You will need to enter a separate timber sale contract with the buyer of the trees.
- Loggers harvest and buy the trees. Certified professional loggers participate in voluntary certification offered by the N.H. Timber Harvesting Council's Professional Logger Program. Certified loggers take courses in first aid, safe and productive felling, fundamentals of forestry, and timber harvesting law. The N.H. Timberland Owners Association (NHTOA) or UNHCE can provide a list of certified loggers.
- A written contract is an important tool to make sure the harvest goes as planned and is required by state law RSA 227-J:15. Information about timber sale contracts, including a sample, is available from your UNH Cooperative Extension county forester.
- Professional forestry advice and supervision during timber harvests makes a difference. Carefully prepared and supervised timber harvests often return more income and help landowners achieve their goals more effectively than unmanaged harvests.
- Income from selling timber products is subject to federal income tax and the New Hampshire yield tax (timber tax).

- Planning for the long-term ownership of forest property is important to the overall sustainability of the forests of New Hampshire. Will the property be sold and developed, or passed on to family members? Careful estate planning includes consideration of future ownership. Conservation easements are one tool that can ensure that the property remains as forest land in perpetuity and can be part of estate planning (1.4 Estate Planning and Land Protection).

RECOMMENDED PRACTICES

- ✓ Contact your UNH Cooperative Extension county forester for a woodlot visit.
- ✓ Know where your boundaries are.
- ✓ Determine your goals and objectives.
- ✓ Develop a management plan.
- ✓ Contact your legal advisers and a local land trust to find out more about estate planning and land protection options.
- ✓ The following are steps you, your forester and your logger can take to ensure a successful timber harvest:
  - Before the harvest
    - Visit several completed harvests and check references.
    - Clarify expectations and objectives.
    - Determine the size and scope of the operation.
    - Know where the ownership boundary is and where the harvest boundaries are.
    - Identify areas of special concern such cultural resources, rare species and wetlands. Contact the N.H. Natural Heritage Bureau to consult for the presence of threatened or endangered species.
    - File an *intent to cut* and other permits as needed, such as a wetlands permit. Refer to *Guide to New Hampshire Timber Harvesting Laws* for an overview of laws related to timber harvesting.
    - Time the timber sale to avoid wet or poor logging conditions, conflicting uses, and to optimize market conditions.
    - Designate trees to leave or those to cut.
    - Lay out truck roads, log yards and skid trails.
    - Use best management practices (BMPs) for erosion control. These guidelines, some of which are law, are found in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire* published by the N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. Consult the latest version of this publication before harvesting timber.
  - During the harvest
    - Supervise the job on a regular basis. Stay in contact with your forester and logger.
    - Avoid operating during wet or thawing conditions.
    - Make sure BMPs are in place to prevent sediment from entering streams or wetlands.
    - Review contract timeline and provisions.
    - Protect the site from vandalism by limiting access.

- After the harvest
  - Review contract provisions.
  - Review all mill slips for understanding and completion.
  - File the *report of cut* form, and pay the timber tax.
  - Seed the log landing, skid trails and other vulnerable areas.
  - Assess BMP effectiveness and plan for future maintenance to avoid degradation and sedimentation of streams, wetlands and other water bodies.

CROSS REFERENCES

1.2 Setting Objectives; 1.3 Forest Management Planning; 1.4 Estate Planning and Land Protection; 1.5 Staying Safe Working in the Woods; 8.1 Timber Products.

ADDITIONAL INFORMATION

Bennett, K. P. 2010. *Directory of Licensed Foresters Providing Service to Forest Landowners in New Hampshire*. UNH Cooperative Extension, Durham, N.H. http://extension.unh.edu/fwt/dir/index.cfm Accessed on August 2, 2010.

Bennett, K. P. 2008. *The Timber Sale Contract*. UNH Cooperative Extension, Durham, N.H. http://extension.unh.edu/resources/files/Resource000994_Rep1143.pdf Accessed March 5, 2010.

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

National Timber Tax website. http://www.timbertax.org/ Accessed March 12, 2010.

N.H. Dept. of Revenue Administration. *Current Use Criteria Booklet*. http://extension.unh.edu/resources/resource/977/Current_Use_Criteria_Booklet Accessed June 3, 2010.

N.H. Board of Licensed Foresters. http://www.nh.gov/jtboard/ls.htm Accessed March 5, 2010.

N.H. Land Surveyors Board. http://www.nh.gov/jtboard/ls.htm Accessed March 5, 2010.

N.H. Timberland Owners Association. *Certified Loggers List*. New Hampshire Timber Harvesting Council's Professional Logger Program. http://www.nhtoa.org/ Accessed March 5, 2010.

RSA 79-A. *Current Use Taxation*. http://www.gencourt.state.nh.us/rsa/html/v/79-a/79-a-mrg.htm Accessed May 27, 2010.

RSA 227-J. *Timber Harvesting*. http://www.gencourt.state.nh.us/rsa/html/xix-a/227-j/227-j-mrg.htm Accessed May 27, 2010.

RSA 310-A. *Joint Board of Licensure and Certification*. http://www.gencourt.state.nh.us/rsa/html/xxx/310-a/310-a-mrg.htm Accessed May 27, 2010.

Smith, S. 2009. *Guide to New Hampshire Timber Harvesting Laws*. UNH Cooperative Extension, Durham, N.H. 37 p.

1.2 SETTING OBJECTIVES

BACKGROUND

Developing objectives is integral to managing forest land.

Your objectives should be driven by the reasons you own your land. (Often we use the words "goals," "objectives," and "goals and objectives" interchangeably. In this manual, we mostly use the term "objectives.") The duration of most plans is 10 years, short when compared with the life of the forest. When setting your objectives think big and long term. List all your hopes and dreams for your property. Thinking long term will help you develop short-term objectives that ensure you reach your long-term goals. Talking with UNH Cooperative Extension county foresters, other foresters, loggers, family, neighbors, and friends can help you develop your objectives.

Your objectives for the current and future use of your property should be specific. You will use your objectives to formulate recommendations that then become a course of action to accomplish these objectives. The more specific and measurable your objectives, the easier to monitor and track whether you are achieving them.

Clear objectives help you decide what actions to take and what actions to avoid. Often landowners tell foresters, "I want to do what is right for the land and make a little money." Foresters manage land based on a landowner's objectives. Without your specific instructions, the forester (or logger) can only make decisions based on their ideas of "what is good for the land," which may not align with your intentions. Consider your wishes for the use of your land before talking with a forester. Be prepared to adapt or revise your objectives as you learn more about your land from your research and from working with your forester.

Setting objectives will help you:

- Invest your time, energy, and financial resources wisely.
- Communicate effectively with professionals who may help you achieve your objectives.
- Avoid undesired changes on your property.
- Think long term about your property and its resources.
- Avoid doing something that may not be in your best interest or in the best interests of your land

Consider and write down the answers to the following questions to help you develop objectives and priorities:

General

- Why do you own your property?
- How long do you expect to own your property?
- How would you like it to be used or managed when you no longer own it?
- How do you currently use your land?
- Do you want to use it differently in the future?
- What is most important to you about your land?
- Are you enrolled in, or interested in current use taxation, Tree Farm, or a financial assistance program through the Natural Resources Conservation Service? Would you like to learn more about these and other programs?

1.2: Setting Objectives

Your interest and ability to work on the land

- Are you interested in working on your own land (pruning, clearing trails or vistas, cutting firewood, tapping sugar maples for syrup, etc.)? If so, how much time can you devote, and what skills do you have or are interested in developing?
- Do you have hand tools or power equipment such as a bow saw, pole saw, loppers, chainsaw, or tractor, etc?

Property Condition

- Are there any insect or disease problems?
- Have any natural disturbances such as ice storms, wind, fire, or flood affected your land?
- Are there special places on your property? A place may be special for sentimental reasons or because of an unusual geological formation, significant wildlife habitat, and many other reasons.
- Are there plants or a particular tree or group of trees you want to protect?

Timber

- Do you want to improve the health or economic value of the forest?
- Are you interested in managing for income from wood products?
- Do you have specific goals for the amount or timing of income?
- Are you willing to cut trees to enhance the timber, aesthetic, recreational, wildlife, or other nontimber resources?
- Do some aspects about timber harvesting concern you?

Aesthetics

- Do you want to maintain views to or from the property?
- Do you want to open up a view?
- If your property has road frontage or other areas viewed by the public, how important is maintaining the appearance to you?

Recreation

- Do you or others walk, hike, camp, fish, hunt, snowmobile, bird watch, swim, bike, ski, snowshoe, or enjoy your land in other ways?
- Do you want to enhance the ability to enjoy these or other activities?
- Would you like to improve the existing trails and roads?
- Do you want to prohibit any activities?

Water and Soil

- Do you want to give special attention to vernal pools, bogs, swamps, seeps, small streams, and wet areas?

Wildlife

- Do you know what wildlife use your property?
- Do you want to enhance the habitat for any of these species?
- Would you like to encourage a broader variety of wildlife by improving habitat for species not currently present?

Diversity

- Do you want to encourage a broad variety of plants and animals?
- Do you want to protect unusual plants and animals?
- Do you want to discourage invasive non-native species?

Cultural Resources

- Do you want to protect cultural features such as stone walls, foundations, cellar holes, or wells?

Other Nontimber Uses

- Do you harvest maple syrup, Christmas trees or other nontimber forest products? Do you want to?
- Are you interested in growing and harvesting non-traditional products such as mushrooms, herbs, and greens?
- Are you interested in using your property for educating others about forests?

OBJECTIVE

Develop objectives to guide management plans and activities.

CONSIDERATIONS

- UNH Cooperative Extension has forms to help you think through and write down your objectives.
- Your objectives might change as you learn more through personal exploration and interaction with professionals, as the land changes, or if your situation changes. Objectives often become more detailed and specific as you learn about your land.
- Your property is part of the larger landscape. Your goals and the opportunity to achieve them may be affected by the characteristics of the surrounding land. Conversely, your actions can affect conditions on nearby lands. Adopting the landscape perspective is especially important when considering wildlife habitat. Different wildlife species need different forest types and ages to meet their needs. Most birds and animals require distinct habitats during different parts of the year or during various stages in their lives. Not all forest landowners own enough acres to meet all the habitat needs of many wildlife species. The benefits of managing for wildlife on smaller tracts may only be realized if this management complements conditions and management on neighboring properties.

RECOMMENDED PRACTICES

- ✓ Determine your objectives and write them down.
- ✓ Involve family members in discussions about your land so they understand your goals and objectives, especially if you plan to leave your land to them.
- ✓ Discuss your objectives with your forester and revise them as you learn more about your land, or if your situation changes. Include written objectives as part of your forest management plan.
- ✓ When wildlife habitat management is an objective, examine your land within its larger context to determine the habitat management that may be effective and reasonable to pursue within your woodlot.
- ✓ Refer to the appropriate chapters in this manual to learn more about the resources that interest you.

CROSS REFERENCES

1.3 Forest Management Planning; 1.4 Estate Planning and Land Protection; Chapters related to individual landowner objectives.

ADDITIONAL INFORMATION

UNH Cooperative Extension. *Landowner Goals and Objective Assessment Forms*. http://extension.unh.edu/resources/resource/972/Landowner_Goal_Assessment Accessed on January 28, 2010.

1.3 FOREST MANAGEMENT PLANNING

BACKGROUND

Most forest land in New Hampshire is privately owned, and the duration of ownership of any piece of land is short compared to the life of a forest. Forests are complex mixes of resources deserving long-term care. Developing a plan can improve the outcome of forest management actions.

Private landowners own nearly 80 percent of New Hampshire forest land. Individual actions contribute to the sustainability of the state's forest, one woodlot at a time.

The trees we see today are here because of climate, topography, soils, and past uses of the land. Today's owners influence what tomorrow's owners will see on the land. Forest management and silviculture (the art and science of establishing and tending trees and forests) give us the tools to help shape what our forests will look like in the future.

Managing a forest using this manual to meet current landowner objectives without negatively affecting its use by future generations, requires active involvement, a sense of responsibility, knowledge of the opportunities, an awareness of the consequences of actions, and a clear set of objectives. The more known about the land, the better. Good stewards of the land consider water quality, aesthetics, fish and wildlife habitat, timber, recreation, soils, wetlands and other unique places, rare plants and unique natural communities, forest protection, and cultural and historical features.

A forest management plan is a working guide with recommendations. Developing objectives for the land is integral to planning (1.2 Setting Objectives). The plan describes the natural resources of a property in light of the landowner's interests and objectives. It normally includes maps and a written report with recommendations, prioritized with suggestions for timing.

The forest is mapped and described by stand (a grouping of trees similar in species, age, and site). Maps can be hand-drawn or computer-generated. They can be developed using remotely sensed information such as aerial photographs, based on field explorations, or some combination. A good map represents what exists on the land. Plans typically include the following composite or separate maps:

- Property—perimeter sketch or survey map with known boundary information such as stone walls or monuments, significant land features, access points, roads, landings, trails, or surface water.
- Forest type—tree species and species groups, size classes, etc.
- Wildlife habitat—significant and critical wildlife habitats and features such as deer wintering areas, heron rookeries, wetlands, beech stands showing heavy bear use, and habitat for species in greatest need of conservation.
- Recreation, aesthetic, water, cultural and other resources—existing and potential sites for recreation, vantage points, trails, historic sites, natural-heritage elements.
- Soils—based on the Natural Resources Conservation Service (NRCS) soil survey information.
- Property location (locus map).

Written stand descriptions and management prescriptions (recommendations) are based on field-data collection. The level and type of inventory and field data gathered depends on the owner's objectives and budget. Stand descriptions include species, density, quality, accessibility, age class, understory vegetation, insects, diseases, and wildlife habitat such as snags, canopy closure, vegetative diversity, nonforest, wetland and other features. Management prescriptions are based on objectives and characteristics of the stand. They specify the likely results and consequences of suggested actions.

OBJECTIVE

Help landowners determine their objectives, assess the resources on their woodlot and develop a long-term plan. The desired outcome is a well-tended woodlot.

CONSIDERATIONS

- Foresters offering services to private landowners for compensation are licensed by the State of New Hampshire. Plan writing is among the many services they offer.
- Developing a long-term plan can help landowners realize their hopes and dreams for their land. But caring for the land can be complicated. A first step in developing a plan is to determine goals and objectives, at least what they are today. Other considerations include the size of the property, the condition of the resource, and the budget for planning. The plan should be scaled to suit owner needs and financial resources.
- A plan can be relatively inexpensive or a major investment, depending on the landowner objectives, which the plan should reflect.
- Plans vary depending on landowner interest and the intended uses. Knowing the intended uses helps determine the type and intensity of the plan developed and results in a plan that can satisfy multiple purposes.
  - **Current Use Plan** satisfies the requirement of the "forest land with documented stewardship" category of current use tax assessment (RSA 79-A). Current use plans include an updated map and:
    - A statement of forest stewardship objectives.
    - Current forest stand descriptions.
    - Current management prescriptions that address timber, fish and wildlife habitat, soil, water quality, recreation, aesthetics, cultural features, forest protection, wetlands, threatened and endangered species, and unique natural communities.
    - A boundary-maintenance schedule.
    - An access road development and maintenance plan, if applicable.
    - The signature of a person qualified to write the plan, usually a New Hampshire licensed forester.

    See the *The Current Use Criteria Booklet* for additional requirements.
  - **Tree Farm Management Plan** satisfies the requirements of the Tree Farm Program. Free inspections are provided to Tree Farmers, but plan preparation isn't included in this free service.
  - **Conservation easements** may require a plan before harvesting or other management activity can occur. The easement deed gives specifics.
  - **Forest Stewardship Plan or Forest Management Plan** developed with federal financial assistance. Federal funding helps cover the cost of hiring a forester to write a plan and may be used to satisfy the requirements of the above plans. Federal program requirements result in a comprehensive plan, and the cost reflects this. It may be more cost-effective to develop a simpler plan.

RECOMMENDED PRACTICES

- ✓ Contact your UNH Cooperative Extension county forester for a woodlot visit. He/she can do a preliminary woodland assessment with you and relate the resources on your land to your interests, as well as put you in touch with information, professionals, and programs. As part of this visit, explore available financial assistance.
- ✓ Work with a forester. Refer to the *Directory of Licensed Foresters Providing Service to Forest Landowners in New Hampshire*.
- ✓ Determine your objectives and share them with your forester for inclusion in the plan. Refer to 1.2 Setting Objectives and a landowner goals and objectives assessment form.
- ✓ Involve family members in discussions about your land so they understand your goals and objectives, especially if you plan to leave your land to them.
- ✓ Determine the type of plan that will meet your needs and contract for a plan that meets those needs. Invest appropriately, based on your objectives, the size of the property, the value of the resource, and your budget.
- ✓ Implement your plan in a flexible and dynamic way, responsive to changing markets, natural occurrences such as ice storms or insect infestations, or changes in your interests and needs.
- ✓ Review the plan before timber harvesting, before undertaking other management activities, and every 10 years.

CROSS REFERENCES

1.1 First Steps in Forest Management; 1.2 Setting Objectives; 1.4 Estate Planning and Land Protection; Chapters related to individual landowner objectives.

ADDITIONAL INFORMATION

Bennett, K. P. 2010. *Directory of Licensed Foresters Providing Service to Forest Landowners in New Hampshire*. UNH Cooperative Extension, Durham, N.H. http://extension.unh.edu/fwt/dir/index.cfm Accessed on August 2, 2010.

UNH Cooperative Extension. *Landowner Goals and Objectives Assessment Forms*. http://extension.unh.edu/resources/resource/972/Landowner_Goal_Assessment Accessed on January 28, 2010.

N.H. Dept. of Revenue Administration. *Current Use Criteria Booklet*. http://extension.unh.edu/resources/resource/977/Current_Use_Criteria_Booklet Accessed on May 27, 2010.

N.H. Tree Farm Program. N.H. *Tree Farm Program Management Plan Template*. http://extension.unh.edu/resources/files/Resource001005_Rep1150.pdf Accessed on January 28, 2010.

1.4 ESTATE PLANNING AND LAND PROTECTION

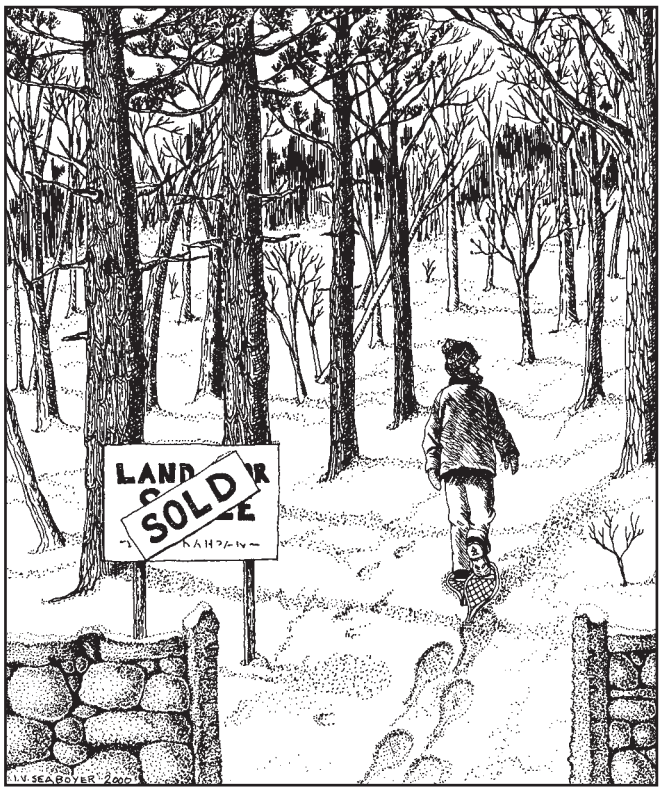
BACKGROUND

Putting a priority on estate planning and permanent land protection will help ensure future generations will have working forests to manage.

Good forestry requires planning and long-term commitment. The need for estate planning and land protection has never been greater than it is now because of three pressing issues: (1) population growth, (2) land-use change and development, and (3) aging landowners. New Hampshire has been the fastest growing state in the northeast for more than four decades. Population growth and development are exacerbated by an aging landowner population. The average age of private landowners is increasing. Without careful estate planning and more emphasis on land protection, New Hampshire will experience an increasingly fragmented forest landscape with permanent loss of forest.

OBJECTIVE

Use estate planning and land protection as an important part of good forest stewardship.



CONSIDERATIONS

- This chapter discusses issues that have legal implications; don't construe the information here as legal advice. Landowners interested in estate planning and land protection should contact legal advisers and conservation professionals.
- **Family Dynamics**—Deciding who to involve and how decisions will be made about the family estate is an important first step. It's difficult enough for individuals or couples to make these decisions. Considering the typical situation—aging owners with children, grandchildren and extended family members, all with feelings of entitlement and fairness—it's not surprising decisions are put off. Keeping to a minimum the number of individuals involved isn't always possible and may not yield the best decisions. Outside help is available through trained facilitators and lawyers with expertise in estate planning.
- **Wills**—Wills are often the least expensive and most easily completed part of estate planning. Basic wills are essential to just about everyone but critical for individuals and families who own valuable assets such as land. Without wills, forest landowners may commit their heirs to a lengthy estate-settlement process. More highly valued estates, estates with significant landholdings, and estates whose owners have complex family structures often require more detailed wills and refined estate planning. Periodic reviews and updates to wills may be needed to reflect changes in land ownership or family structure.

- **Equal Division of Property—**Most people have an overriding desire to do the fair thing, sharing estates equally among heirs. This may work with many assets and material possessions, but land is different. Dividing up land may:
  - Result in an unequal allocation.
  - Reduce the ability to manage forest land.
  - Result in land fragmentation.
  - Damage or destroy critical natural resources.

  Other options allow the property to remain largely intact providing shared benefits of more extensive acreage to the next generation. The options can be fairly simple (e.g., a family trust), or complex (e.g., a family limited partnership [FLP], s-corporation, or limited liability company [LLC]). All these options require the services of an experienced legal professional, preferably with experience in estates with landholdings.
- **Permanent Land Protection—**Permanent land protection measures often are a routine component of estate planning, particularly if there are financial needs and strong emotional and family ties to the land. Permanent measures can offer ways to meet both financial and emotional goals. Options include:
  - Giving or selling land to an entity that will carry on long-term stewardship.
  - Retaining the land, but giving or selling a conservation easement.
  - Combining these approaches.

  Alone or combined, these options can provide opportunities for reducing value to minimize state or federal estate taxes and provide income tax benefits to the current generation of landowners, enabling management to continue and restricting development on key segments of the property.
- **Conservation Easements—**A conservation easement is a flexible, effective tool to permanently protect land from subdivision, development, and mineral extraction. Easements are designed to reflect and maintain a property's conservation values and to incorporate landowner and easement-holder objectives. The landowner retains ownership, the land remains on the tax rolls, and the easement restrictions pass with the land to future owners. A conservation easement may allow a landowner to:
  - Continue good stewardship of the land. Most New Hampshire easements encourage good forest and farm management, and allow harvesting wood and agricultural products. An easement may require a forest management plan and harvest supervision by a forester.
  - Ensure the land remains undeveloped in perpetuity, or allows limited development while restricting subdivision, structures, and commercial and industrial uses on most of the property.
  - Provide income or estate tax benefits. Development rights given up through an easement can be valued by a qualified appraiser. If the easement meets IRS requirements, the easement value may be considered a charitable donation for income tax purposes. A conservation easement generally lowers the value of the land and may reduce the value of an estate, thereby reducing potential federal estate taxes.
  - Receive direct financial benefits by selling a conservation easement, though this option is available in limited cases.

RECOMMENDED PRACTICES

- ✓ **Get help.** Seek an adviser with experience in estate planning, real estate, and land conservation. Landowners can find help by contacting one of the approximately 40 private, nonprofit land trusts operating in New Hampshire. The Land Trust Alliance is a national organization that provides training, guidance, accreditation and coordination for land trusts and lists them at www.lta.org. UNH Cooperative Extension offices in each county have staff who can provide further advice and guidance.
- ✓ **Plan ahead.** It's never too early to begin the estate planning or land conservation process. It is the best way to realize your long-term goal for good forest stewardship.

CROSS REFERENCES

1.1 First Steps in Forest Management; 1.2 Setting Objectives; 1.3 Forest Management Planning.

ADDITIONAL INFORMATION

Frame, G. 2006. *A Forester's Guide to Conservation Easements*. Society for the Protection of New Hampshire Forests, Concord, N.H. 36 p.

Lind, B. 2005. *Conserving Your Land: Options for New Hampshire Landowners*. Center for Land Conservation Assistance, Concord, N.H.

Levite, R. *Conservation Restrictions and Estate Planning*. UMass Extension. http://www.umass.edu/nrec/pdf_files/conservation_restrictions_land_protection.pdf Accessed January 28, 2010.

Levite, R. *Estate Planning for Private Landowners*. UMass Extension and the Green Valley Institute. http://www.rifco.org/Estate_Planning_for_Private_Landowners.pdf Accessed January 28, 2010.

Penn State College of Agricultural Sciences, Agricultural Research and Cooperative Extension. *Forest Stewardship Series—Estate Planning*. 2008. The Pennsylvania State University. UH-105. 6 p.

USDA Forest Service. *Preserving the Family Woods*. USDA For. Serv. NA—State and Private Forestry. http://na.fs.fed.us/pubs/stewardship/preserving_family_woods_lr.pdf Accessed January 28, 2010.

Siegel, W., H. Haney, and J. Greene. *Estate Planning for Forest Landowners: What Will Become of Your Timberland?* USDA For. Serv. Gen.Tech. Rep. SRS-112. http://www.srs.fs.usda.gov/pubs/gtr/gtr_so097.pdf Accessed January 28, 2010.

1.5 STAYING SAFE WORKING IN THE WOODS

BACKGROUND

If good safety practices aren't followed, working in the woods alone with chainsaws and other equipment can result in swift and serious injuries or death. Expensive equipment can be damaged or destroyed if operated in an unsafe manner.

Loggers and others whose occupation is associated with tree cutting take courses on safety and are generally expected to conform to certain safety practices. Private landowners don't have similar requirements but are encouraged to attend chainsaw and other safety classes or orientations and hands-on training. A few basic practices can make the difference between a productive and exhilarating (even if tiring) session in the woods and possible serious personal injury, damage to equipment, or damage to residual trees.

OBJECTIVE

Avoid personal injury, damage to equipment, and damage to residual trees by practicing good safety as a matter of routine.

CONSIDERATIONS

- This chapter addresses two important aspects of woods safety for landowners:
  - Staying safe when working in the woods, for example when cutting firewood.
  - Staying safe when others are working in the woods and you are visiting.
- Other safety considerations exist beyond the scope of this chapter.
- Hearing protection may seem unnecessary or unimportant, but frequent exposure to high decibel noise can result in premature hearing loss.
- RSA 508:14 limits the liability of landowners in the absence of intentionally caused injury or damage and unless willful, wanton, or reckless conduct is shown.
- Safety equipment may be costly, but the reduction in medical expenses, lost work days, and even funeral costs is well worth it.
- Heavy equipment operating in the woods is dangerous for onlookers. Equipment operators are concentrating on their machines. They aren't likely to expect, and consequently not likely to see,

people in the vicinity. Feller-bunchers or shears can throw pieces of wood 100 feet or more and can throw rocks, a broken metal tooth or other metal, 300 feet or more.

- A commercial operation can pose other safety concerns. New skid trails and truck roads can be unstable, slippery, or have deep mud, holes, sharp branches, and other surprises. There may be sizeable quantities of fuel and lubricants that could pose a fire danger or spill potential. Logs may be stacked in large piles. Such piles can be unstable and should they roll, a child or an adult could suffer injury or death.

RECOMMENDED PRACTICES

- ✓ Seek advice from your insurer or lawyer to ensure adequate coverage.
- ✓ Know your physical condition. Don't risk injury. Stop working when you feel tired.
- ✓ Know proper felling techniques, chainsaw maintenance and safety. Seek answers to equipment and safety questions from UNH Cooperative Extension county foresters, consulting foresters, loggers, or equipment dealers.
- ✓ Keep a first-aid kit with you where you are working.
- ✓ Work with a partner at a safe distance.
- ✓ Be sure someone knows your location or leave a note where it will be easily found with a good description of where you will be.
- ✓ Carry a well-charged cell phone and check for reception.
- ✓ Check for hazards. Be careful when working around dead or dying trees. Look for "widow makers" (dead, broken, or "hung" branches) that could fall when least expected.
- ✓ Wear eye protection and good leather gloves when sawing, cutting brush, weed-whacking, or splitting wood, or when operating any logging equipment.
- ✓ Wear sturdy leather boots at a minimum; when chainsawing, steel-toed boots.
- ✓ Wear chainsaw chaps and gloves to protect legs and hands when using a chainsaw.
- ✓ Wear a hard hat when felling trees or checking an active logging job. A protective face visor and built-in hearing protection provide safety and convenience.
- ✓ Don't work above your head with a chainsaw or operate a chainsaw from a ladder, stone wall, or other object. These practices can lead to serious injury in the event of a fall or chainsaw kickback. (Kickback occurs when the teeth on the chain catch something as they rotate around the tip of the blade, causing the blade to kick back violently towards the operator.)
- ✓ Use extra caution when chainsawing in brush. It can cause kickback.
- ✓ Learn to identify poison ivy. Sawing or weed-whacking vines any time of the year can result in ivy poisoning.
- ✓ Find out what safety concerns your loggers may have while they're doing the work.
- ✓ Talk with the operator during a break when the machine is shut down. If you must talk with an operator immediately, get his/her attention at a distance by waving, flagging or by other means. Wait until the machine stops before approaching.
- ✓ Stay well away from operating equipment and don't permit children to play around machines, even a machine that's not operating.
- ✓ Minimize access to your property, or at least the area of active logging, to preclude a visitor being hurt.

CROSS REFERENCES

1.1 First Steps in Forest Management; 3.1 Timber Harvesting Systems.

ADDITIONAL INFORMATION

RSA 508:14. *Limitation of Actions*. http://www.gencourt.state.nh.us/rsa/html/lii/508/508-14.htm Accessed May 27, 2010.

UNH Cooperative Extension. 2001. *Safe Timber Harvesting*. http://extension.unh.edu/resources/files/Resource001062_Rep1293.pdf Accessed on January 26, 2010.

SILVICULTURE

TOPICS IN THIS SECTION

2.1 New Hampshire Forest Types
2.2 Forest Structure
2.3 Regeneration Methods
2.4 Managing for High-Value Trees

ADDITIONAL READING

Working with Your Woodland: A Landowner's Guide
Mollie Beattie, Charles Thompson, and Lynn Levine
University Press of New England
1993 (second edition)

Introduction to Forest Ecology and Silviculture
Thom J. McEvoy
University of Vermont
School of Natural Resources and Extension System
Natural Resource, Agriculture and Engineering Service
2000 (second edition)

2.1 NEW HAMPSHIRE FOREST TYPES

BACKGROUND

Forest types are distinctive associations of trees, shrubs and herbaceous plants. They are named for the predominant tree species.

There are other ways to group and describe forests. Natural communities and wildlife habitat are commonly used. Natural communities describe current and potential vegetation in the absence of disturbance. A comparison of these three methods is in the *New Hampshire Wildlife Action Plan* (Appendix C of the plan).

Forest types describe large expanses of land, or site-specific forest stands (grouping of trees similar in species, age and site). The common forest types in New Hampshire are white pine, northern hardwood, spruce-fir, red oak, hemlock, and aspen-birch.

Climate, elevation, soil conditions, and land use history all play a role in determining which forest type is growing in a particular area. Forest type, in turn, influences the variety of wildlife inhabiting an area and the silvicultural options available.

A forest type may be dominated by a single tree species or by several species growing together. White pine often occurs in a single-species stand. Northern hardwood, composed of sugar maple, beech, yellow birch and smaller amounts of other species, is a multiple-species type. Two types can blend together to form a mixed-wood type. Mixed-wood stands often occur in transition zones between major types. Two common mixed types are the pine-oak and spruce-fir-northern hardwood combinations.

White Pine

This type is most common in southern New Hampshire. White pine occurs in pure stands or mixed with red pine, hemlock, red oak or other hardwoods.

White pine often colonizes abandoned agricultural land. On fertile sites it is gradually replaced by hardwood or hemlock through succession. On less fertile, sandy soils the type is more persistent.

On sandy soils, acid-loving plants such as blueberries, starflowers, and pink lady's slippers are common. Associated wildlife include red squirrel, deer mouse, pine warbler, and red-breasted nuthatch. Owls often use white pine for winter roosting.

Northern Hardwood

Most common in central and northern New Hampshire, northern hardwood is usually a mix of sugar maple, beech, yellow birch, red maple, and white ash. Sugar maple is typically the most abundant species on sites with fertile soils. Beech increases in abundance on drier sites and yellow birch becomes more prominent on moist sites.

Northern hardwood tends to be a relatively stable and permanent forest type. Stands typically grow on the slopes of hills and mountains, where the soils are fertile and well-drained. Sugar maple and beech are shade-tolerant trees that can reproduce and grow in the shade of a forest canopy. Yellow birch and white ash are less tolerant of shade and require more sunlight to reproduce and grow.

Common understory trees and shrubs include striped maple, witch hazel, and hobblebush. Associated wildlife include gray fox, flying squirrel, red-eyed vireo, white-breasted nuthatch, and ovenbird.

Spruce-Fir

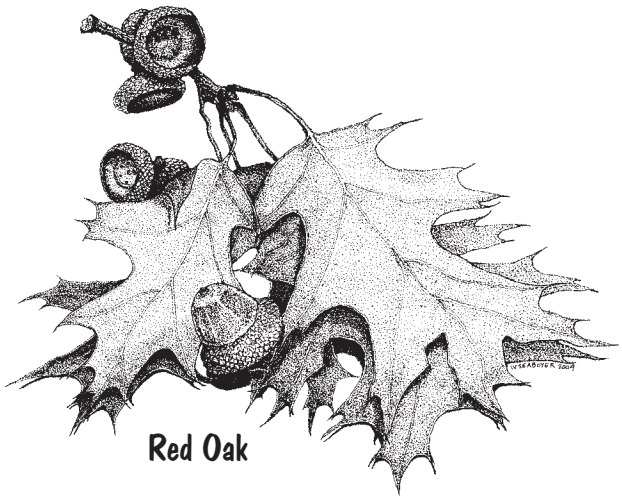
Most common in the north, red spruce and balsam fir dominate this type, which grows on poorly drained flats and the shallow, rocky soils of mountaintops.

Because of where they grow, these trees are susceptible to windthrow. The spruce budworm is a native insect which can impact vast areas during periodic outbreaks. Heart-rot fungi can affect overmature balsam fir.

Bunchberry, goldthread, and trilliums are common wildflowers and associated wildlife include pine marten, snowshoe hare, spruce grouse, gray jay, black-backed woodpecker, and ruby-crowned kinglet. Deer often use spruce-fir stands for winter cover.

Red Oak

The red oak type occurs in close association with white pine in southern New Hampshire. Stands of nearly pure red oak are common on ridge tops. On abandoned agricultural land, red oak mixes with white pine to form the pine-oak type. Red maple and black birch are common associates. Maple-leaved viburnum, bracken fern, and whorled loosestrife are common understory species.


Red Oak

Deer, turkey, gray squirrel, and many other species eat acorns. Blue jays, tufted titmice, scarlet tanagers, and eastern towhees are some of the birds that commonly nest in red oak and pine-oak stands.

Hemlock

Hemlock occurs on wet flats, rocky ridge tops, and moist slopes in southern and central New Hampshire. Its ecological characteristics are similar to the spruce-fir type of the north.

Striped wintergreen and downy rattle-snake plantain sometimes grow under dense hemlock. Hobblebush and maple-leaved viburnum may grow in small canopy openings. Red-breasted nuthatches, solitary vireos, black-throated green warblers, and hermit thrushes are typical breeding birds. Deer often use hemlock stands for winter cover.

Aspen-Birch

Aspen-birch is a pioneer type relatively uncommon in the state. The type is composed primarily of quaking and big-toothed aspen and white birch and occurs on a wide variety of soils.

Aspen and white birch require full sunlight to grow. Disturbances such as fire, windstorms, or clearcutting create the conditions necessary for reproduction. In the absence of disturbance, natural succession leads to aspen-birch stands being replaced by other types.

Common associates in young stands are raspberries and blackberries. Aspen-birch provides valuable habitat for ruffed grouse, woodcock, Nashville warbler, mourning warbler, and beaver.

OBJECTIVE

Manage a diverse forest to meet landowner objectives and for the environmental, economic and social well-being of the state.

CONSIDERATIONS

- New Hampshire is 84 percent forested and most is privately owned. Forests provide a wide variety of goods and services to meet our everyday needs and comforts. Forests are a source of aesthetic and recreational enjoyment, a critical habitat for wildlife, and a natural filter assuring water quality. Maintaining viable forest products industries that provide enough economic incentive for landowners to hold and manage forest land will encourage landowners to implement many of the recommendations in this manual.
- Each forest type poses its own management challenges.
- Perhaps the most important sustainability issue facing all forest types is the conversion of forest land to urban uses. When forest land is converted to residential or commercial uses, its ability to produce timber products, wildlife habitat and other amenities is usually lost forever.
- High grading is an important sustainability issue. High grading occurs when the best trees are cut and poor-quality trees are left to grow. Over time, a forest repeatedly high-graded will become dominated by low-quality, low-value trees.
- The current forest type on a property may be there because of past human and natural disturbance and may not be the type most suited for the site.
- Without active management white pine may gradually disappear from many former agricultural lands, especially on better soils.
- An important sustainability issue for spruce-fir concerns the forest age-class structure. Due to the cyclical nature of spruce budworm outbreaks and historic cutting patterns, the type tends to grow in a boom-and-bust cycle. Because of the 1970's budworm epidemic and the heavy salvage cutting that followed, there is a relative shortage of mature and middle-aged stands of spruce-fir. This boom-bust cycle affects regional timber supply and wildlife habitat.
- The hemlock woolly adelgid, a non-native, exotic insect, poses a serious threat to hemlock. The insect has already moved into southern New Hampshire. To help prevent its spread, authorities have imposed a quarantine in the area where the adelgid is found. Any hemlock material from within the quarantine zone needs to be certified clean of adelgid before shipment out of the zone (5.1 Insects and Diseases).
- Other non-native insects and plants are potential threats to long-term forest health.
- The aspen-birch type is becoming less common as fire and clearcutting become less common (6.7 Aspen Management).

RECOMMENDATION PRACTICES

✓ Use the silvicultural techniques and other recommended practices in the following chapters to manage the mix of species most appropriate for the site and most appropriate to help you achieve your objectives.

CROSS REFERENCES

2.2 Forest Structure; 2.3 Regeneration Methods; 2.4 Managing for High-Value Trees; 5.1 Insects and Diseases; 6.7 Aspen Management; 7.1 Natural Communities and Protected Plants.

ADDITIONAL INFORMATION

New Hampshire Fish and Game. *New Hampshire Wildlife Action Plan appendix C: Comparison between forest types, natural communities and wildlife habitat*. 2005. http://www.wildlife.state.nh.us/Wildlife/Wildlife_Plan/WAP_pieces/WAP_App_C_Nat_Comm_Crosswalk.pdf Accessed March 5, 2010.

2.2 FOREST STRUCTURE

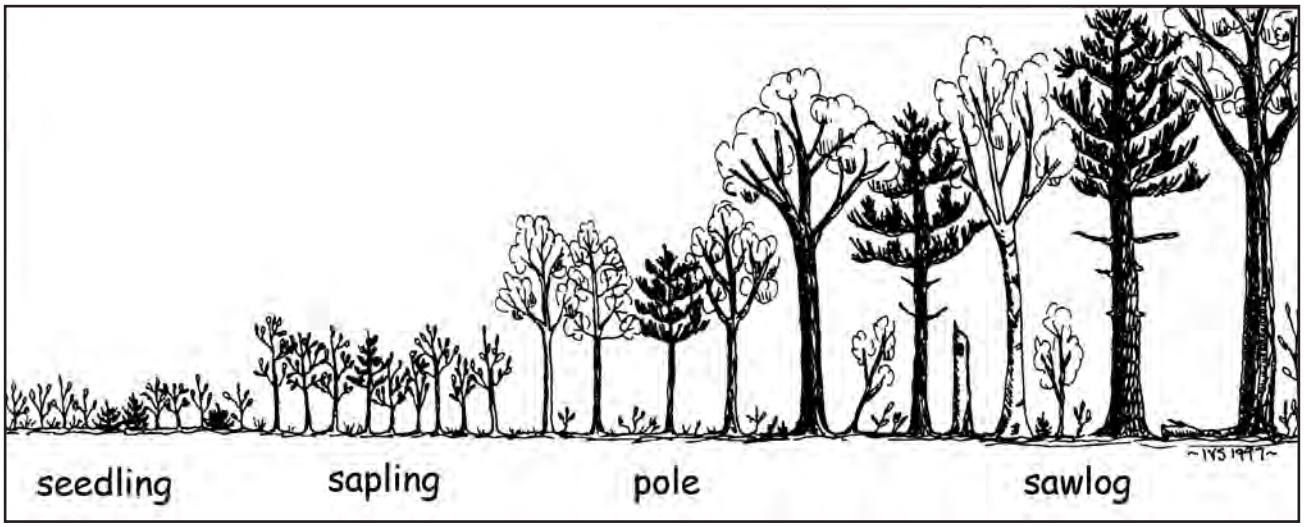
BACKGROUND

Managing forest structure can meet landowner objectives including a sustainable flow of forest products, wildlife habitat, aesthetics, clean water, and other benefits.

Forest structure is the horizontal and vertical distribution of layers in a forest including the trees, shrubs, and ground cover (which includes vegetation and dead and down woody material). Structure looks at the proportion of small, medium, and large trees and is usually reported as trees per acre by diameter class. These age- or size-class groupings are further defined as seedling, sapling, pole, and sawlog.

Size Class Groupings

	Diameter in Breast Height (DBH) in inches
Seedling	up to 1
Saplings	1-4
Pole	5-11
Sawlog	12 and larger



Forests can have a simple structure or they can be very complex. Based on the range of ages among the different levels of structure, forest stands are defined as even-aged, two-aged or uneven-aged.

Even-aged structure means a stand has one distinct age and size class. (An age class is comprised of trees within 20 years of age). They are often less diverse and composed of fewer species than other structures. Most of the tree diameters come close to the average stand diameter. A plantation provides an extreme example of an even-aged structure.

Two-aged stands are often, but not always, a result of human intervention and may be a temporary condition as management works towards developing an even-aged or uneven-aged stand. Structure within these stands will often have patchy or partial overstory canopies with a well-defined second story, or layer, of either poletimber or seedlings and saplings.

Uneven-aged structure means a stand has three or more age classes. This type of structure is a result of increasing species, age- and size-class diversity within a stand. Different species grow at different rates, and a distinct overstory canopy may no longer be recognizable. Each species or age class exhibits an average stand diameter of its own, and smaller diameter classes may contain more trees per acre than the next larger one. Uneven-aged stands are considered balanced when they have three or more age classes occupying approximately equal areas. When this is achieved, the stand can be considered self-sustaining.

Wildlife biologists and foresters are often interested in structure because of its relationship to timber flow, biological diversity and wildlife habitat. Other chapters in this publication address habitat issues. The focus of this chapter is on the role of structure in maintaining a flow of timber products over time.

OBJECTIVE

Maintain a sustainable flow of quality timber through control of stand and forest structure.

CONSIDERATIONS

- A forest inventory is useful for analyzing and understanding structure.
- Controlling stand structure requires appreciable effort, especially in uneven-aged stands, and will require professional assistance with stand inventory and timber marking practices.
- Maintaining a balanced stand structure is more practical on larger ownerships.
- Attempts to sustain production of quality timber by simple rules such as keeping harvest equal to growth is only possible after the stand structure becomes balanced at an optimum level. Keeping harvest equal to growth may not allow for other practices in this publication.
- A true uneven-aged condition takes time to establish and can be difficult to implement when harvesting.
- While in theory uneven-aged management requires maintaining size-class balance at the stand level, in practice it may be more feasible to maintain this balance across larger management units, with individual stands managed for a muti-aged (though not perfectly balanced) structure.
- Stand and forest structure and density guidelines vary by species. See the Recommended Practices for general guidelines to cover the likely range in conditions.
- Uneven-aged stands often provide a variety of vertical structure (i.e. multiple canopy layers, for example; overstory, midstory and shrub layers). Even-aged stands can provide some vertical structure, particularly when routinely thinned.
- Even-aged stands can provide horizontal diversity (i.e. a variety of forest types and age classes across the landscape). Uneven-aged stands can provide some horizontal structure, especially when group selection is used.
- Site factors such as soil type can influence stand structure.
- Stand growth and harvest yields will differ depending on any stand's existing structure and the intention of management.
- Rotation age will be fixed or nearly so for even-aged stands, whereas uneven-aged stands have a continuum of harvests and regeneration and theoretically have no end of rotation date.
- Shade tolerance, a species' ability to thrive and prosper depending on the amount of available light and competition from others, will often dictate what species will regenerate (2.3 Regeneration Methods).

- Advance regeneration are those young trees established naturally without the influence of harvesting. When present, they can simplify the silviculture needed to sustain the future forest.
- Forest structure within the understory also includes down woody material, shrubs, forbs, grasses, and other herbaceous plants. These dead and living plant materials comprise an important part of the forest ecosystem, vital to habitat, forest soils and biodiversity.
- The prevalence of mechanized harvesting systems and the growing demand for biomass fuel make it efficient and profitable to manage even-aged stands.
- The selection system, both group and individual, establishes an uneven-aged structure. Small group cuts are most often used and preferred over individual tree selection, which can lead to high grading.

RECOMMENDED PRACTICES

✓ Have a clear understanding of the goals and objectives for a stand and how the existing structure can or can't be manipulated to achieve the stated goals.

✓ Inventory the stand to gather data on the species composition, trees per acre, average diameter, basal area, and stem quality.

Even-aged Management

✓ Provide an array of even-aged stands over time using clearcut or shelterwood harvest practices (2.3 Regeneration Methods).

✓ Use even-aged harvest techniques to regenerate shade-intolerant or moderately tolerant species.

✓ Strive for the following percentages of acres in seedling/sapling, pole, and sawlog stands:

Tree Size	Percent of Acres
Seedling/Sapling	20-30
Pole	25-35
Sawlog	35-55

These targets are based on rotation ages of about 80 to 120 years (shorter if there is a predominance of short-lived species such as aspen, white birch or balsam fir). They are most applicable at the landscape scale or on large properties (several thousand acres or larger).

✓ Change the percentages suggested in the above table in seedling/sapling stands and the percentages in sawlog and mature stands when biodiversity, wildlife or aesthetic goals extend or shorten rotation ages. For example, lower the percentage of seedling/saplings and increase the percentage of sawlogs when rotation age is extended.

✓ Identify, maintain, and regenerate wildlife habitat inclusions (e.g. aspen, soft mast, hemlock, or oak raptor-nesting trees).

Uneven-aged Management

✓ Develop stands with a range in tree sizes using some form of partial cutting such as individual tree selection or group selection.

✓ Use uneven-aged management to favor shade-tolerant species (e.g., northern hardwoods).

✓ Harvest trees to adjust stand conditions to within the recommended ranges below. Sustained yield is ensured by the ever-increasing number of younger trees available in the stand.

Tree Diameter	Percent Basal Area (of Sq. Ft./ Acre)	Percent Nos. (of Trees/ Acre)
6-10	30-50	60-80
12-14	20-30	15-20
16-22+	25-50	5-20

Examples (using the mid-range in above categories):

(1) If a stand contained a basal area of 100 square feet per acre, 40 square feet per acre may represent trees 6-10 inches in diameter at breast height (DBH), 25 square feet may represent trees 12 to 14 inches DBH and 35 square feet may represent trees 16 inches DBH or greater.

(2) If the stand contained 100 trees per acre, those same classes may contain 70, 17.5 and 12.5 trees per acre respectively.

✓ Identify, maintain, and regenerate wildlife habitat inclusions (aspen, soft mast, hemlock, oak raptor nesting trees).

CROSS REFERENCES

2.1 New Hampshire Forest Types; 2.3 Regeneration Methods; 2.4 Managing for High-Value Trees; 6.2 Cavity Trees, Dens and Snags; 6.3 Dead and Down Woody Material; 6.4 Overstory Inclusions; 6.6 Temporary Openings Created by Forest Management; 6.7 Aspen Management; 7.5 Old-Growth Forests.

ADDITIONAL INFORMATION

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and J.W. Lanier. 1992. *New England Wildlife: Management of Forested Habitats*. USDA For. Serv. Gen. Tech. Rep. NE-144. 271 p.

Frank, R.M., and J.C. Bjorkbom. 1973. A *Silvicultural Guide for Spruce-Fir in the Northeast*. USDA For. Serv. Gen. Tech. Rep. NE-6. 29 p.

Lancaster, K.F., and W.B. Leak. 1978. *A Silvicultural Guide for White Pine in the Northeast*. USDA For. Serv. Gen. Tech. Rep. NE-41.13 p.

Leak, W.B., D.S. Solomon, and P.S. DeBald. 1987. *Silvicultural Guide for Northern Hardwood Types in the Northeast (revised)*. USDA For. Serv. Res. Pap. NE- 603. 36 p.

2.3 REGENERATION METHODS

BACKGROUND

Carefully designed regeneration practices help perpetuate desired tree species.

Regeneration refers to the seedlings and saplings that develop beneath a forest stand, in openings within a stand, or following the removal of a stand (grouping of trees similar in species, age and site). In younger stands with potentially valuable trees, the immediate goal may be to manage the existing trees for timber as described in 2.4 Managing for High-Quality Trees. If the stand is older or contains an abundance of poor-quality trees, the emphasis can shift to a regeneration harvest using the techniques described in this section.

Silviculture is the art and science of establishing and tending trees and forests. Controlling the composition, health, structure, and growth of forest stands to help meet the landowner's objectives lies at its foundation. Landowner objectives may include timber products, wildlife, aesthetics, recreation, or overall health and stability. Some owners may wish to develop a forest that appears completely natural or untouched. Landowner objectives play a predominant role when choosing a silvicultural approach.

Successful regeneration involves analyzing the condition of the existing trees, advanced regeneration and seed source, and the site capability, then choosing a harvest practice that will regenerate the species best meeting your objectives. Regeneration is one of the most important factors affecting the long-term value and productivity of a forest property.

Financial and Biological Maturity

The need for income, promoting wildlife habitat or creating special aesthetics are but a few reasons to regenerate a stand. Financial maturity is one indication of whether or not to harvest. A tree is financially mature when its rate of return becomes less than what other financial investments (such as stock or bonds) can yield. Trees growing on better sites become financially mature at larger diameters than the same species growing on average or poor sites, since they grow faster and are able to deliver a higher rate of return for a longer period. Likewise, poor-quality trees mature financially at much smaller sizes than high-quality ones. Approximate diameters for financially mature, high-quality trees are given below. Maturity varies depending on tree condition, site quality, and markets.

Except for short-lived species such as paper birch and balsam fir, financial maturity isn't highly correlated with biological maturity. Most tree species can live for decades or centuries past their financial maturity. Biological maturity occurs when a tree begins to decline. Biological maturity may trigger a regeneration harvest, but these older trees provide benefits described in other chapters. Approximate ages are listed below.

Financial Maturity by DBH and Biological Maturity by Age

Species	Financial Maturity (DBH) inches	Biological Maturity years
Sugar maple, white ash, yellow birch, red oak	18-24	150-200
Red maple, beech	14-18	120-150
Paper birch, aspen	12-14	80-100
White pine	18-24	150-200
Red spruce	12-16	200-300
Balsam fir	10-14	60-80
Hemlock	16-18	200-300

Site Capability

Analysis of site capability gives insight into which species are best adapted to grow on a particular site. Some general guidelines are:

Species	Preferred Site and Soil Conditions
White ash, sugar maple	Moderately well-drained and enriched fine-textured soils, especially with low acidity (higher pH soils)
Beech	Sandy tills, but common on a wide variety of soils
Red oak *	Sandy tills and outwash (where red oak may be poorly formed and defective)
White pine*	Outwash and, to a lesser extent, sandy tills
Yellow birch	Moderately well-drained, fine-textured soils; also on somewhat poorly drained pan soils in mixture with softwood
Red spruce, hemlock, balsam fir	Shallow pan soils and lakebed sediments often somewhat poorly drained; outwash; or shallow-to-bedrock
Paper birch, aspen, red maple	Adapted to a variety of soils, but often on sites that supported shade-tolerant softwoods.

** Currently found growing on a variety of soils due to agricultural history and generally difficult to regenerate on the better soils.*

New Hampshire soils are complex and highly variable, primarily due to their glacial origins. The Natural Resources Conservation Service (NRCS) categorizes site capability to correlate with county soil survey maps. Referred to as Important Forest Soil Groups, these categories can be used to evaluate the relative productivity of soils and better understand patterns of plant succession and the ways soil and site interactions influence management decisions. All soils are grouped into one of six categories. For a more complete treatment see the appendix. NRCS field offices can provide more information.

Site index is another way to categorize site quality. It is expressed as the height of a species at a given age, usually at age 50. The higher the site index, the taller the tree will grow in the given amount of time, and the better the site is for that species. A poor site for one species may be adequate for another. In New England, a site index of 45 or lower is poor, 55 to 65 is average, and 80 is excellent.

Tolerance

Shade tolerance, a species' ability to thrive and prosper depending on the amount of available light and competition from others, influences what will regenerate.

Sugar maple, American beech, red spruce, hemlock, and balsam fir are shade-tolerant. They can survive under heavy shade, including shade from the species itself, although growth is usually more rapid in the open.

White ash, red oak, white pine, and yellow birch are intermediate and can survive under partial shade or in small openings. Red maple is intermediate to tolerant.

Paper birch and aspen are shade-intolerant and survive best with full sunlight. They are called pioneer or early successional species, because often they are the first to inhabit openings after a disturbance.

In the absence of advanced regeneration, tree tolerance provides guidance as to which species may regenerate from a given harvest technique.

2.3: Regeneration Methods

Advanced Regeneration

Seedlings or saplings established naturally without the influence of harvesting under a forest canopy are called advanced regeneration. Often it will determine what species will regenerate.

Some hardwoods such as beech and red maple are aggressive as advanced regeneration on certain sites. When crushed during timber harvesting, they sprout profusely. Other hardwoods aren't as aggressive and may sprout from small stumps but their survival and future in the stand is less certain.

Other species including most softwoods, may be persistent as advanced regeneration but may be eliminated from a stand from crushing if harvesting practices don't protect them. Most softwoods don't sprout. If advanced regeneration is destroyed during a timber harvest, new stems must start over from seed. Many softwood species are slow starters, giving hardwoods a head start.

Lack of advanced regeneration may provide opportunities to establish desired species suitable to the site. Measures may be taken to establish the desired species as advanced regeneration, or harvest practices may encourage regeneration at the time of harvest.

Seed Source

During all phases of management, it's important to maintain or increase a source of seed for the several species of most interest. The best seed producers are sawlog-sized trees with well-developed crowns. However, there is great variation among individual trees and seed crops vary greatly from year to year. If the desired species aren't present as advanced regeneration, harvest during the fall or winter of a good seed year. Most seeds fall within a couple hundred feet of the seed tree, but some seeds, notably red and white oak, may be moved (and eaten) by birds and small mammals such as squirrels. Both red and white oak are heavily consumed by wildlife.

Seeding Characteristics of Selected Trees

Species	Seeding Interval (good years)	Other Seeding Characteristics
Birches	1-2	wide dispersal on snow
Sugar maple	3-7	
Red maple	1-2	
Beech	2-5	occasional animal dispersal
White ash	2-5	most germination second year after dispersal
Red oak	3-5	two years to mature; look closely for small one-year acorns
White oak	3-5	one year to develop
White pine	3-10	two years to mature; look for one-year cones
Red spruce	3-8	
Eastern hemlock	2-4	

Regeneration Harvest Methods

Knowing landowner objectives, site capability, advanced regeneration and seed sources helps to choose an optimum regeneration harvest method. Regeneration practices are applied in even-aged stands at the end of the rotation when the stand is mature and ready for final harvest. In uneven-aged stands, regeneration takes place after every harvest cut. The methods described below cover a wide range of disturbance levels, some approximating natural disturbances:

Single tree selection

- Removes about ¼ to ⅓ of the trees singly or in small groups, leaving a range of tree sizes—roughly one-third to half the basal area in sawlog and the remainder in poletimber.
- Encourages tolerant species such as beech, sugar maple (on good sites), red maple, red spruce, balsam fir, and hemlock.
- Produces or perpetuates an uneven-aged stand (three or more age classes). If the tolerant understory that develops is undesirable (e.g. beech), choose a different system such as groups, patches or clearcuts.

Group selection

- Creates openings of ¼ to 2 acres centered on clumps of mature or defective trees.
- Regenerates intermediate shade-tolerant species such as white ash, yellow birch, red oak, and white pine.
- Harvested in larger groups (> ⅔ acre), it promotes aspen and paper birch.
- Produces a patchy, uneven-aged stand.
- Produces consistent timber flow when harvested in groups the equivalent of about 1 percent of the stand for each year between harvests. For example, for a 10-year entry period, about 10 percent of the stand is harvested in groups, as well as some trees between groups.
- Works well for stands with patches of large trees intermixed with patches of immature trees.

Shelterwood

- A flexible system ranging from high-density shelterwoods (removing about ⅓ of the basal area) to encourage tolerant regeneration to low-density shelterwoods (removing about ⅔ of the basal area) to encourage intermediate and some intolerant-species regeneration.
- A standard shelterwood harvest is followed by a removal harvest of the remaining overstory trees in 5 to10 years, producing an even-aged stand.
- In a deferred shelterwood, the overstory is left in place for perhaps several decades, resulting in a two-aged stand.

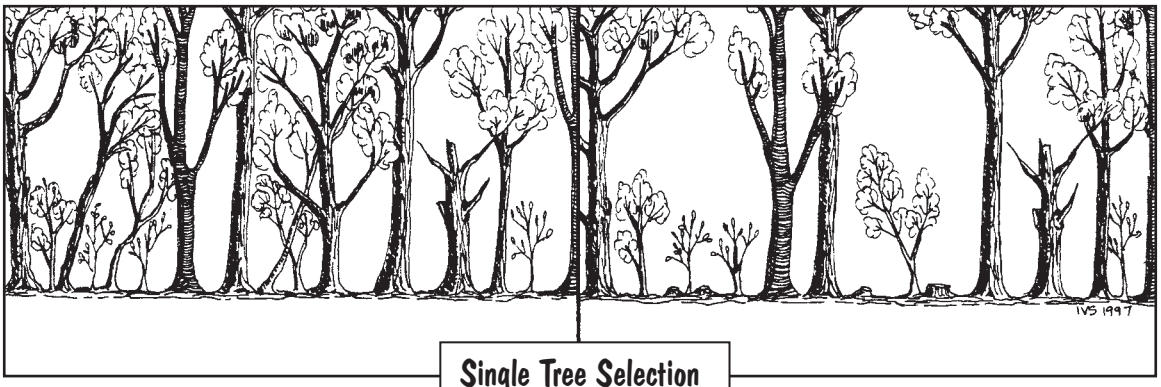
Clearcut

- Removes all trees (above 2 inches DBH). If necessary, unmerchantable stems may be removed by a followup noncommercial operation.
- Commonly about 5 acres or larger. Smaller openings (2 to 5 acres) are often called patch cuts.
- Results in early successional (intolerant) regeneration including paper birch, aspen, pin cherry, and *Rubus* species together with intermediate and tolerant species.
- Useful in mature, overmature, and defective stands and stands subject to windthrow, or to produce early successional wildlife habitat.
- Not generally effective for softwood regeneration unless advanced regeneration is present (sometimes called a natural shelterwood or overstory removal).
- The retention of uncut groups of trees can improve the appearance and provide diversity.

Strip cut

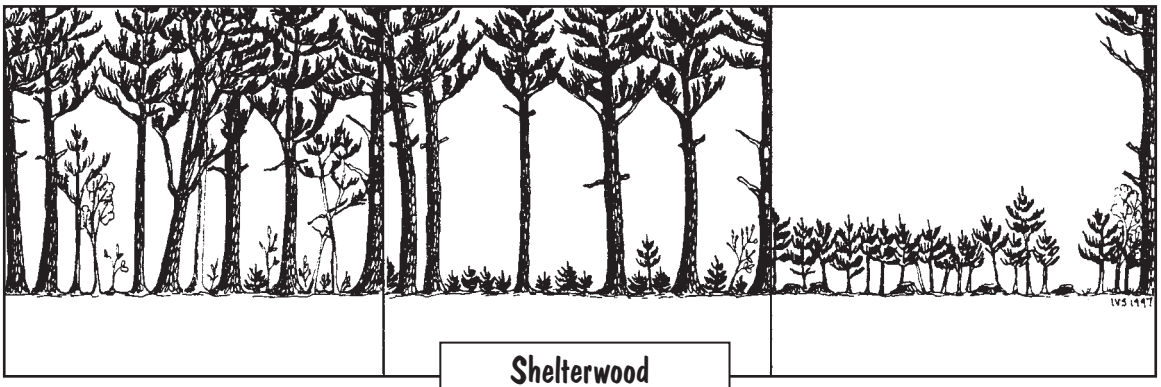
- All trees are removed in strips ranging from perhaps 25 to 100 feet wide.
- A progressive strip cutting leaves three to four uncut strips, which are harvested at intervals over a rotation.

Regeneration Harvest Methods

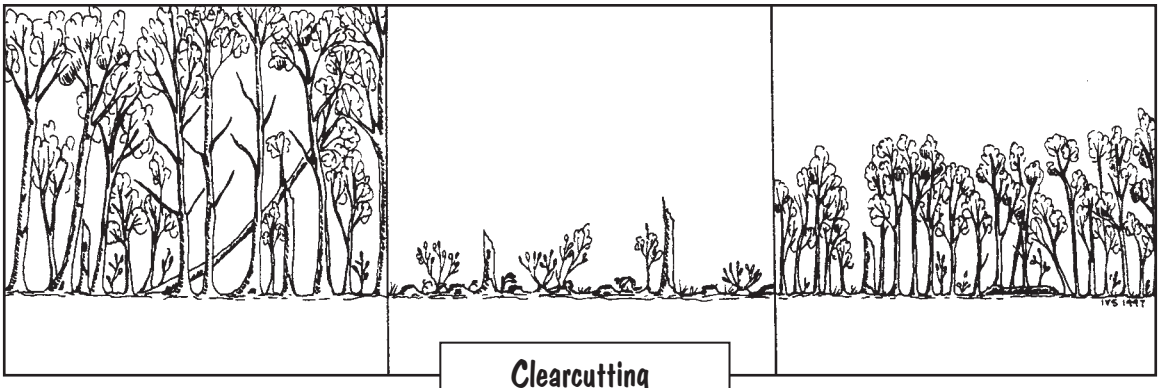


Single Tree Selection

Group Selection



Shelterwood



Clearcutting

- Strip cutting (especially without snow cover) provides maximum ground disturbance and is useful for removing unwanted advance regeneration or other undesirable vegetation.
- A strip shelterwood consists of a clearcut strip and an adjacent strip harvested by shelterwood methods. During the next entry the shelterwood strip is harvested by overstory removal and another adjacent strip is shelterwood-harvested, etc., until the cycle is complete and ready to be repeated.

Overstory removal

- Removal of the larger overstory trees to release advanced regeneration—removing overstory trees in the absence of advanced regeneration isn't truly an overstory removal.

Natural disturbance and natural process silviculture

- Natural disturbance silviculture approximates natural disturbances from windthrow, disease, and natural mortality. Trees are harvested, sometimes in small groups, when they approach biological maturity and begin to decline. The system resembles small group or individual tree selection and creates an abundance of large, old trees, dead woody material, and shade-tolerant regeneration.
- Natural process silviculture is concerned with maintaining ecological processes: natural succession, nutrient cycling, woody-material production, forest-floor maintenance and development, multiple-age and size-classes development, and minimal aesthetic impacts.

Practices Not Recommended

- Diameter limit removes all trees above a fixed diameter. It is considered a poor practice unless accompanied by precautions such as varying the diameter limit by species, removing poor growing stock, releasing acceptable regeneration, and controlling residual basal area.
- High grading removes the most valuable trees, usually the largest. It causes a progressive decline in stand value.
- Liquidation completely removes all merchantable trees, usually without measures to protect the site or provide for future harvests. It may be associated with a land-use change.

OBJECTIVE

Select a harvest practice that regenerates desired species rapidly and economically, consistent with landowner objectives and site capability.

CONSIDERATIONS

- Natural regeneration in New Hampshire is prolific due to favorable conditions of climate, soil, and native species. Natural regeneration is usually the best option, although seeding or planting may be useful to meet certain objectives.
- Predation and browsing may impact regeneration success or necessitate revision of the management objective or harvest method. Examples include predation on acorns and other seeds from small mammals, deer, turkeys, and insects; browsing from moose, deer, and rabbits; and defoliation of understory white pine by gypsy moth.
- The success of regeneration practices can be clearly evaluated only 5 to 10 years after the regeneration is well established. There are no hard-and-fast rules that will result in successful regeneration of the desired species every time.
- Some common trees and shrubs may out-compete more valuable commercial trees. Hobblebush, striped maple, ferns, and beech-sucker growth are common, competitive, noncommercial species.

RECOMMENDED PRACTICES

- ✓ Determine the species to regenerate, based on landowner objectives, site capability, the presence or absence of advanced regeneration, and biological and economic risks.
- ✓ Choose a regeneration method based on the general guidelines below:

Species	Harvest Method
Beech, sugar maple, red spruce*, balsam fir*, hemlock*	Single tree/small group selection (< ¼ acre) or narrow strips (< 50 feet wide)
White ash, yellow birch, red oak, white pine	Group selection (¼-2 acres) or medium strips (50-100 feet wide)
Aspen, paper birch	Group selection (> ⅔-2 acres) or medium strips (50-100 feet wide)
Red oak, white pine, red spruce, balsam fir, hemlock	Shelterwood (natural or planned)**
Aspen, paper birch, yellow birch	Clearcut or wide strips (> 100 feet)

** On wet and shallow soils, windthrow can be a problem if using single tree selection.*
***A natural shelterwood is a removal cut where advanced regeneration is present.*

- ✓ Plan for the following special features when regenerating the species listed below:

Species	Special Feature
Red oak, white pine, red spruce, hemlock, balsam fir, sugar maple	Advanced regeneration important
Red oak, white pine	Important to bury the seed through harvesting activity or site preparation
Aspen, beech	Sprout from roots of trees present in the stand
Red maple, red oak	Prolific sprouters from stumps of poletimber or small sawlog trees
Sugar maple, red oak, red maple, yellow birch	Browsed heavily by deer
Paper birch, aspen	Short-lived species that typify early succession with pin cherry and *Rubus* sp.

- ✓ Regenerate oak on better sites by encouraging small stump-sprouts by fall and winter harvesting or shelterwood cutting during the fall and winter of a good seed year (coupled with special treatment to bury the seed).
- ✓ Reduce unwanted shade-tolerant advanced regeneration through groups, clearcuts and heavy harvesting to convert the stand to earlier-successional species.
- ✓ Where there is an undesirable understory of beech or other species, harvest in snow-free seasons to reduce the understory and provide a scarified seedbed.
- ✓ Where there is a minimal undesirable understory with overstory beech, harvest in the winter to minimize beech-suckering, unless scarification is required for regeneration of desired species.
- ✓ Reserve clean beech trees that show resistance to beech bark disease. Lightly harvest nearby to encourage resistant root suckers.

- ✓ Regenerate hemlock by releasing patches of advanced regeneration in the winter. To encourage advanced regeneration, apply very light harvests coupled with ground disturbance during late fall of a good seed year.
- ✓ In areas subject to heavy deer browsing (over 10 to 15 deer per square mile), use larger patches or clearcuts or regenerate species such as black birch or softwoods, or spot-plant with spruce or white pine.
- ✓ Invasives (e.g. European buckthorn) may almost completely inhibit desired regeneration, especially in areas with intense deer browsing. Try patch or clearcuts, making sure there are adequate nearby seed sources, or obtain professional advice on chemical control.
- ✓ Evaluate advanced regeneration by recording the species of the dominant (tallest) seedlings and saplings in a series of small circular plots about 3.7 feet radius (1/1000 acre). Advanced regeneration is adequate if 50 percent of the plots are stocked. Percent of stocked plots by species approximates predicted species composition following harvest.
- ✓ Retain snags and patches of mature live trees for wildlife habitat.
- ✓ Consider the aesthetic impact of the proposed harvest using the visual quality protection techniques described in 3.2 Logging Aesthetics.
- ✓ When clearcutting, give consideration to the landscape in which the cut occurs as part of an overall forest management strategy to maintain a sustainable balance of forest structures, age classes, and habitats across the landscape. Separate clearcuts by a manageable stand of at least the width of the area being harvested. Avoid the following areas:
  - Slopes > 35%.
  - Thin organic soils on top of bedrock ("duff soils") and soils classified in NRCS soil surveys as having severe erosion hazard.
  - Riparian management zones—except for specific wildlife management purposes.
  - In or around seeps, or vernal pools.
  - In highly visible or aesthetically sensitive areas.

CROSS REFERENCES

2.2 Forest Structure; 2.4 Managing for High-Quality Trees; 3.1 Timber Harvesting Systems; 3.2 Logging Aesthetics; 3.5 Soil Productivity; 4.1 Water Quality; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 5.4 Logging Damage; 6.1 Mast; 6.2 Cavity Trees, Dens and Snags; 6.3 Dead and Down Woody Material; 6.7 Aspen Management; 7.2 Seeps; 7.3 Vernal Pools; Appendix: Important Forest Soils Group.

ADDITIONAL INFORMATION

Beattie, M., C. Thompson, and L. Levine. 1993. *Working with Your Woodland: A Landowner's Guide (2nd ed.)*. University of New England Press, Hanover, N.H. 279 pp.

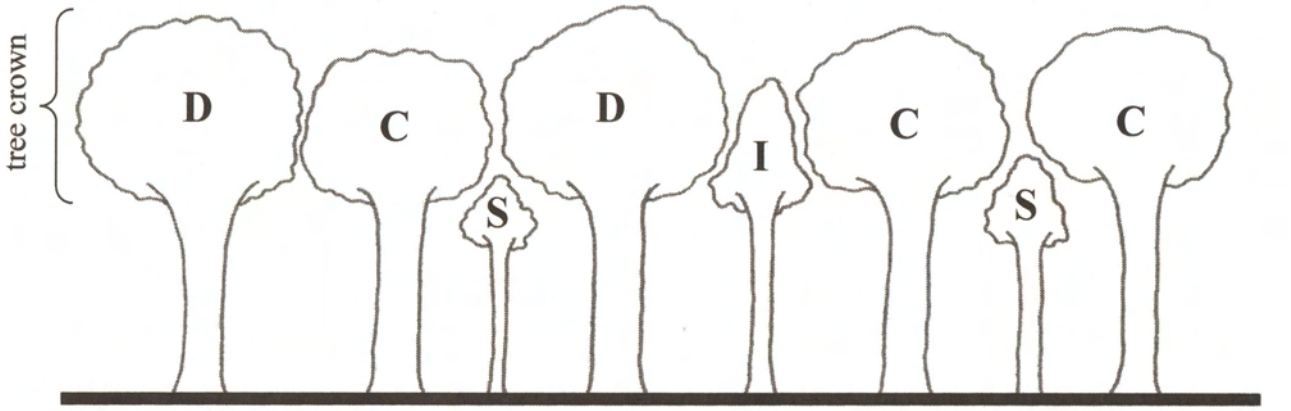
Bennett, K.P., and K. Desmarais (eds.). 2003. *Managing white pine in a new millennium: 2003 workshop proceedings*. UNH Cooperative Extension, Durham, N.H. 78 p.

Ward, J.S., T.E. Worthley, P.J. Smallidge and K.P. Bennett. 2006. *Northeastern Forest Regeneration Handbook: A Guide for Forest Owners, Harvesting Practitioners, and Public Officials*. USDA For. Serv. NA—State and Private Forestry, NA-TP-03-06. 66 p.

2.4 MANAGING FOR HIGH-VALUE TREES

BACKGROUND

Quality timber trees are important to the region's wood products industry.
Quality is determined by tree size and the amount of clear, knot-free lumber the tree produces. Both are heavily influenced by the density of the stand. Stand density also affects tree growth. When the density is too high, tree growth will slow. When density is too low, individual trees may grow quickly, but growth per acre diminishes because there are too few trees. There may be problems with excessive branching because low stand density interferes with natural pruning. Excessive branching results in reduced lumber quality. Pruning excess branches is expensive but can increase timber quality.



Tree crown position as it relates to dominance in a forest stand. D=Dominant, C=Codominant, I=Intermediate, S=Suppressed
(by M. Tarr adapted from Smith 1986)

Stand Development: Tree diameter isn't always correlated with age.
Many forest stands are even-aged because they developed following major disturbances such as agricultural abandonment or clearcutting. Although many stands contain trees of different diameters, most overstory trees are in fact the same age. Diameter isn't always correlated with age.

Trees are grouped into four crown classes: dominant, codominant, intermediate and suppressed. Dominant and codominant trees are the largest trees and form the main canopy of a stand. Dominant and codominant trees have larger crowns and grew faster than their neighbors. Intermediate and suppressed trees are the smallest trees and generally are overtopped by dominant and codominant trees. They have much smaller crowns than dominant and codominant trees.

Trees with the largest crowns are the fastest-growing and healthiest trees. In many stands, a 16-inch diameter tree and a 10-inch diameter tree of the same species are the same age. To improve the timber quality and growth of an even-aged stand, focus on removing the weak competitors (intermediate and suppressed trees) and leaving the well-formed strong competitors (codominant and dominant). In an even-aged stand don't remove the large trees to favor the small trees.

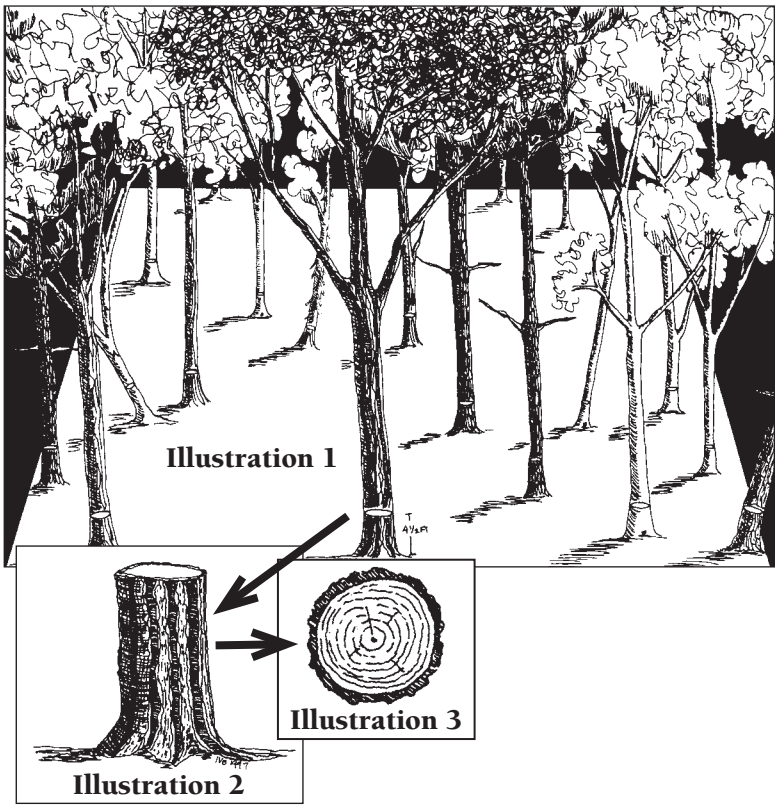
Stand Density

Stand density, or crowding, is based on tree size (diameter), the number of trees per acre, and how close together they are growing. Stand density is calculated in terms of basal area. Basal area is a measure of the area of the cross-section of tree diameter at breast height (DBH).

Basal area is usually expressed in square feet. To picture basal area, imagine that all the trees in a stand were cut off at 4.5 feet above the ground (illustration 1). The area of the top surface of the stump

(illustration 2) is measured to determine the basal area of that tree (illustration 3). If the basal areas of all trees on an acre are added together, the result is square feet of basal area per acre. It takes several small trees to equal the basal area of a large tree. For example, the basal area of four 6-inch DBH trees equals the basal area of one 12-inch DBH tree.

Adjust a stand's density by cutting some trees and removing them for firewood (or some other use) or by girdling (cutting into the cambium in a complete ring around the tree) and letting them die in place. Different standards apply to even-aged and uneven-aged management. Thinning is the silvicultural tool most often applied to improve timber quality and growth. When done before the trees are ready to harvest, it is called precommercial.



Precommercial Treatments

Precommercial treatments, also known as timber stand improvement, refers to a variety of noncommercial practices that improve growth, value and regeneration of desired species. Focus timber stand improvement activities on the better growing sites—soils with a site index of 60 or higher for the desired species (see 2.3 Regeneration Methods for a discussion of site index). Stands with shallow-to-bedrock soils or excessively wet soils are less of a priority. The poorer growing conditions increase the probability of the trees being in poor form or declining health. Stands dominated by one species, such as oak or white pine, benefit more from precommercial thinning than mixed-species stands. For stands dominated by a single species, start releasing the crop trees when they reach 5 to 8 inches DBH. Releasing involves removing the less desirable trees whose crowns overtop or otherwise touch the crowns of the crop trees. The goal is to give more sun to the crop trees' crowns. The sooner released, the faster they will grow in diameter.

Weeding controls the species composition by cutting or girdling unwanted species and favoring desired ones. Weeding is usually most needed in mixed stands of conifers and hardwoods when conifers are the crop trees. Release conifers by weeding out overtopping hardwood in sapling stands (1 to 4 inches DBH and 10 to 20 feet tall). Bring the upper crowns of valuable stems into full sunlight. Stands remaining after treatment should be dense enough to assure self-pruning of lower limbs, straightness of stem, and protection against snow and ice damage.

Financial benefits of timber stand improvement are questionable especially if the costs per acre are too high. Often the increased growth provided by releasing a crop tree at a young age is offset by the cost that is carried (and compounded) for decades. Generally, releasing fewer crop trees per acre and having a commercial harvest as soon as possible helps maximize the return.

Crop Tree Management

Crop tree management is a thinning technique where high-quality trees with vigorous crowns are identified as crop trees and competing trees are cut to release their crown. It encourages the fastest growing, highest quality trees to have as large a crown as possible by allowing increased amount of sun on

the crown. The larger the crown, the faster the tree will grow in diameter. Focus crop tree release on those trees that are most likely to increase in volume and value.

A crown thinning releases one to four sides of the crop tree from trees that touch its crown. A crown thinning should provide 5 to 10 feet of free growing space for the crown of the crop tree by removing competing trees. When two crop trees grow in close proximity, treat them as one tree and remove all trees whose crowns touch those of the two crop trees.

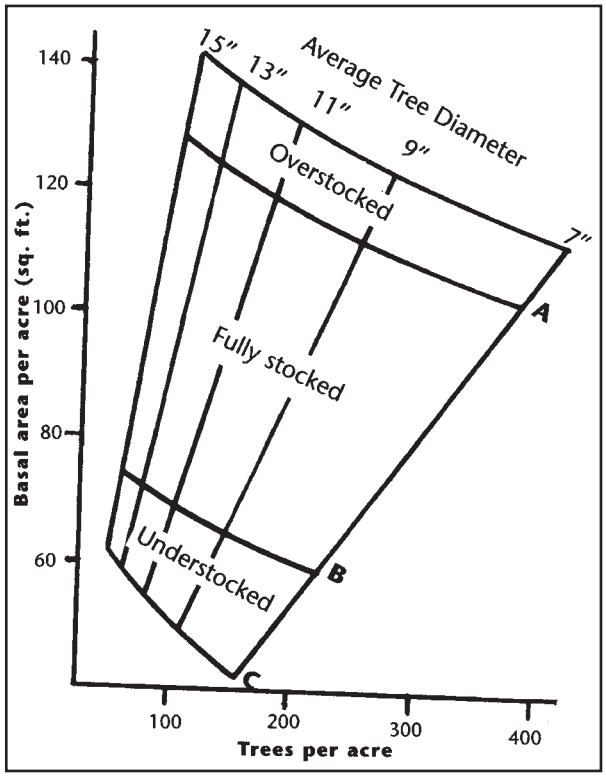
Timber crop trees have the following characteristics:

- Dominant and codominant trees at least 25 feet tall.
- Healthy, vigorous crown.
- High-quality butt-log potential.
- No epicormic branches (sprouts).
- No high-risk trees such as splitting forks or leaners.
- High-value commercial species (red oak, sugar maple, yellow birch, black birch, black cherry, white pine, red maple, white ash and red spruce).
- Expected longevity of at least 20 years.
- Species well-adapted to the site (see table in 2.3 Regeneration Methods for site requirements by tree species).

Fully releasing the crown of a crop tree increases the possibility for epicormic branching, which lowers its timber quality. Practicing crop tree management only on the best growing sites limits epicormic branching. Black cherry and red oak have strong epicormic branching tendencies; red maple has moderate tendencies; white ash and yellow birch low; and sugar maple has low tendencies on good sites.

Even-aged Management

When a forest stand is managed for one distinct age class, it is termed even-aged management. These stands are regenerated by clearcut, shelterwood, or seed tree cutting methods. Two-aged stands result when larger trees are left temporarily to aid regeneration or for goals other than regeneration (e.g., for wildlife). Two-aged methods regenerate and maintain stands with two age classes for a longer time period, even after regeneration is established. Two-aged management is included as an even-aged technique in this and other references.



The best density for even-aged stands is reflected in stocking guides (also called stocking charts). These guides help the timber manager determine if the forest is stocked too heavily with trees (overstocked), too lightly (understocked), or adequately (fully stocked).

Stocking guides provide at least two reference lines, an A-line and a B-line. In general, the A-line shows the upper density limit of a naturally developing uncut forest stand, although some stands do become more dense. The B-line estimates the best density for sawtimber growth in the stand. If the stand's density is

higher than the B-line, the stand is too crowded and diameter growth will be slow. If density is lower than the B-line the stand is understocked, resulting in lower timber growth per acre and potentially excessive branchiness, resulting in knots in the timber.

When density has increased to halfway between the A-line and the B-line, foresters generally reduce the stand's density to the B-line level. This typically permits a commercial harvest and increases diameter growth. The trees removed are often the poorest quality, so the growth is concentrated on the best quality trees (crop trees). Crop trees may be chosen on the basis of commercial value, aesthetic quality, or their contribution to desired wildlife habitat. Since crop trees are the most capable of achieving the desired goals, use extra consideration when deciding the spacing around these trees and how much light they receive.

Uneven-aged Management

In uneven-aged management, forest stands are managed for three or more age classes. This technique simultaneously provides for regeneration, thinning competing trees, and harvesting mature timber.

All diameter classes are in the stand. Since the relative proportions of the diameter classes to each other are the same, there is generally one best density range after the harvest. Foresters mark the trees to be cut in the stand to achieve a desired distribution of diameter classes. Diameter classes are used because age is difficult to determine in standing trees. Harvests can be considered when the basal area is at least 30 square feet above the desired distribution (See Recommended Practices for specifics).

OBJECTIVE

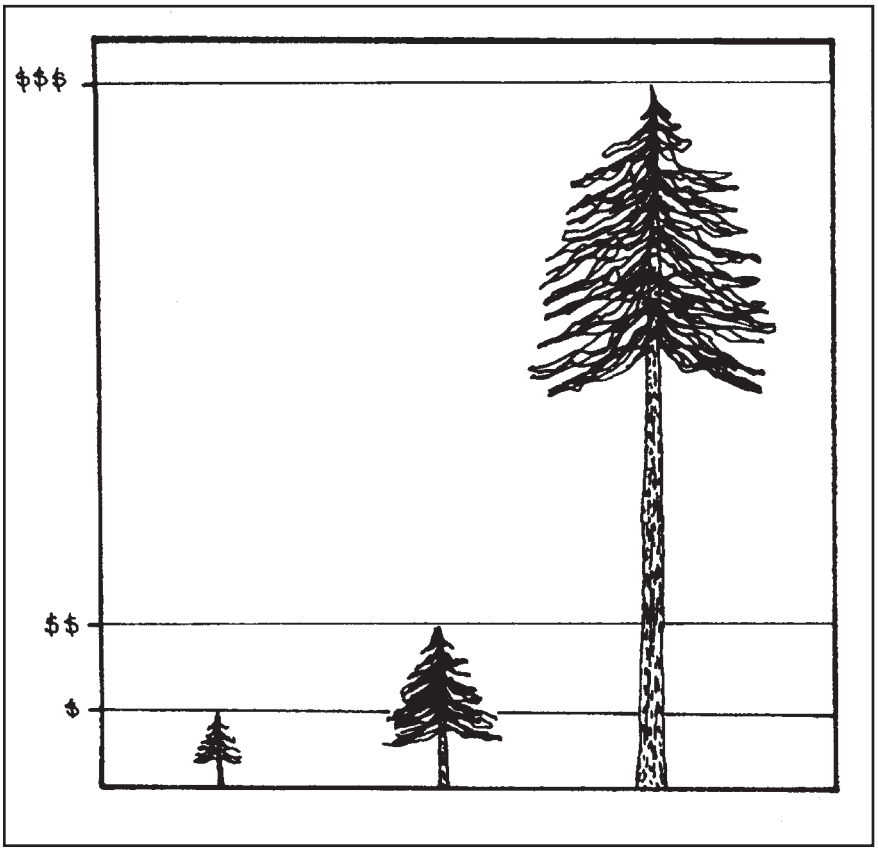
Control the growth and quality of forest stands through maintenance of optimum stand densities.

CONSIDERATIONS

- Providing a sustainable flow of timber depends on maintaining density and stand structure, and providing for regeneration.
- Thinning is the silvicultural tool most often applied to improve timber quality and growth of a stand.
- Young stands, where most of the trees to be removed won't produce commercial products, may require noncommercial treatments. These stands may qualify for federal financial assistance. Pruning also may qualify.
- Markets for timber are variable, especially over the span of a couple of decades. What is a low-value species today could become a high-value species in 20 years. Maintaining a diversity of tree species with good form and vigorous crowns will help lessen the impacts of our limitations in predicting future timber markets.
- The following conditions affect the optimum residual basal areas in uneven-aged stands:
  - The time between harvests (the cutting cycle, which ranges from 10 to 25 years). When the cutting cycle is short, the density of the remaining forest stand should be on the high end of the suggested density range because of the shorter growing period until the next harvest. When the cutting cycle is long, the density of the remaining forest stand after cutting should be on the low end of the suggested range. This accommodates the longer period of growth available and prevents overcrowding within the stand toward the end of the cutting cycle.

- Occasionally the stand density must be decreased to the lower ranges of the suggested density to accommodate harvesting trees that would otherwise die or deteriorate. There are many causes for this such as insect attack, diseases, ice damage, drought stress, or an uneven distribution of age classes.

- A dramatic jump in value usually occurs as a tree grows into the sawlog class (greater than 8 to10 inches DBH for softwood and greater than 10 to 12 inches DBH for hardwoods). An even greater jump in value may occur as a tree grows past the 10 to 18 inch DBH classes. The difference in value between a 12-inch DBH sawlog-grade tree and an 18-inch veneer-grade tree can be 400 percent to 500 percent.



- The overall quality of a stand being considered for uneven-aged management may be so low (less than 40 square feet per acre of high-quality trees in hardwoods and 60 square feet per acre of high-quality trees in softwoods and mixed-woods), that even-aged management may be a better option.
- Growing high-quality trees can't be accomplished through high grading (removal of the best trees) or liquidation (removal of all merchantable trees). Diameter-limit cuts also aren't preferred. If used, they should be based on an inventory and use different diameter limits by species to qualify as a quality-sustaining practice.

- Stand density varies by the species mix:

Stocking Table for Hardwood, Mixed-Wood and Softwood

Mean DBH (inches)	Hardwood A-line (sq. ft./acre)	Hardwood B-line (sq. ft./acre)	Mixed-Wood A-line (sq. ft./acre)	Mixed-Wood B-line (sq. ft./acre)	Softwood A-line (sq. ft./acre)	Softwood B-line (sq. ft./acre)
4	90	54	100	81	114	100
8	117	61	155	101	199	125
12	122	63	173	106	230	137
16	125	64	180	108	240	141

Hardwood = less than 25% softwood.
Mixed-wood = 25% to 65% softwood.
Softwood = greater than 65% softwood.

Stocking Tables for White Pine and Spruce/Fir/Hemlock

Mean DBH (inches)	White Pine A-line (square feet / acre)	White Pine B-line (square feet / acre)	Spruce / Fir / Hemlock A-line (square feet / acre)	Spruce / Fir / Hemlock B-line (square feet / acre)
8	240	90	205	110
12	255	100	270	150
16	285	150		

- Another approach to managing for high-value, fast-growing pine is called low-density white pine management. Low-density management grows fewer crop trees per acre than traditional stocking guides suggest. The goal of this technique is to grow a high-quality butt log free of knots in the shortest time possible. To achieve this goal white pine crop trees (100 or fewer per acre) are heavily released and pruned to a height of 1½ logs (a log is 16 feet long). Recommended residual stocking densities are well below the C-line on traditional white pine stocking guides.

RECOMMENDED PRACTICES

Even-aged Management

✓ Measure the basal area and average stand diameter of the overstory trees only. Leave out the trees that are in the understory and are completely overtopped by other tree crowns.

✓ Follow the density guidelines in the stocking table. Thin when the density is halfway between A and B, or higher.

Example: A mixed-wood stand is determined to have an average stand diameter of 8 inches and a basal area of 135 square feet per acre. Locate the average diameter in the first column and follow that row across to the mixed-wood category. Half the distance between the A-line and the B-line would be:

(155 + 101) ÷ 2 = 128 square feet per acre.

The basal area of the stand presently (135 square feet per acre) is greater than half the distance between the A-line and the B-line.

Uneven-aged Management

- ✓ Measure the basal area of all trees down to 4.5 to 5.0 inches in DBH. (Since uneven-aged stands have a range of tree size, average stand diameter isn't used as a guide.)
- ✓ Use the following optimum ranges. Schedule a harvest when the basal area exceeds the desired residual basal area by about 30 square feet.

Stand Type	Residual Basal Area (sq.ft./acre)
Hardwood	70-80
Mixed-wood	70*-100
Softwood	70*-120

** The lower end of the range is based on spruce-fir and applies to longer cutting cycles. The suggested minimum residual basal area is higher for white pine. The higher end of the range will maximize growth.*

Precommercial Treatments

- ✓ Protect crop trees susceptible to epicormic sprouting (most hardwoods) from receiving too much light on their trunks. For those trees not prone to epicormic sprouting and growing on good sites, release on at least three sides of its crown to increase diameter growth. Check with your UNH Cooperative Extension county forester to see if financial assistance is available.
- ✓ Follow the following guidelines when pruning:
  - Prune pole-sized crop trees (4 to 6 inches in DBH and never larger than 10 inches).
  - Limit the number of crop trees pruned per acre to those that can be carried to full maturity and add enough growth of clear, knot-free wood to justify the pruning investment. Prune no more than 100 softwood and no more than 50 to 75 hardwood crop trees per acre.
  - Pruning should follow, rather than precede, thinning. Keep damage to crop trees at an absolute minimum during harvests.
  - Document when and where pruning occurred.

CROSS REFERENCES

2.2 Forest Structure; 2.3 Regeneration Methods; 5.4 Logging Damage.

ADDITIONAL INFORMATION

Beattie, M., C. Thompson, and L. Levine. 1993. *Working with Your Woodland: A Landowner's Guide (2nd ed.)*. University Press of New England, Hanover, N.H. 279 p.

Perkey, A.W., and B.L. Wilkins. 1993. *Crop Tree Management in Eastern Hardwoods*. USDA For. Serv. NA—State and Private Forestry. NA-TP-19-93. 6 p.

Perkey, A.W., and B.L. Wilkins. 2001. *Crop Tree Field Guide: Selecting and Managing Crop Trees in the Central Appalachians*. USDA For. Serv. NA—State and Private Forestry. NA-TP-10-01. 140 p.

TIMBER HARVESTING

TOPICS IN THIS SECTION

ADDITIONAL READING

A Guide to Logging Aesthetics:
Practical Tips for Loggers, Foresters, and Landowners
Geoffrey T. Jones
Natural Resource, Agriculture, and Engineering Service, and
Society for the Protection of New Hampshire Forests
1993

3.1 TIMBER HARVESTING SYSTEMS

BACKGROUND

Choosing the most appropriate timber harvesting system can meet management objectives and minimize environmental impact.

A timber harvesting system is one of several combinations of equipment used for felling and extracting timber. Every system requires (1) a mechanism for felling trees and (2) a mechanism for removing felled trees or portions of felled trees to a roadside log landing for transportation to a mill. Matching the equipment to the site, implementing proper harvest layout, and hiring a skilled operator all contribute to successful logging. A licensed forester and a certified logger can help choose the right system. Landowners choosing to harvest timber on their own must decide if they have the time, skill, equipment, and knowledge to do so or if they wish to contract the services.

OBJECTIVE

Select a timber harvesting system appropriate to the site and landowner objectives.

CONSIDERATIONS

- Financial return is often a factor when considering which harvesting system to use. Costs associated with different logging methods vary and may affect the income received.
- Time of year can influence equipment choice. Frozen winter conditions may be suitable to almost any system, while a summer or fall harvest may limit use of some equipment, particularly on sites with wet soils.
- Ground conditions such as wet sites, rocky terrain, or steep slopes may limit use of the equipment.
- The size of the harvest area, tree density, and the size and value of the timber may limit the practicality of using some harvest systems. Equipment should be able to fell and move timber efficiently to the landing. Equipment that is too small may struggle handling large timber and damage the remaining trees. Skidding distances longer than half a mile may limit the feasibility of some equipment. Using equipment that is too large may result in higher levels of residual damage in tight stands of small timber. It may be inefficient to use large machines on lots smaller than 10 acres.
- The quality and quantity of the timber and the expected products help determine the feasibility of a method. Are there more high-quality sawlogs or more pulpwood? Will the tops be chipped? In a woodlot growing small, scattered, low-value trees, the cost of logging may be higher than the financial return. The ability to sort for multiple markets depends on the right mix of equipment, as well as the experience and skill of the operator.
- Systems using the entire tree may result in an aesthetically pleasing appearance and may be desirable on highly visible sites.
- Layout of truck roads, landings and skid trails affects efficiency and differs for each harvesting system. Long skidding distances and limited landing size may also limit the choice of equipment. Mechanized systems tend towards high production, covering more ground more quickly than conventional systems, making presale layout and sale supervision important.

- Operator skill plays the greatest role in determining success, regardless of the equipment chosen. A skilled operator reduces equipment impact, while an inexperienced one can do damage in a short time.
- The environmental sensitivity of a woodlot may dictate which logging equipment is most suitable. Crossing wetlands, logging near cultural artifacts and threatened and endangered plants, scarifying soil to promote regeneration, or minimizing disturbance to advanced regeneration may be some of the factors to consider. Implementing best management practices (BMPs), silvicultural prescriptions, and job layout for the equipment, then carefully closing out the sale will go a long way to achieving a successful timber harvest.
- Safety is integral to all decision-making including who operates in the woodlot, what equipment they bring, and what steps they take to ensure safe operating procedures. Some equipment provides a much greater level of safety and control, allowing work to be conducted in hazardous conditions. Operators must take responsibility for ensuring that everyone in and around the logging operation is safe at all times.

Commonly Used Timber Harvesting Systems

The following descriptions represent commonly used systems (but don't represent every possible combination).

- Conventional logging—uses a chainsaw and cable skidder.
- Mechanized logging—uses a feller-buncher, grapple skidder or other auxiliary equipment such as a loader, delimber, slasher, and chipper. Whole-tree (biomass) harvesting is a form of mechanized logging that typically adds a chipper for processing whole trees into chips at the landing, a loader to feed the chipper, and a trailer into which the chips are blown.
- Cut-to-length system—mechanized logging using a processor and forwarder combination.
- Other systems include draft animals, tractors, and other machines

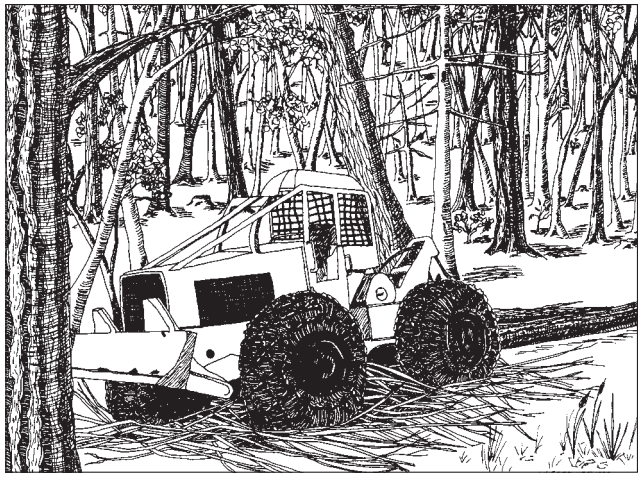
Conventional Logging

- **Felling System - Chainsaw**

  The chainsaw is the most common method for manually felling trees. A skilled chainsaw operator can fell trees directionally. Training in chainsaw use and maintenance is critical for safely felling trees.

- **Extraction System - Cable Skidder**

  A cable skidder uses a winch, cable and chokers (chain) to gather and drag a load (hitch) of trees or logs. A cable skidder allows the operator to pull the cable to the trees rather than driving the machine to each tree. This allows for flexibility on uneven terrain. The cable-skidder operator must exit the machine to attach each tree to the cable. The winch pulls the trees, butt first, to the skidder by reeling the cable over an arch. The arch raises the hitch off the ground, reducing the friction and impact to the ground during the course of the skid.



Cable Skidder

- **Pros:**
  - Allows large, valuable trees to be felled without damage.
  - Allows trees to be removed from sensitive and difficult locations.
  - Because trees are topped and limbed in the woods, reduces the size of the hitch, which in turn may reduce residual stand damage. Tops left in the woods may reduce nutrient depletion on poor sites.
  - May prove cost-effective, especially on small jobs.
- **Cons:**
  - Requires extreme physical exertion and exposure to adverse environmental conditions.
  - Leaves the chainsaw operator vulnerable to falling debris and chainsaw injury.
  - Is typically slower than a mechanized system.
  - May damage advanced regeneration more than mechanized systems.

Mechanized Logging

- **Felling System**

  Feller-bunchers

  A feller-buncher, or harvester, describes any number of machines that cut (fell) and gather and pile (bunch) trees. The machine either drives to the base of the tree or reaches to the tree with a boom (extending arm). It severs the tree, using either a circular saw or a chainsaw-type head which cuts the tree, or a shear which pinches the tree off. Shears have fallen out of favor for use in high-quality timber because they crush the tree's fiber when the tree is severed.

  After felling, trees are piled into hitches in or along skid trails for removal to the landing by a skidder. Mechanized operations tend to be whole-tree operations, which remove the entire tree from the forest for processing at the landing. This requires the support of several pieces of auxiliary equipment such as a loader, delimber, slasher and chipper. The loader moves products around the landing as trees are processed into logs and chips. The delimber removes branches, and the slasher cuts logs to length. Poor-quality stems and tops are run through the chipper to create biomass.

  3-wheeled Harvesters

  The 3-wheeled harvesters are rubber tired and highly maneuverable and designed for smaller-diameter trees. Typically configured with a fixed shear head, they work well in tight stands and on even terrain.

  4- and 6-wheeled Harvesters

  A felling machine with a fixed head mounted (typically) on a rubber-tired machine. The fixed-head harvester requires the operator to drive to the tree base to fell the tree.

  Tracked Harvester

  These tracked felling machines feature a cutting head mounted on a boom which reaches up to 20 feet. This reach aids harvesting on rough and steep terrain. The boom also allows the machine to harvest and carry large-diameter trees, as well as to direct the felling, which protects the residual stand.

- **Extraction System - Grapple Skidder**

  A grapple skidder uses a grapple to bunch, hold and drag a load of trees or logs. The operator doesn't get out of the machine to assemble a load, improving efficiency and operator safety. The grapple raises the hitch off the ground, reducing the friction and impact to the ground during the skid. Because the grapple skidder requires the operator to drive to the felled trees, some machines also have a cable with which to pull trees.

- **Pros:**
  - The feller-buncher is able to carefully cut trees and lay them down where desired, protecting advanced regeneration, residual trees, cultural resources, and sensitive sites.
  - Tracked machines may reduce soil compaction.
  - Self-leveling, track-mounted feller-bunchers aid harvesting on steep slopes.
  - Small feller-bunchers are maneuverable in tight stands.
  - Mechanized logging offers high production.
  - The operator remains in the cab of the machine.
- **Cons:**
  - May result in residual stand damage, as well as greater soil disturbance or compaction.
  - Smaller feller-bunchers may not be able to handle large trees.
  - Mechanized logging, particularly a whole-tree operation, requires larger landings and skid trails.
  - Logs may be damaged from multiple handling, improper machine adjustment, or operator inexperience.
  - Whole-tree harvesting may deplete soil nutrient levels on poor sites over time.
- **Auxiliary Harvesting Equipment**

  Delimber

  The delimber takes the limbs off of the tree either by dragging the stem horizontally through a metal frame or by passing a metal arm down the length of the stem. The delimber is also an integral part of the processing head on a cut-to-length processor.

  Slasher

  A slasher is a circular saw or chainsaw mounted on a steel frame. The stem is placed in the frame horizontally by a loader and cross-cut or bucked to length. The slasher allows for high-volume processing of stems while protecting the operator in a cab.

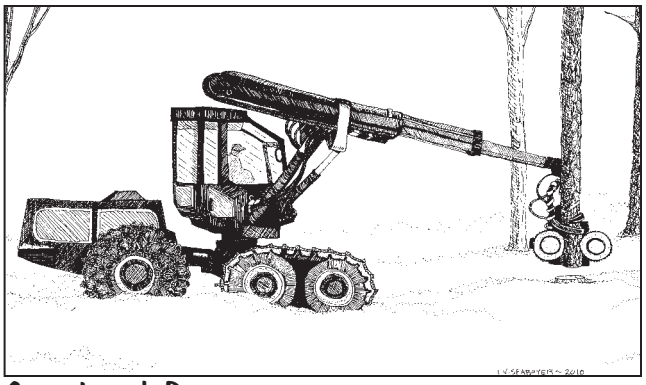
  Chipper

  The chipper used on a logging operation is capable of processing large, low-quality stems and branches into chips. The resulting whole-tree chips (biomass) are used as fuel at wood-to-energy power plants. A flail chipper (chipper which removes the bark from the stem before chipping), can produce pulp-quality (clean) chips used in paper or wood-pellet manufacturing. The bark and other flail material can be used as fuel, mulch or matting on sensitive logging areas. Chips are blown into tractor-trailer vans for transport.

Cut-to-Length System

- **Felling System - Processor**

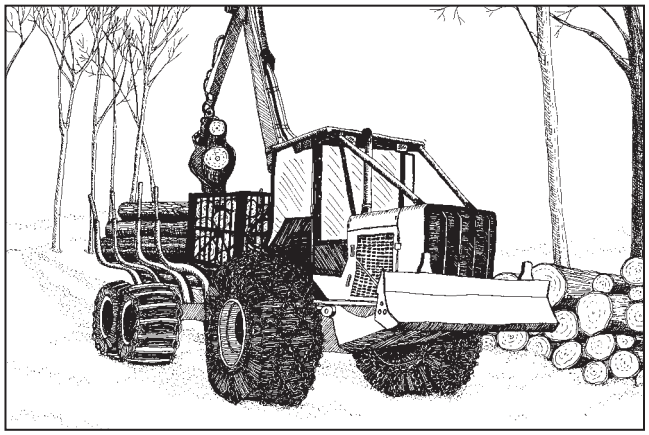
  A tracked or rubber-tired machine with a computerized cutting head used to fell, delimb, and buck (cut into smaller lengths) trees at the stump. A processor combined with a forwarder is referred to as a cut-to-length system. The cut-to-length system is often used on sensitive sites. The operator doesn't have to exit the machine to harvest and process trees. Limbs and tops are typically left in skid trails.



Cut-to-Length Processor

- **Extraction System - Forwarder**

  A self-loading machine designed to carry trees or parts of trees. The forwarder, when combined with a processor forms a cut-to-length system. The forwarder may be used in combination with a feller-buncher and/or a chainsaw. A forwarder is often preferred on sensitive sites, because it carries rather than drags the wood.



Forwarder

- **Pros:**
  - The processor head allows the operator to make decisions about the entire stem at the stump.
  - The forwarder reduces ground impact because it carries logs rather than drags them.
  - The increased surface area of the forwarder's wheels running over a mat of tree tops deposited on the trails protects the ground and distributes the weight of the loaded machine.
  - The logs may be cleaner, which some mills prefer.
  - The system allows for smaller landing sizes.
  - Processing tops and limbs in the forest may reduce nutrient depletion.
  - The operator remains in the cab of the machine.
- **Cons:**
  - A cut-to-length system is expensive.
  - The processor may have difficulty with larger trees.
  - The processor head (rollers) can damage sawlogs.
  - Hand felling and delimbing may be required, especially with larger hardwood.
  - The system isn't usually as productive as traditional mechanized logging and has a higher overhead for equipment, which may result in slightly reduced stumpage prices.

Other Skidding Systems

Horses, oxen and mules can be used to skid trees, though logging with animals is slow and not common. Operators need training and care to ensure the safety of the animals as well as the logger. Draft animal loggers have the option of drawing stems and loads on the ground or raising them with an arch, sled or forwarder. Stems or logs are often bunched on the ground by a single animal and then forwarded by a team on an arch, sled or forwarder to minimize ground disturbance and residual stand damage. Draft animal logging creates narrow skid trails and may be a feasible system for removing small volumes of high-value trees from visually sensitive areas.

Farm tractors equipped with specifically designed winches may be used to skid smaller trees. Operators must not exceed the limitations of the machine.

Other machines used to skid logs included all-terrain vehicles (ATV), bulldozers and trucks. Each machine has its benefits and limitations. Care is needed with any non-traditional logging machine to ensure the safety of the operators as well as those working in the vicinity.

RECOMMENDED PRACTICES

- ✓ Get professional help. (See below for listings of licensed foresters and certified loggers).
- ✓ Choose an experienced logger. Visit several completed harvests to see what different equipment and operators can do before making a final selection. Check references.
- ✓ Clarify expectations and objectives, and use a written contract.
- ✓ Lay out truck roads, landings and skid trails, and designate trees to cut (or leave) in advance. Tailor the layout to the harvest system selected (1) to reduce residual stand damage, soil compaction and erosion, and (2) to preserve advanced regeneration, unique species and cultural artifacts.
- ✓ Time the harvest (1) to avoid wet or poor logging conditions and conflicting uses, and (2) to optimize market conditions.
- ✓ Use BMPs for erosion control and to prevent sediment from entering streams or wetlands. You can find these guidelines in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*, published by the N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. Consult the latest version of this publication before harvesting timber.

CROSS REFERENCES

1.1 First Steps in Forest Management; 1.5 Staying Safe Working in the Woods; 2.3 Regeneration Methods; 3.2 Logging Aesthetics; 3.3 Aesthetics of Skid Trails, Truck Roads and Landings; 3.4 Harvesting in High-Use Recreation Areas; 3.5 Soil Productivity; 4.1 Water Quality; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 4.4 Stream Crossings and Habitat; 5.4 Logging Damage; 6.3 Dead and Down Woody Debris; 7.7 Steep Slopes and other chapters in the Sensitive Areas section; 8.1 Timber Products.

ADDITIONAL INFORMATION

Bennett, K. P. 2010. *Directory of Licensed Foresters Providing Service to Forest Landowners in New Hampshire*. UNH Cooperative Extension, Durham, N.H. http://extension.unh.edu/fwt/dir/index.cfm Accessed on August 2, 2010.

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

N.H. Timberland Owners Association. *Certified Loggers List*. New Hampshire Timber Harvesting Council's Professional Logger Program. http://www.nhtoa.org/ Accessed March 5, 2010.

UNH Cooperative Extension. 2001. *Safe Timber Harvesting*. http://extension.unh.edu/resources/files/Resource001062_Rep1293.pdf Accessed on January 26, 2010.

Smith, S. (ed). 2005. *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality*. UNH Cooperative Extension, Durham N.H. http://extension.unh.edu/resources/representation/Resource000248_Rep267.pdf Accessed February 8, 2010.

Smith, S. 2009. *Guide to New Hampshire Timber Harvesting Laws*. UNH Cooperative Extension, Durham, N.H. 37 p.

Virginia Tech Forestry. 2008. *Timber Harvesting (Logging) Machines and Systems*. http://www.cnr.vt.edu/harvestingsystems/index.htm Accessed March 11, 2010.

3.2 LOGGING AESTHETICS

BACKGROUND

Timber harvesting creates a temporary change in the visual quality of the forest.

By creating a variety of tree sizes and types and different opening sizes, harvesting can have a long-term positive aesthetic effect. Some short-term aesthetic concerns include woody debris (slash) on the ground, broken or bent trees, ruts, clearcuts, or a general change in the appearance of the forest. Improving the appearance of a harvest may result in trade-offs with wildlife-related recommendations, resulting in fewer habitat elements, e.g., coarse woody material on the ground or standing snags (dead and dying trees). A forest that looks "neat" may not be ecologically healthy.

In many cases, doing a lot of little things can collectively make a big difference. For example, changing the timing of forest management activities can impact how a job looks and affect recreation on a woodlot. Roads built during dry seasons are cheaper to construct and look nicer. Operating on frozen ground that has good snow cover results in less damage to the soil, ground cover, seedlings, and the residual trees, which often translates into a better-looking job. Many outdoor recreational activities take place during specific seasons of the year. Harvesting activities scheduled to avoid peak use will help to minimize potential conflicts.

Planning and adherence to some basic recommendations will balance the aesthetic outcome with achieving the long and short-term objectives of the landowner.

OBJECTIVE

Minimize the visual impacts of timber harvesting.

CONSIDERATIONS

- Following recommended practices may result in additional cost or less income.
- Bark on trees is tender and easily damaged from late spring (bud break) through mid-July.
- Many aesthetic concerns are exacerbated during wet conditions.
- When operating in heavily stocked or high-value stands, planning and logger skill are more important to the aesthetic outcome than equipment size.
- All timber harvesting produces slash.
- Slash near roads, lakes, streams, and property boundaries is subject to regulation under the slash law, RSA 227-J:10. Briefly stated, this law requires that slash be removed from within 25 feet of a property line; from within 50 feet of any great pond or body of water greater than 10 acres, or from a public highway or active railroad bed; and 100 feet of any occupied structure.
- Slash helps maintain soil on-site and protect developing seedlings from temperature extremes and overbrowsing by deer. It can benefit wildlife by creating microhabitats for small mammals, birds, and other species.
- Manual treatment of slash can be dangerous to the logger.
- Maximum use of merchantable wood conflicts with recommended practices regarding dead and down woody material.

- The branches, twigs, leaves, and needles of trees contain a higher percentage of nutrients than their trunks. On some sensitive sites, it may be more important to leave this biomass for nutrient recycling, instead of removing it.
- Slash can be a fire hazard.
- The basal area law (RSA 227-J:9) requires forested buffers along town and state roads, streams, and bodies of water following timber harvests.
- Clearcutting is a management tool used to create vistas or early successional wildlife habitat, or to regenerate specific tree species. Aesthetic considerations may conflict with these objectives.
- Clearcutting can open new or historic views.
- The visual impact of a clearcut area will vary with its size, shape, location, and time of year it is viewed.
- Clearcuts are most noticeable in the first few years following the harvest. The perceived negative aesthetics decrease as the area regenerates.

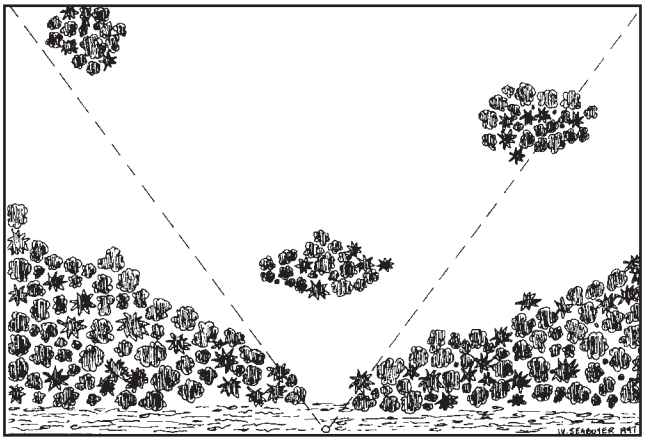
RECOMMENDED PRACTICES

- ✓ Follow local and state regulations, allowing enough time to obtain necessary permits. Adhere to the basal area law (RSA 227-J:9) and slash law (RSA 227-J:10). Refer to *Guide to New Hampshire Timber Harvesting Laws*.
- ✓ Schedule phases of a harvest with the appropriate seasons to limit costs and disturbance. Minimize the impact on sensitive sites by harvesting on dry or frozen ground. Refer to *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire* by the N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. Consult the latest version before harvesting timber.
- ✓ Minimize visual and audible impacts of forest management activities by scheduling such activities during the appropriate seasons of the year and, where recreation is a priority, during periods of lower recreational use.
- ✓ Reduce the impact of noisy equipment when operating near residential areas by modifying working hours, shutting down idling equipment, or reducing truck noise (by using lower rpm's) to and from the landing. Consider using equipment with noise-reducing features.
- ✓ Notify abutters or others who may be affected by the logging operation. Posting signs will help recreational users and others understand the reasons and timing of the harvest.
- ✓ Supervise the job on a regular basis to identify and solve problems in a timely fashion.
- ✓ Sweep mud off paved roads whenever log trucks leave muddy landings.
- ✓ Cut stumps as low to the ground as possible. Re-cut multiple stems when trees are cut high on the trunk above a crotch.
- ✓ Cut whips, leaners, bent saplings, and broken trees, particularly in visible sections of the woodlot.
- ✓ Protect the residual stand, not only for aesthetics, but also for maintaining the biological and economic health of the forest, by:
  - Designating trees for removal only if they can be felled and removed without causing excessive damage to the residual stand.
  - Marking trees (to cut or leave) with paint on two sides to enable the logger to make better choices regarding directional felling and hitch selection.
  - Matching equipment to terrain, tree size and product and other site conditions.
  - Using directional felling techniques to avoid damage to unmarked trees during felling and to position the downed tree for the skidder to reduce damage to trees from skidding.

✓ Slash

- Minimize slash consistent with the slash law, RSA 227-J:10.
- Use tree tops down to 4 inches or less in diameter, or as markets permit.
- Lop tops to a height of 2 feet or less within 50 feet of a recreational trail. It may be desirable to pull the tops back 50 feet or more before lopping. Otherwise lop tops 4 feet or less above the ground.
- In areas where the presence of slash is a visual problem, consider using mechanized operations that remove slash and low-grade wood that otherwise would be left.
- Slash can be placed and crushed in skid trails to minimize soil disturbance, but plan for the location of recreational trails before harvest layout. Avoid placing slash in trails destined for recreational use.

✓ Clearcuts



- Design clearcuts to take into account slope, topography, existing vegetation patterns, and principle viewing points. Integrate clearcuts into trail systems in a manner that allows viewing of scenic vistas and for wildlife viewing.
- In visually sensitive areas, clearcut in multiple stages.
- Leave patches (or islands) of varying sizes and shapes of trees to break up the cut area and reduce its apparent size.
- Keep openings into harvest areas narrow to limit the view from public roads, lakes and rivers, or recreation areas.
- Use the natural terrain to minimize apparent size.
- Shape clearcuts to resemble natural openings, using topography and vegetative patterns. Integrate partial harvests along roadsides and highly visible slopes.
- Avoid long, straight edges for harvest bounds (boundaries of the logging job) that intersect with roads or trails at hard angles, or that are visible from roads or water bodies.
- Maintain an uncut or partially cut buffer of 150 feet along recreational trails and in residential areas. Maintain a partially cut buffer along roads, streams and certain ponds as required by the basal area law.

CROSS REFERENCES

2.2 Forest Structure; 3.1 Timber Harvesting Systems; 3.3 Aesthetics of Skid Trails, Truck Roads and Landings; 3.4 Harvesting in High-Use Recreation Areas; 3.5 Soil Productivity; 5.4 Logging Damage; 6.2 Cavity Trees, Dens and Snag; 6.3 Dead and Down Woody Material.

ADDITIONAL INFORMATION

Jones, G. T. 1993. *A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners*. Natural Resource, Agriculture, and Engineering Service. NRAES-60. NRAES Cooperative Extension, Ithaca, N.Y. 28 p.

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

RSA 227-J. *Timber Harvesting*. http://www.gencourt.state.nh.us/rsa/html/xix-a/227-j/227-j-mrg.htm Accessed May 27, 2010.

Smith, S. 2009. *Guide to New Hampshire Timber Harvesting Laws*. UNH Cooperative Extension, Durham, N.H. 37 p.

3.3 AESTHETICS OF SKID TRAILS, TRUCK ROADS AND LANDINGS

BACKGROUND

Skid trails, permanent truck roads, and log landings create visually dramatic and permanent changes in a woodlot.

Without skid trails, truck roads, and landings, most management wouldn't be possible. Besides facilitating timber harvests, they can enhance landowner woodlot access, improve wildlife habitat, and provide a means for recreation and fire and pest control. They also can be the greatest expense of a timber harvest. Careful planning reduces costs and minimizes negative aesthetic impact. When built and used during the dry season, they hold up better, look neater, erode less, and are less expensive to construct and use. On some sites, using roads, trails, and landings on frozen ground may be preferable, especially for temporary winter use. Cutting and removing trees on the road right-of-way in advance of bulldozing results in better looking roads.

Landings are cleared areas where timber is brought from the woods, sorted, and stored until it is trucked to a market. Many times landings are located beside a public road. People often judge the quality of a timber harvest by the appearance of the landings, both during and after the harvest, without ever stepping into the woods. A clean, properly sized, well-organized landing will help improve productivity, provide a safer work environment, reduce cleanup costs, and draw positive attention from the public.

Economics and terrain may determine the location of skid trails, roads, and landings, but pre-planning, use of best management practices (BMPs), and good close-out techniques will minimize aesthetic impacts.

OBJECTIVE

Plan, construct, use, and maintain skid trails, truck roads, and landings to minimize their visual impact.

CONSIDERATIONS

- The State or municipality may hold landowners, loggers, or foresters responsible for damage to public roads.
- Frequency of access, amount of anticipated traffic, seasons during which access is required, and safety concerns affect the number, type and layout of roads and landings.
- Building roads and landings to accommodate visual-quality concerns, or using existing roads that require traveling greater distances, may involve increased costs or may impact ecologically sensitive areas.
- Traffic during wet periods can increase maintenance needs and create unsightly ruts.
- Roads provide access for undesirable activities such as dumping or unwanted traffic that could damage roads and have negative aesthetic impacts.
- A well-maintained road improves recreational uses, provides fire-protection access, and supports other forest management activities. It may also save money.

- The portion of a timber sale where neatness and organization are the most noticeable is the landing.
- The volume of timber harvested, the need to sort logs by species and products, and the equipment type and size often determine landing size.
- Topography, the location of timber, and the proximity of the harvest to public roads or high-use areas can affect the placement, size and number of landings.
- After the harvest, landings can be used for parking, camping, wildlife openings or future harvest operations. Their placement and size may depend on planned subsequent uses, including preventing unwanted use.
- Landing cleanup and seeding practices will increase costs.
- Leaving landings in their natural state, including leaving woody debris unburied, may benefit wildlife. Logging debris left on landings must comply with the slash law, RSA 227-J:10.

RECOMMENDED PRACTICES

Design and Planning

- ✓ Follow state laws and file all necessary highway permits.
- ✓ Follow BMPs. Refer to *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire* by the N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. Consult the latest version before harvesting timber.
- ✓ Consult the Natural Resources Conservation Service (NRCS) or your UNH Cooperative Extension county forester for help and to learn of the availability of federal financial assistance.
- ✓ Designate "bumper trees" along skid trails to minimize damage to residual trees. Leave them after harvesting for future protection and as future cavity trees.
- ✓ Minimize the number of access roads approaching public roads. Creating curves in access roads as they approach public roads makes them less obvious.
- ✓ Plan landings to access future timber sales, keeping their number to a minimum, and sizing them to accommodate products and equipment needs. Locate landings where invasive plants aren't growing, or remove them before construction.
- ✓ Avoid placing landings within view of public roads, trails, or recreation and residential areas. Consider a short, curved road to landings.
- ✓ In sensitive areas, leave an uncut or partially cut buffer of 150 feet or more between landings and major roads, recreational trails, rivers, and residential areas.
- ✓ Identify disposal areas for blocks and other debris in advance. Push unmerchantable debris into those areas over the course of the job. Blocks, stumps and other woody debris from on-site logging buried on-site are exempt from N.H. Dept. of Environmental Services permitting requirements for stump dumps.

Construction and Use

- ✓ When constructing a new road, if stumps can't be trucked or buried, push them off the road and leave in an upright position. Stumps left in this manner look more natural. Hardwood stumps often sprout, further softening their look.
- ✓ Use merchantable timber within trails, roads and landings, and dispose of slash without filling vernal pools or cultural features such as old cellar holes.

- ✓ When upgrading existing roads, clear trees and brush along roads for only the minimum essential width needed for basic construction, maintenance, and traffic needs. Limit the number and length of truck roads.
- ✓ Avoid tracking mud from truck roads and landings onto public roads by using clean fill, wood chips, or mats. Sweep mud from paved roads.
- ✓ Shape and seed ditches and exposed areas to avoid erosion and improve visual impact. Place waterbars as recommended in the BMPs.

When using on-site gravel (borrow) pits

- ✓ Follow state and local regulations pertaining to gravel operations.
- ✓ Avoid locating pits where non-native invasive plants are growing, or remove them before using the pit to avoid moving them with the fill.
- ✓ Locate borrow pits out of the visible corridor as much as possible, or screen them using existing vegetation. Avoid facing them directly toward the road.
- ✓ Before "putting the pit to bed," consider stockpiling gravel for future use.
- ✓ Rehabilitate pits on completion of use as per RSA 155-E.

During the Harvest

- ✓ Organize landings to accommodate sorting, processing, and short-term storage and to allow safe movement of workers and equipment.
- ✓ Minimize the amount of wood waste on the landings through good utilization of the harvested trees and by cutting and leaving unmerchantable sections in the woods or hauling unused blocks back to the woods.
- ✓ Remove slash from landings as soon as possible.
- ✓ Avoid creating landings that evolve into one continuous zone along public roads.
- ✓ Limit the number of skid trails entering and leaving the landing to minimize the amount of disturbance.
- ✓ Properly dispose all trash, motor oil, and other refuse daily.

After the Harvest

- ✓ Clear landings of woody debris by burying, piling, or moving it into the woods. Level and smooth the ground. Plant with recommended seed mix only if necessary to stabilize the soil, for wildlife, or for appearance. Otherwise, let natural vegetation establish itself. Contact NRCS for information on site-specific seeding recommendations.
- ✓ Regularly inspect roads and trails. Maintain roads on a schedule to include mowing, cleaning ditches and culverts, repairing washouts, and other activities as needed. Periodic mowing may be necessary to keep the landing open for wildlife and other future use.
- ✓ Install a gate or block access with boulders or other obstacles to keep unwanted vehicles off roads. Post signs that help send a positive stewardship message, yet restrict harmful uses.

CROSS REFERENCES

2.2 Forest Structure; 3.1 Timber Harvesting Systems; 3.2 Logging Aesthetics; 3.4 Harvesting in High-Use Recreation Areas; 3.5 Soil Productivity; 4.1 Water Quality; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 4.4 Stream Crossings and Habitat; 5.2 Invasive Plants; 5.4 Logging Damage; 6.2 Cavity Trees, Dens and Snag; 6.3 Dead and Down Woody Material; 6.5 Permanent Openings.

ADDITIONAL INFORMATION

Carbee, H., and S. Smith. 2006. *Forest Products Road Manual: A Handbook for Municipal Officials and Forest Products Industry*. UNH Cooperative Extension, Durham, N.H. 15 p.

Jones, G. T. 1993. *A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners*. Natural Resource, Agriculture, and Engineering Service. NRAES-60. NRAES Cooperative Extension, Ithaca, N.Y. 28 p.

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

RSA 155-E. *Local Regulation Excavations*. http://www.gencourt.state.nh.us/rsa/html/NHTOC/NHTOC-XII-155-E.htm Accessed May 27, 2010.

RSA 227-J. *Timber Harvesting*. http://www.gencourt.state.nh.us/rsa/html/xix-a/227-j/227-j-mrg.htm Accessed May 27, 2010.

3.4 TIMBER HARVESTING IN HIGH-USE RECREATION AREAS

BACKGROUND

Minimizing conflicts between timber harvesting and recreational use can leave visitors with a positive impression of forest management.

The primary exposure many people have to timber harvesting occurs when they're hiking, camping, mountain biking, wildlife viewing, horseback riding, hunting, fishing, or enjoying other recreational activities on managed lands. Whether harvesting near trails on their own land or harvesting in proximity to recreational areas on adjacent lands, a landowner's actions can significantly affect the public's perception of harvesting, for better or for worse. Attention to the impact of harvesting on recreational uses can enhance the public's recreational experience and create a positive impression of forest management.

OBJECTIVE

Minimize the visual and audible impacts of timber harvesting in or near areas used for recreation.

CONSIDERATIONS

- Many hiking trails use old logging routes and logging roads often become new hiking trails.
- Recreational use can conflict with forest management activities.
- Scheduling a timber harvest during periods of low recreational use may not coincide with the best operating conditions.
- Limiting recreational access during harvest operations may be the safest alternative.

RECOMMENDED PRACTICES

- ✓ Before harvest, erect signs to inform, educate, and warn recreational users about harvesting activities and alert people to safety concerns.
- ✓ Notify abutters, recreational user groups, conservation commissions, or others who may be affected. Consider having a local newspaper run a story on the timber harvest.
- ✓ Monitor the job on a regular basis to identify and solve problems in a timely fashion.
- ✓ Leave large, attractive trees in high-use public areas.
- ✓ Lay out skid trails and roads with future recreational uses in mind, so they can be incorporated into trail systems.

- ✓ Leave uncut or partially cut buffer zones along recreational trails. Limit the number of skid-trail crossings, keeping them at right angles to the recreational trails and angling them just beyond the buffer zone to minimize sight lines down the skid trails.
- ✓ Lop tree tops 2 feet or less in high-use areas. Otherwise lop tops 2 to 4 feet above the ground. Where deer severely disrupt natural regeneration, leave slash higher to protect new seedlings.
- ✓ Conduct disruptive phases of management operations such as road or landing construction during periods of low recreational use.
- ✓ When harvesting operations can't avoid peak recreational use, consider the following:
  - Temporarily relocate recreational trails away from the management activity.
  - Reduce the impact of noisy equipment by modifying working hours, shutting down idling equipment, reducing truck noise (by using lower rpm's) to and from the landing, and consider using equipment with noise-reducing features.
- ✓ Limit skidding on recreational trails. During the harvest, protect recreational trails impacted by skidding from erosion by using best management practices (BMPs). After harvesting, remove woody material, smooth ruts, and seed as necessary.
- ✓ Invite the public to tour your woodlot to learn more about harvesting operations.

CROSS REFERENCES

1.5 Staying Safe Working in the Woods; 3.1 Timber Harvesting Systems; 3.2 Logging Aesthetics; 3.3 Aesthetics of Truck Roads, Skid Trails and Landings; 7.8 Cultural Resources.

ADDITIONAL INFORMATION

Jones, G. T. 1993. *A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners*. Natural Resource, Agriculture, and Engineering Service. NRAES-60. NRAES Cooperative Extension, Ithaca, N.Y. 28 p.

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

3.5 SOIL PRODUCTIVITY

BACKGROUND

Forest soil productivity can affect how fast trees grow and what kinds of trees grow.

The characteristics of a forest soil are defined by varying combinations of mineral particles, organic matter, water, and air. Soil productivity is influenced by levels of mineral nutrients available from the rocks from which that soil is derived. For example, limestone-derived soils tend to have a higher pH, allowing nutrients to be more available and in turn, to be more fertile. Soils derived from granite tend to have a lower pH, which locks up nutrients and so tends to be less fertile. The lack of practical, economically feasible means of increasing soil productivity underscores the importance of maintaining existing soil nutrients.

Soil nutrients can be lost through leaching and timber harvesting. Acid deposition and other forms of air pollution leach certain soil nutrients, especially calcium. These losses may equal or exceed losses from timber harvesting over the length of the rotation. Exposing soil can result in small amounts of harvest-induced leaching. Soil type and the amount of trees removed also influence the amount of leaching. Prompt revegetation can minimize soil nutrient losses.

Nutrient loss from timber harvesting is affected by the portion(s) of a tree taken, the harvest method, and the frequency with which a stand is harvested. More frequent harvests and a higher percentage of fiber removed during harvests increase the amount of nutrients removed. Whole-tree (biomass) harvesting removes more nutrients than bole-only harvests, because the tops, limbs and leaves serve as a significant reservoir for many nutrients.

Though nutrient loss is a concern with biomass harvests, current knowledge is limited regarding the effect of intensive harvesting on soil productivity. Two studies at the Hubbard Brook Experimental Forest in Thornton, N.H. didn't find perceptible soil nutrient loss from whole-tree clearcutting. However, nutrient response is site-dependent and difficult to apply from one soil to another and additional research on a variety of soils is needed. Erosion control and other best management practices maintain soil integrity and minimize losses.

The greatest concern for nutrient depletion arises when the more intense practices are applied repeatedly on sites already low in nutrients (e.g., most coarse-textured sands, some shallow-to-ledge soils, and some soils with high seasonal water tables). In general, whole-tree harvests by the clearcut method on short rotations (e.g. 40 years) should produce the greatest nutrient losses.

Erosion and soil compaction may also diminish soil productivity for tree growth. Timber harvesting can cause soil damage by disrupting topsoil, mixing soil layers, creating deep ruts, or compacting soil layers. The primary factor contributing to soil erosion is the exposure of bare soil.

A typical soil is 45 percent mineral material, 25 percent air, 25 percent water, and 5 percent organic material. Half the feeder roots in a forest are found in the top 6 inches of soil. Roots need both air and water and activities that compact the soil, eliminating space for air and water, lower a site's productivity.

Repeated passes of heavy equipment over certain types of soil, especially during wet conditions, can compact soil pore space, reducing the availability of air and water necessary for trees, impeding root growth, and allowing the entry of pathogens that cause root diseases. To some extent, natural soil processes such as freeze/thaw cycles and activities of soil organisms help restore compacted soils to near preharvest conditions. The rate of recovery depends on soil type, soil depth, and degree of compaction.

3.5: Soil Productivity

Low-fertility soils, those with a high silt, clay, or organic matter content, and soils shallow to bedrock may be more subject to erosion and compaction or have most of the fine roots very near the surface, where they may be easily damaged.

OBJECTIVE

Maintain long-term soil productivity.

CONSIDERATIONS

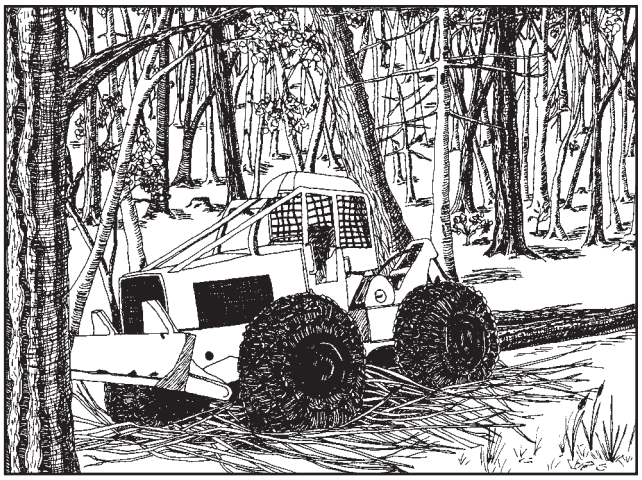
- Well-planned and executed timber harvests can minimize the effects on soil nutrients, erosion, and compaction.
- Leaves, branches, and small-diameter trees left after a harvest contribute to on-site nutrient recycling. Even whole-tree harvests leave behind a percentage of these fine, woody materials.
- Some exposure of mineral soil is important for regeneration of certain species (e.g., white pine and yellow birch).
- Growth decline in New England stands due to environmental effects isn't evident except in red spruce at high elevations.
- Commercial wood ash and biosolids from municipal wastewater treatment may become a sources of forest-soil nutrient additives. Their application is governed by state and federal law and may be limited by local regulation.

RECOMMENDED PRACTICES

✓ Contact the Natural Resources Conservation Service (NRCS) for soil maps and advice on which soils may be low fertility or susceptible to erosion or compaction. Or use the NRCS *Web Soil Survey,* an internet tool that provides easy-access, up-to-date soil mapping, interpretations, and descriptions. Incorporate soils information into forest management plans and activities.

✓ Limit disruption of soil organic layers except when needed to accomplish silvicultural objectives such as regeneration of species that need a bare mineral soil seedbed.

✓ Design roads, skid trails, and landings in advance of the harvest.



Cable skidder driving on limbs and tops.

✓ Minimize damage to areas susceptible to erosion or compaction by:

- Harvesting during dry, snow-covered, or frozen ground conditions.
- Using designated skid trails.
- Using equipment suited to the site and the size of material being harvested.
- Using low-impact equipment.
- Spreading limbs and tops on skid trails to cushion the impact of harvesting equipment.

- ✓ Use bole-only harvesting (taking out the main portion of tree only, leaving branches and limbs in the woods) on low-fertility soils as a precaution against nutrient loss. Lopping tops in the woods where they fall will leave a greater percentage of the nutrients to recycle.

CROSS REFERENCES

2.2 Forest Structure; 3.1 Timber Harvesting Systems; 3.2 Logging Aesthetics; 4.3 Forest Management in Riparian Areas; 5.4 Logging Damage; 6.2 Cavity Trees, Dens and Snags; 6.3 Dead and Down Woody Material; Appendix-Important Forest Soils.

ADDITIONAL INFORMATION

Beattie, M., C. Thompson, and L. Levine. 1993. *Working with Your Woodland: A Landowner's Guide (2nd ed.)*. University Press of New England, Hanover, N.H. 279 p.

Campbell, J.L., C.T. Driscoll, C. Eager, G.E. Likens, T.G. Siccama, C.E. Johnson, T.J. Fahey, S.O. Hamburg, R.T. Holmes, A.S. Bailey, and D.C. Busco. 2007. *Long-term Trends from Ecosystem Research at the Hubbard Brook Experimental Forest*. USDA For. Serv. Gen. Tech. Rep. NRS-17. 41 p.

Evans, A.M., R.T. Perschel, and B.A. Kittler. 2010. *An Assessment of Biomass Harvesting Guidelines*. The Forest Guild, Sante Fe, N.M. 33 p.

Evans, A.M. 2008. *Synthesis of Knowledge from Woody Biomass Removal Case Studies*. The Forest Guild, Sante Fe, N.M. 39 p.

The Forest Guild Biomass Working Group. 2010. *Forest Biomass Retention and Harvesting Guidelines for the Northeast*. The Forest Guild, Sante Fe, N.M. http://www.forestguild.org/publications/research/2010/FG_Biomass_Guidelines_NE.pdf Accessed on July 23, 2010.

McEvoy, T. 2000. *Introduction to Forest Ecology and Silviculture*. Natural Resource, Agriculture, and Engineering Service. NRAES-126. NRAES Cooperative Extension, Ithaca, N.Y. 75 p.

McEvoy, T. 2004. *Positive Impact Forestry:A Sustainable Approach to Managing Woodlands*. Island Press, Washington, D.C. 296 p.

USDA Natural Resources Conservation Service. *Web Soil Survey*. http://websoilsurvey.nrcs.usda.gov/app/ Accessed February 16, 2010.

WATER RESOURCES

TOPICS IN THIS SECTION

4.1 Water Quality
4.2 Wetlands
4.3 Forest Management in Riparian Areas
4.4 Stream Crossings and Habitat

ADDITIONAL READING

Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire
N.H. Dept. of Resources and Economic Development
Division of Forests and Lands
2004

Best Management Practices for Forestry: Protecting New Hampshire's Water Quality
Edited by Sarah Smith
UNH Cooperative Extension
2005

Buffers for Wetlands and Surface Waters: A Guidebook for New Hampshire Municipalities
Vicky Chase, Laura Deming, and Francesca Latawiec
Audubon Society of New Hampshire
1995

Guide to New Hampshire Timber Harvesting Laws
Sarah Smith
UNH Cooperative Extension
2009

Guide to Wildlife Habitats of Maine
Edited by Cathy Elliott
University of Maine Cooperative Extension
1988

New England Wildlife: Habitat, Natural History, and Distribution
Richard M. DeGraaf and Mariko Yamasaki
University Press of New England
2001

Technical Guide to Forest Wildlife Habitat Management in New England
Richard M. DeGraaf, Mariko Yamasaki, William B. Leak, and Anna M. Lester
University of Vermont Press and University Press of New England
2006

Riparian Management in Forests of the Continental Eastern United States
Edited by Elon Verry, James Hornbeck, and C. Andrew Dolloff
Lewis Publishers
2000

Wildlife Forests and Forestry: Principles of Managing Forests for Biological Diversity
Malcolm L. Hunter, Jr.
Prentice-Hall
1990

4.1 WATER QUALITY

BACKGROUND

Human uses of surface waters, the survival of fish and other aquatic organisms, and the quality of groundwater supplies all depend on clean surface water.

The most important aspect of protecting water quality is maintaining the integrity of wetlands, instream, and riparian areas (see other chapters in the water resources section). Guidelines for conducting forest management in and adjacent to wetlands and surface waters are known as best management practices, or BMPs. They are designed to protect water quality. These guidelines, some of which are law, are found in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire* published by the N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. We address other water-quality topics in more detail in other water resources chapters.

OBJECTIVE

Protect water quality during and following harvesting and road-building.

CONSIDERATIONS

- The N.H. Dept. of Environmental Services (NHDES) regulates wetlands (RSA 482-A: Fill and Dredge in Wetlands). The N.H. Dept. of Resources and Economic Development regulates, among other things, basal area and slash (RSA 227-J).
- Forest management is exempt from RSA 483-B, the Comprehensive Shoreland Protection Act (CSPA) as long as it isn't associated with shoreland development or land conversion and is conducted in compliance with RSA 227-J:9. Forestry conducted by or under the direction of a water supplier for the purpose of managing a water supply is also exempt from the CSPA.
- Timber harvesting near surface-water drinking supplies may be governed by specific statutes. Some water-supply watersheds are protected by state rules establishing setbacks and/or requiring the water supplier's approval prior to timber harvesting.
- A majority of timber harvests will encounter wetlands or surface waters. Crossing wetlands or surface waters (4.2 Wetlands, 4.4 Stream Crossings and Habitat) may require notifying NHDES before the start of the operation. NHDES requires that all wetland and stream crossings follow BMPs.
- Maintaining permanent culverts and other stream crossings could save a substantial amount of money in repairs in the long run.
- Timber harvesting may impact aquifers, wells, and municipal- and public-water supply reservoirs. These resources may be located outside your property and are vulnerable if located downstream. GIS data layers showing the location of some stratified drift aquifers, wellhead protection zones, and public water supplies are available at NH GRANIT.
- Water quality is affected by activities throughout a watershed, many of which may be beyond the control of the landowner or land manager.

RECOMMENDED PRACTICES

- ✓ Lay out timber harvests when the ground is bare (without snow) to identify water and other natural resources. Locate landings, roads and skid trails to minimize stream and wetlands crossings.
- ✓ Minimize soil disturbance near surface waters and wetlands. Regulations govern harvesting within certain distances of surface waters and wetlands.
- ✓ Apply BMPs according to guidelines in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. Consult the latest version before harvesting timber.
- ✓ When stream crossings are necessary, follow BMPs and regularly inspect and maintain crossings to make sure they function properly. Temporary stream-crossing structures shouldn't impede streamflow and should handle the increased flow that could occur in a storm during a harvest operation (4.4 Streams Crossings and Habitat).
- ✓ Monitor sites before, during and after harvesting, and also during rainstorms, for visible signs of erosion and sedimentation. Signs may include:
  - Cloudy or muddy water.
  - Increased growth of algae in streams or ponds (green slime).
  - Deposits of silt or muck on rocky or gravel streambeds.
  - New run-off channels or gullies.
- ✓ After the timber harvest, install water bars on skid trails, remove temporary stream-crossing structures, seed and mulch embankments, and apply other soil-stabilizing techniques as needed.
- ✓ In watersheds containing brooks or streams draining directly into a water supply reservoir, consult with a water company or municipal water supply representative. The water supplier may have specific recommendations to avoid or minimize water quality impacts. To determine whether a watershed is covered by special rules, consult N.H. Administrative Rules Env-Ws 386, or contact NHDES's Drinking Water Source Protection Program.
- ✓ Fill and maintain equipment well away from open water or wetlands. Park equipment and oil tanks where they won't leak into water. Keep sawdust or other absorbent material (a spill kit) on the site to soak up accidental spills or leaks. Report spills to NHDES unless:
  - The spill is less than the amount listed in the regulations as reportable for that chemical (25 gallons for oil).
  - The spill is immediately contained.
  - The spill doesn't threaten surface or groundwater.
  - All discharge and contamination are removed within 24 hours.

  If a spill occurs, contact NHDES for information at 271-3899 or, after hours or on weekends, the State Police at 271-3636.
- ✓ Consider using vegetable-based bar-and-chain oil as an alternative to petroleum-based oil. Check equipment manufacturer warranties to ensure biodegradable oils and lubricants won't damage equipment or invalidate the warranty.

CROSS REFERENCES

3.1 Timber Harvesting Systems; 3.2 Logging Aesthetics; 3.3 Aesthetics of Skid Trails, Truck Roads and Landings; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 4.4 Streams Crossings and Habitat; 6.8 Beaver-Created Openings.

ADDITIONAL INFORMATION

N.H. Administrative Rules Env-Wt 101. http://www.gencourt.state.nh.us/Rules/state_agencies/env-wt100-800.html Accessed on May 27, 2010.

N.H. Administrative Rules Env-Ws 386. http://des.nh.gov/organization/commissioner/legal/rules/documents/env-ws386.pdf Accessed on February 1, 2010.

N.H. Dept. of Environmental Services. 2007. *Reporting Oil Spills, Hazardous Waste Spills and Groundwater Contamination*. http://des.nh.gov/organization/commissioner/pip/factsheets/rem/documents/rem-13.pdf Accessed on February 1, 2010.

N.H. Dept of Environmental Services. *Drinking Water Source Protection Program*. http://des.nh.gov/organization/divisions/water/dwgb/dwspp/index.htm Accessed on February 1, 2010.

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

NH GRANIT. http://www.granit.unh.edu/ Accessed on February 1, 2010.

RSA 227-J. *Timber Harvesting*. http://www.gencourt.state.nh.us/rsa/html/xix-a/227-j/227-j-mrg.htm Accessed May 27, 2010.

RSA 482-A. *Fill and Dredge in Wetlands*. http://www.gencourt.state.nh.us/rsa/html/l/482-a/482-a-mrg.htm Accessed May 27, 2010.

RSA 483-B. *Comprehensive Shoreland Protection Act*. http://www.gencourt.state.nh.us/rsa/html/l/483-b/483-b-mrg.htm Accessed May 27, 2010.

Smith, S. (ed). 2005. *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality*. UNH Cooperative Extension, Durham N.H. http://extension.unh.edu/resources/representation/Resource000248_Rep267.pdf Accessed February 8, 2010.

Smith, S. 2009. *Guide to New Hampshire Timber Harvesting Laws*. UNH Cooperative Extension, Durham, N.H. 37 p.

4.2 WETLANDS

BACKGROUND

Wetlands are ecologically important and should receive special consideration to protect water quality, wildlife habitat, and aesthetic values.

Wetlands protect water quality, help control floods, recharge groundwater, and provide recreational and scenic opportunities. Wetlands are among the most critical parts of any forest ecosystem. Forested wetlands can include economically important trees as well as rare plants and natural communities. Forty-seven rare plants grow in forested wetlands in New Hampshire, including 31 listed as endangered. Riparian areas and wetlands are used by more than 90 percent of the region's wildlife species and are the preferred habitat for more than 40 percent of them.

Wetlands are identified by hydrological features, soils, and vegetation. Wetland hydrological indicators include the presence of water at or near the soil surface, swollen tree trunks, drift lines, and water or silt-stained leaves or plant stems. All wetlands have saturated soil for at least part of the growing season, and all support vegetation adapted to wet conditions.

Wetlands may be forested (such as red maple or cedar swamps) or nonforested (such as marshes, wet meadows, scrub-shrub wetlands, peatlands or beaver-created meadows). They can have open water. Shrub wetlands are dominated by shrubs and saplings and may be in a transitional state between an open wetland and a forested one, or they may remain shrubby. They include small or ephemeral areas such as seeps and vernal pools (7.2 Seeps and 7.3 Vernal Pools). Riparian areas are associated with wetlands and surface waters (4.3 Forest Management in Riparian Areas). *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire* includes a basic guide to wetland identification.

Wetlands and the adjacent uplands have a long history of use and alteration by humans. Combined pressures, along with their ecological significance, underscore the importance of properly managing those that aren't yet heavily impacted and restoring those that are currently degraded. Wetlands protection begins with careful road and skid-trail layout to minimize wetland and surface-water crossings. The timing and silvicultural methods used in wetlands and adjacent uplands also are key.

Illustration by Victor E. Young, courtesy of UNH Cooperative Extension

OBJECTIVE

Maintain the important functions and values of wetlands.

CONSIDERATIONS

- The N.H. Dept. of Environmental Services (NHDES), pursuant to RSA 482-A, regulates activities in wetlands and the N.H. Dept.

of Resources and Economic Development, pursuant to RSA 227-J, regulates timber trespass, basal area and slash. Together they regulate forestry practices in wetlands.

- Municipalities may further identify wetlands of significant value worthy of extra protection because of their uniqueness, fragility, or unspoiled character. These wetlands and the 100-foot buffer adjacent to the wetland are designated as "prime wetlands" and are afforded special protection under RSA 482-A.
- Guidelines for harvesting in and adjacent to wetlands and surface waters are known as best management practices, or BMPs. These guidelines are found in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire* by the N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. Consult the latest version before harvesting timber.
- Proper planning reduces the number, width, and length of surface-water and wetland crossings, and also saves money.
- Use of corduroy or tree tops minimizes impact to the ground. In wetlands these materials are considered fill and require a permit from NHDES. However, corduroy can be left in place where the stream channel isn't defined.
- Excessive rutting in wetlands affects the surface hydrology, severs plant roots, and can cause erosion.
- Identification of forested wetland boundaries may be difficult.
- Activities of others throughout the watershed may affect the integrity of wetlands.
- Forested wetlands may be highly productive. Limiting harvesting in wetlands and upland areas bordering them may entail an economic loss.
- Some wetlands are rare, some are designated exemplary natural communities, and some wetlands are more sensitive to disturbance than others. Look to the N.H. Natural Heritage Bureau (NHNHB) as a source for determining whether a wetland is rare, an exemplary natural community, or susceptible to disturbance.
- Wetlands can be surrounded by productive upland forests and may be affected by cutting along the wetland edge. Uplands bordering wetlands filter run-off, capture pollutants before they enter the wetland, and are critical to the survival of wetland-dependent wildlife.
- A wetland buffer, as used in this chapter, is the vegetated upland area adjacent to a wetland. Deciding on the width and management actions in wetland buffers depends on what functions and values you want to preserve. It is difficult to generalize about wetland buffer widths because of the many types of wetlands and the diversity of wildlife.
- Different wildlife species require different widths for breeding, nesting, and overwintering. Leaving the understory adjacent to wetlands intact will provide many wildlife and water-quality services. Timber harvesting within a wetland buffer can provide benefits to wildlife habitat (6.8 Beaver-Created Openings). The size of a buffer is influenced by, among other things, the type of wetland, steepness of slope surrounding the wetland, the erodibility of soils, the size and type of vegetation within the wetland, and the landowner's objectives.
- Landowners may have wildlife, ecological and silvicultural reasons to harvest in wetlands.

RECOMMENDED PRACTICES

- ✓ Survey the property (ideally in early spring) and identify important hydrologic features such as streams, ponds and wetlands including seeps and vernal pools.
- ✓ Consult a natural resource professional to help identify wetlands and determine what permit(s)

you need.

- ✓ Check with the NHDES or the city or town before timber harvesting in or within 100 feet of prime wetlands.
- ✓ Protect surface waters and wetlands by appropriately locating roads before harvesting begins and applying other BMPs.
- ✓ When logging in and near forested wetlands, avoid rutting and other damage by cutting when the ground is frozen or sufficiently dry to support the type of equipment used.
- ✓ Before harvesting within or near rare or highly sensitive wetlands, consult with the NHNHB for suggested management recommendations specific to the wetland type and landscape context.
- ✓ Designate a wetland buffer adjacent to forested and nonforested wetlands. Include steep slopes, highly erodible soils, known threatened and endangered species habitat, rare plants and exemplary natural communities, and heron, eagle or osprey nests. A buffer's effectiveness increases with its width. Sensitive wetlands require larger areas of upland to reduce the risk of disturbance.
- ✓ Leave the area closest to the stream, pond, or wetland unharvested to provide increased protection to aquatic habitats and allow a reliable long-term supply of cavity trees, snags, and downed woody material. Larger zones will increase the protection of nontimber values, however, no-harvest zones may not always align with ecological or silvicultural objectives.
- ✓ Retain trees with cavities, standing dead trees, downed logs, and large supracanopy trees.

CROSS REFERENCES

2.2 Forest Structure; 2.3 Regeneration Methods; 3.5 Soil Productivity; 4.1 Water Quality; 4.3 Forest Management in Riparian Areas; 4.4 Stream Crossings and Habitat; 5.2 Invasive Plants; 6.8 Beaver-Created Openings; 6.9 Deer Wintering Areas; 6.10 Woodland Raptor Nest Sites; 6.11 Bald Eagle Winter Roosts; 6.12 Heron Colonies; 6.13 Wildlife Species of Greatest Conservation Need; 7.1 Natural Communities and Protected Plants; 7.2 Seeps; 7.3 Vernal Pools.

ADDITIONAL INFORMATION

Chase, V., L. Deming, and F. Latawiec. 1995. *Buffers for Wetlands and Surface Waters: A Guidebook for New Hampshire Municipalities*. Audubon Society of New Hampshire, Concord, N.H. 80 p.

Elliott, C.A. 1988. *A Forester's Guide to Managing Wildlife Habitats in Maine*. University of Maine Cooperative Extension Service, Orono, Maine.

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

RSA 227-J. *Timber Harvesting*. http://www.gencourt.state.nh.us/rsa/html/xix-a/227-j/227-j-mrg.htm Accessed May 27, 2010.

RSA 482-A. *Fill and Dredge in Wetlands*. http://www.gencourt.state.nh.us/rsa/html/l/482-a/482-a-mrg.htm Accessed May 27, 2010.

Smith, S. (ed). 2005. *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality*. UNH Cooperative Extension, Durham N.H. http://extension.unh.edu/resources/representation/Resource000248_Rep267.pdf Accessed February 8, 2010.

Smith, S. 2009. *Guide to New Hampshire Timber Harvesting Laws*, UNH Cooperative Extension, Durham, N.H. 37 p.

4.3 FOREST MANAGEMENT IN RIPARIAN AREAS

BACKGROUND

Riparian areas should be managed to protect water quality, streamflows, fish and wildlife habitat, and scenic values.

A riparian area is land adjacent to and directly influenced by streams, rivers, ponds, lakes, and associated nonforested wetlands. It forms a transition from aquatic to terrestrial ecosystems. Soils and growing conditions are often moister, more nutrient-rich, and more productive than those in surrounding uplands, resulting in considerable species diversity and productivity. Because of their proximity to surface waters, riparian areas are vital for maintaining water quality and aquatic resources.

Riparian areas have a long history of use and alteration by humans, including urbanization, road-building, agriculture, dam-building, and timber harvesting. The combined pressures of these activities, along with the documented ecological significance of these areas, underscore the importance of properly managing the riparian forest.

The Functions and Values of Riparian Areas

Riparian areas provide many ecosystem services and benefits such as:

- Flood control and streamflow regulation, especially where the riparian area includes a river's floodplain.
- Water-quality protection by filtering and retaining sediment, nutrients, and other pollutants from upslope areas, as well as through bank stabilization.
- Aquatic habitat protection including:
  - Regulating temperatures by shading streams, particularly important for lower-order streams that support coldwater fish (e.g., brook trout). Increases in water temperature can have negative effects on stream chemistry, aquatic insects, stream flora, and fish.
  - Large, woody material (e.g., fallen trees and large branches) that creates pools, riffles, debris-jams, and related aquatic habitat including spawning habitat for brook trout.
  - Leaves, twigs, fruit and insects contributing energy (food) to drive aquatic food webs. Headwater streams and small rivers derive most of their energy this way.
  - Fish habitat during high flow periods.
- Rare natural communities (e.g., ***calcareous riverside seeps, swamp white oak floodplain forest***) and many rare plants. More than one-third of all New Hampshire's vascular plants occur in riparian natural communities, including 93 rare species.
- Habitat for feeding, cover, and travel for many amphibians, birds, furbearers, and reptiles. Deer wintering areas are often associated with riparian softwood forest. Large trees in these areas are the primary nesting sites for bald eagles, osprey, and colonial waterbirds.
- Recreational and scenic opportunities, such as hiking, fishing, hunting, boating, bird-watching, and wildlife viewing.

Identifying Riparian Areas and Designing Riparian Management Zones

Riparian areas are defined by their location adjacent to lakes, ponds, streams and rivers, by their characteristic vegetation, and by the function they serve. Vegetation can vary from a narrow band of shrubs to floodplain forests hundreds of yards wide. The size depends on what function is being considered and may include upland forest as well as truly riparian communities.

4.3: Forest Management in Riparian Areas

Riparian management zones (RMZs) are linear zones along the shores of lakes, ponds, rivers, streams, and associated wetlands, within which special forest management practices are used.

Just how wide should the RMZ be? Unique combinations of ecological functions, physical characteristics, and landscape context make it difficult to arrive at a one-size-fits-all width. An important first step is to identify what you wish to protect—the width needed to provide shade to a stream, for example, may be one tree height or less, whereas riparian wildlife habitat may extend several hundred feet into upland forests adjacent to a river or lake. Foresters and landowners are in the best position to consider and apply localized factors.

Variable, tailor-made RMZs reflect localized site conditions, but are generally more complicated to consistently define, apply, and monitor. Fixed-width RMZs have the practical benefit of being clear, consistent, relatively simple to apply and monitor, and provide reasonable confidence that RMZ values and goals will be attained. We suggest a tiered approach that provides the practical benefits of a fixed-width, but includes key modifiers offering some added benefits of a variable-width approach. For additional information about establishing RMZs, see chapter 2 in *Riparian Management in Forests of the Continental Eastern United States*.

We recommend the following widths as general guidelines. The RMZ extends upland from the top of the streambank or from the upland edge of any stream-, pond-, or lake-side wetland (see illustration).

Table 1. Guidelines for Riparian Management Zones

	Legally Required[1]		Recommended	
	Riparian Management Zone (feet)	No Harvest Zone[2] (feet)	Riparian Management Zone (feet)	No Harvest Zone[2] (feet)
Intermittent streams	none[1]	none	75	none
1st and 2nd order streams	50[1]	none	100	25
3rd order streams[5]	50[1]	none	300[4]	50[3]
4th order and larger streams[5]	150[1]	none	300[4]	25
Pond <10 acres	50[1]	none	100	none
Lake or Great Pond (>10 acres)	150[1]	none	300	25

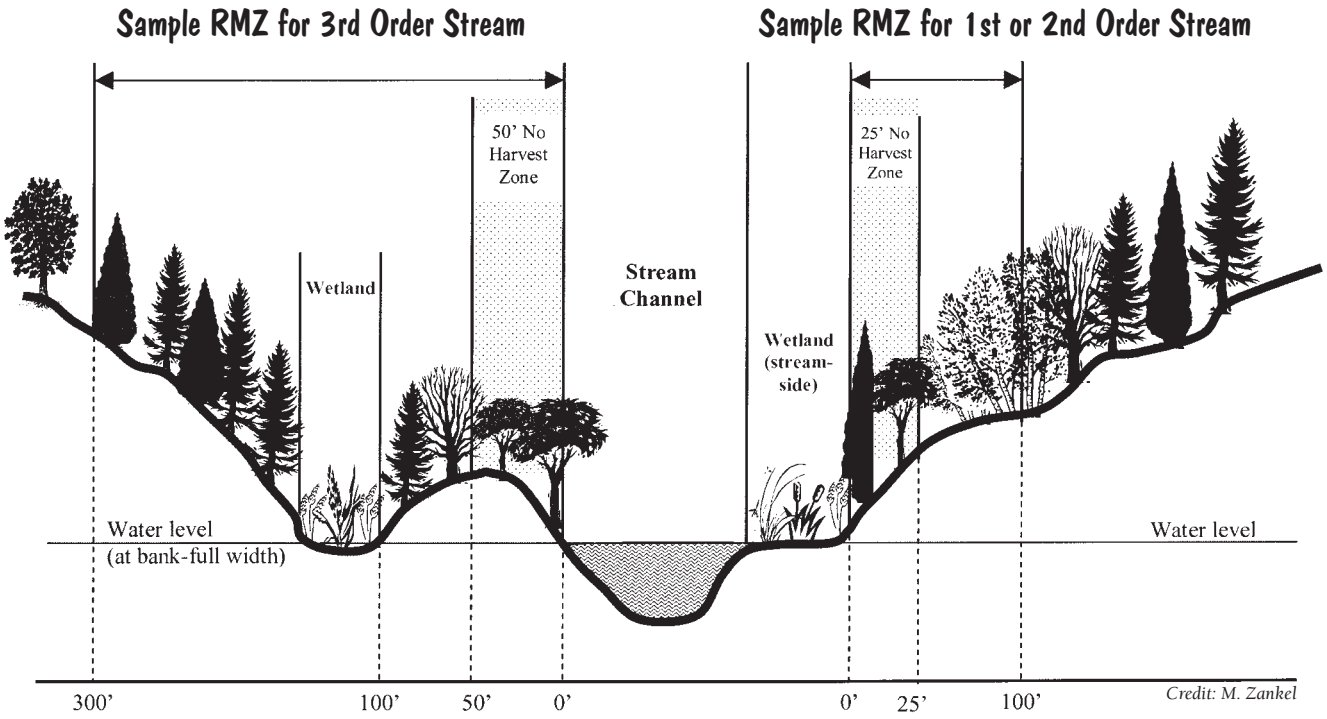
1 Width required under RSA 227-J:9 (basal area law). Within a 12-month period, no more than 50 percent of the basal area may be cut in these areas. Includes ponds less than 10 acres associated with a stream or brook that flows throughout the year.

2 Portion directly adjacent to the water body in which no cutting is recommended. It may be desirable to expand if there are steep slopes (>25%), unstable soils, sensitive wetlands, or exemplary natural communities. Increasing the width of the no-harvest zone will provide greater protection of nontimber values, but will also encumber a larger amount of timber. There may be valid ecological and silvicultural reasons to harvest in the no-harvest zone.

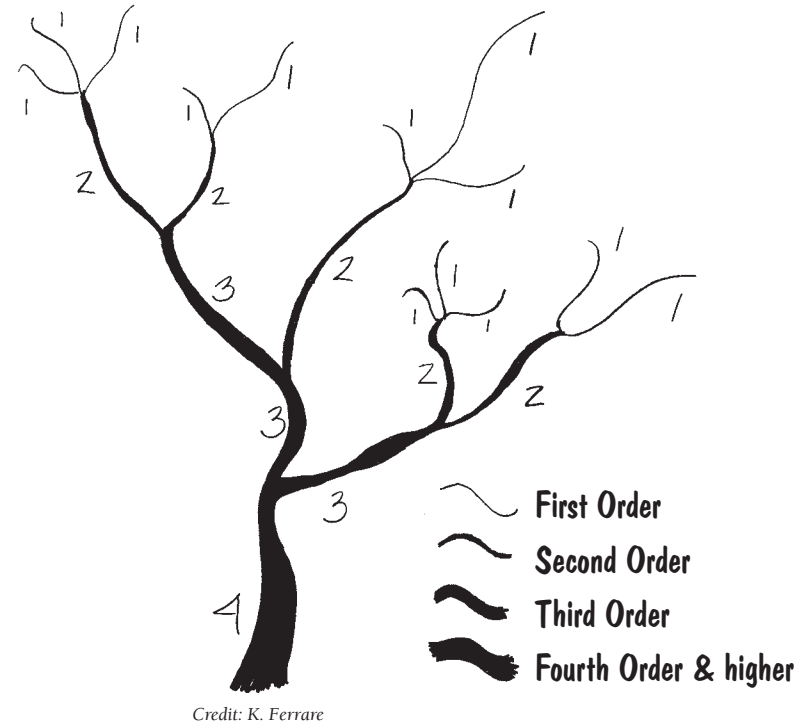
3 A 50-foot, no-harvest zone is recommended for 3rd order streams because of the importance of large woody material on streams of this size.

4 RMZ width on 3rd & 4th order and larger streams and rivers may expand to encompass known wildlife travel corridors, drinking water supply considerations, and the full extent of the 100-year floodplain.

5 For a list of fourth-order and higher streams see N.H. Dept. of Environmental Services Consolidated List of Waterbodies Subject to RSA 483-B.



The left side of the illustration shows the recommended RMZ for a 3rd order stream. The right side shows the recommended RMZ for a 1st or 2nd order stream. Note that the RMZ on the right side is measured from the upland edge of the streamside wetland. If there is no wetland at the edge of the stream, the RMZ is measured from the top of the streambank (at bankfull width). The disjunct wetland on the left side overlaps and is included within the RMZ.



Stream order classifies streams according to their size and position in the watershed. When two first-order streams intersect, the downslope stream is assigned an order of two. When two second-order streams intersect, the downslope stream is assigned an order of three, and so on. This most common method of ordering is known as the Strahler Method.

OBJECTIVE

Maintain the important ecological functions and values of forested riparian areas.

CONSIDERATIONS

- Wetland permits (RSA 482-A) or other legal requirements (RSA 227-J) may apply to forestry operations in riparian areas (4.2 Wetlands). Timber harvesting is exempt from RSA 483-B, the Comprehensive Shoreland Protection Act, so long as it isn't associated with shoreland development or land conversion and is conducted in compliance with RSA 227-J:9.
- Landowner objectives, water-body size, landscape context, vegetative composition, slope, and other factors helps determine the appropriate width and management of RMZs.
- There are benefits to managing riparian areas with a long-term perspective (>100 years). Some potential effects of harvesting in riparian areas may be short-lived; others (e.g., reduced input of large woody material) are much longer lasting. Trees retained today become the source of key terrestrial and instream habitat structure many decades into the future.
- No harvest zones within an RMZ provide optimal water quality benefits, protect sensitive riparian natural communities and wildlife movement corridors, promote quantities of large woody material, and avoid soil disturbance.
- Active forest management can be compatible with maintaining riparian functions and values. Trees regenerated today will provide the future source of cover, cavity trees, woody material, and snags. Some silvicultural and wildlife habitat objectives can conflict with no-harvest or limited harvest RMZs. For example, maintaining beavers at an active flowage within a particular stream reach may require active tree harvesting within these zones (6.8 Beaver-Created Openings). Soil scarification improves the likelihood of regenerating white pine, red oak, or red spruce, and may conflict with the recommendation to minimize ground disturbance.
- Riparian forests may be highly productive. Limiting harvesting in RMZs will entail some financial loss to riparian landowners.
- The integrity of aquatic and riparian ecosystems may be affected by activities of others throughout the watershed.

RECOMMENDED PRACTICES

✓ Survey the property (ideally in early spring) and identify important hydrologic features such as rivers, streams, lakes and ponds.

✓ Establish RMZs along streams, rivers, ponds, and lakes. Recommended minimum zone widths and key considerations are described above and reflected in Table 1.

✓ Include maintaining or restoring riparian functions and values as a silvicultural objective in RMZs.

- Retain trees with cavities, standing dead trees, downed logs, and large supracanopy trees (especially white pine).
- Leave windfirm trees that are well-distributed. Leave other vegetation, including existing groundcover.
- Choose a regeneration system most likely to maintain riparian functions and values and rapidly regenerate the site with the desired trees. Choosing a method is complicated by wet soils and the desire to maintain forest structure that contributes to wildlife habitat and other ecological values.

- Use uneven-aged techniques such as single tree or small group selection, maintaining 60 to 70 percent crown closure or full stocking as recommended in silvicultural guides. (To convert crown closure percentages to basal area, see Leak and Tubbs 1983).
- Use even-aged techniques such as shelterwood or patch cuts to achieve regeneration goals when rapid regeneration is likely (2.3 Regeneration Methods).

✓ Locate new truck roads and log landings outside RMZs, except where doing so would result in greater overall adverse environmental impacts.

✓ Design roads and skid trails within RMZs to minimize the long-term impacts on water quality and wildlife habitat. Apply BMPs according to guidelines in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. Consult the latest version before harvesting timber. Put roads to bed using BMPs to stabilize the soil, control run-off, and control unwanted vehicular access at the end of the harvest.

✓ Minimize ground disturbance. Operate ground-based equipment when the ground is dry or frozen.

✓ Time harvesting to avoid disturbance to nesting birds (6.10 Woodland Raptor Nest Sites) and other sensitive species.

✓ Leave the area closest to the stream, pond or wetland unharvested to provide increased protection to aquatic habitats, protect wildlife trails, and allow a reliable long-term supply of cavity trees, snags, and down woody material. Refer to the Table 1 for guidance. Larger zones increase the protection of nontimber values; however, no-harvest zones may not always be consistent with ecological or silvicultural objectives.

✓ Keep trees along banks to stabilize shorelines.

✓ Avoid leaving isolated riparian management zones with long distances of abrupt edge (a sharp change in type and size of vegetation). Riparian forests next to heavy cuts, agricultural, or urban land uses may be subject to increased edge effects (e.g., invasives, nest predation) and risk of blowdown. Practices that minimize these risks include limiting harvest within the riparian management zone, increasing the width of the zone, or feathering the edges of a heavy cut.

✓ Refer to 4.2 Wetlands for recommended practices specific to wetlands.

CROSS REFERENCES

2.2 Forest Structure; 2.3 Regeneration Methods; 3.5 Soil Productivity; 4.1 Water Quality; 4.2 Wetlands; 4.4 Stream Crossings and Habitat; 5.2 Invasive Plants; 6.8 Beaver-Created Openings; 6.9 Deer Wintering Areas; 6.10 Woodland Raptor Nest Sites; 6.11 Bald Eagle Winter Roosts; 6.12 Heron Colonies; 6.13 Wildlife Species of Greatest Conservation Need; 7.1 Natural Communities and Protected Plants; 7.3 Vernal Pools.

ADDITIONAL INFORMATION

Chase, V., L. Deming, and F. Latawiec. 1995. *Buffers for Wetlands and Surface Waters: A Guidebook for New Hampshire Municipalities*. Audubon Society of New Hampshire, Concord, N.H. 80 p.

Leak, W.B., and C.H. Tubbs.1983. *Percent crown cover tables for applying in the shelterwood system in New England*. USDA For. Serv. Res. Note. NE-313. 4 p.

N.H. Dept. of Environmental Services. 2010. *DES Consolidated List of Waterbodies Subject to RSA 483-B, the Comprehensive Shoreland Protection Act*. http://des.nh.gov/organization/divisions/water/wetlands/cspa/documents/consolidated_list.pdf Accessed February 8, 2010.

RSA 227-J. *Timber Harvesting*. http://www.gencourt.state.nh.us/rsa/html/xix-a/227-j/227-j-mrg.htm Accessed May 27, 2010.

RSA 482-A. *Fill and Dredge in Wetlands*. http://www.gencourt.state.nh.us/rsa/html/l/482-a/482-a-mrg.htm Accessed May 27, 2010.

RSA 483-B. *Comprehensive Shoreland Protection Act*. http://www.gencourt.state.nh.us/rsa/html/l/483-b/483-b-mrg.htm Accessed May 27, 2010.

Verry, E.S., J.W. Hornbeck, and C.A. Dolloff (eds.). 2000. *Riparian Management in Forests of the Continental Eastern United States*. Lewis Publishers, Boca Raton, Fla.

4.4 STREAM CROSSINGS AND HABITAT

BACKGROUND

Roads are necessary for forest management and access for outdoor activities such as hunting, fishing, hiking, wildlife watching and snowmobiling. Roads that cross streams can impact stream habitat and streamflow.

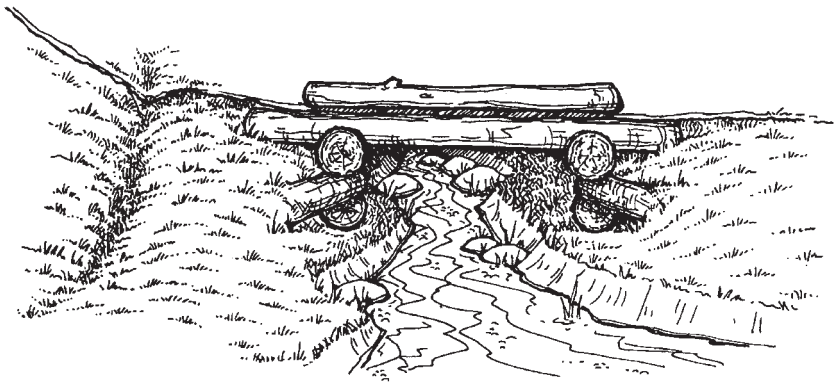
This chapter addresses the needs of fish and other aquatic organisms. The importance of intermittent streams is also addressed. Best management practices (BMPs) to prevent erosion can be found in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire* published by the N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. You can learn about additional practices in *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality*. Using BMPs minimizes the impact of crossings on streams and stream habitat during timber harvesting.

Aquatic organisms move upstream and downstream throughout their life cycles. The survival of a population depends on access to spawning habitat, feeding areas, and shelter, as well as the dispersal and colonization of available habitat by juveniles. A healthy population also depends on unrestricted gene flow; crossings may isolate populations, making them vulnerable to extirpation. Many species of amphibians, reptiles, and mammals use riparian zones as travel corridors, and their movement may be impeded by certain crossings.

Instream wood (trees and branches), sediment, and ice transport are important. Trunks and branches (1) retain nutrients within the stream and keep excess nutrients from going into waterbodies downstream, (2) create pools for fish and other aquatic animals, and (3) are used by fish as refuges to avoid predators and high water velocities that occur during floods. Downed trees are a natural component of streams, and they are often transported long distances from where they initially entered the stream channel. It's important not to create conditions that cause downed wood from upstream to block the stream crossing. Sediment and ice are also integral parts of stream systems; like branches they can plug undersized stream crossings. Erosion can cause an increase in nutrients, reducing water quality, especially in downstream waterbodies (4.3 Forest Management in Riparian Areas).

These same processes occur in intermittent streams and perennial (year-round) streams. The surrounding forest provides leaves and coarse woody material critical to the food web along the entire stream course. These materials are carried downstream, as are the invertebrates that feed on them. Crossings on intermittent streams should also allow for aquatic organism passage, since aquatic invertebrates, some unique to intermittent streams, occupy these streams year-round.

The following is a brief discussion of the more common types of crossings most often used in timber harvesting operations:



Courtesy of the New Hampshire Division of Forests and Lands.

Bridges

Bridges span streams entirely, and can be the best way to protect the stream and crossing structure. They can be permanent or temporary and made of wood, metal or a

combination. Permanent bridges are often used for truck roads, while temporary bridges may be used for skid trails. Sited properly, bridges won't affect water flow and will reduce or eliminate erosion of the bank. Improperly constructed abutments can cause bank erosion.

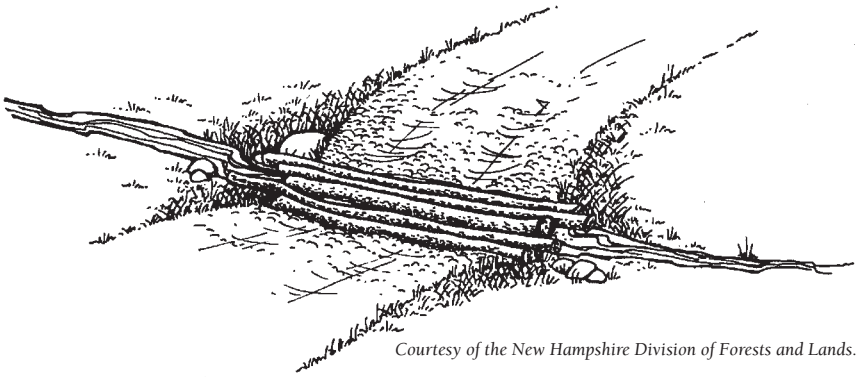
Culverts

A culvert is a corrugated pipe, well-casing, or other type of pipe placed under a truck road or a major skid trail to permit the crossing of an intermittent or perennial stream. A culvert can be either temporary or permanent. (Culverts used as cross-drainage in truck roads aren't covered in this chapter). In general, culverts installed within truck roads are permanent crossings.

An improperly designed, sized, or installed culvert can block fish, other animals and natural materials from moving downstream. Culverts can lead to streambed and bank erosion on the downstream side of the culvert due to the increased water velocities exiting the pipe. The result is a perched culvert with its downstream end above the water. The resulting waterfall can prevent aquatic animal passage.

Poled Fords

A poled ford is a temporary stream crossing in which natural materials are used to fill a defined channel to allow for the passage of vehicles. Per RSA 482-A, poled fords are a BMP and must be removed as soon as the site is closed. Leaving them in place after the permit expires is considered fill and violation of state law. Leaving them in place can also lead to streambed and bank erosion and reduced aquatic animal passage. Corduroy (poles, logs or brush laid perpendicular to the direction of travel), used to fill wet places that aren't streams, aren't considered poled fords and may be left in place.



Courtesy of the New Hampshire Division of Forests and Lands.

Stone Ford

Stone fords use the stable stream bottom or stone fill as the road bed. They are intended as permanent crossings since their removal can cause erosion and turbidity. On roads where the wide width and shallow water combine to make a bridge or culvert unworkable, a stone ford combined with a culvert sized to accommodate fish and other aquatic organism passage is an option.

OBJECTIVE

Provide safe stream crossings that allow passage of aquatic animals up and down the stream and protect water quality.

CONSIDERATIONS

- The N.H. Dept. of Environmental Services regulates the design and installation of temporary and permanent stream crossings. A wetlands permit may be required before the installation of a temporary or a permanent stream crossing, including bridges that don't run bank to bank. Bridges running bank to bank may not need a permit.

- Streams are inherently dynamic, and natural processes in stream morphology can have dramatic impacts on stream crossings and associated roads. Undersized crossings can become plugged with downed wood and sediment, leading to increased maintenance costs and sometimes to the failure of the stream crossing.
- Watershed size and topography affect the amount of water and "flashiness" of flood events.
- Planning road, landing, and skid-trail layout without snow cover makes it easier to see intermittent and perennial streams.
- Limiting stream crossings can reduce costs.
- The type and size of crossings will affect both cost and permitting requirements. Appropriate designs can minimize installation costs and reduce cost over the expected life of the crossing. Costs depend on the structure, site conditions and expected lifespan.
- A permanent crossing is generally installed within a truck road. Temporary crossings are generally installed within a skid trail.
- Portable bridges are an option for skid trails that are expected to be used for a short period of time.
- The installation cost of a permanent bridge may be more than that of a culvert, but the savings over the course of its life may be less due to reduced maintenance needs and costs.
- Although a temporary crossing can remain for the life of the wetlands permit (two years), removing it as soon as the harvest is complete and the ground conditions allow minimizes the impact to aquatic animals.
- Culvert size, placement and bottom substrate are all important considerations.
  - Guidelines are available in *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality*.
  - Continuing the natural substrate of the stream through the culvert ensures aquatic animal passage. Open bottom culverts maximize aquatic organism passage by maintaining a natural streambed.
  - The practice of laying two or more small culverts side by side blocks flow and can require higher maintenance by blocking natural material that floats downstream.
- While fords are appropriate for maintaining water quality, they block the stream channel, even when used in combination with a culvert.
- Bridges and culverts are preferred over stone fords for permanent crossings to accommodate aquatic animal passage.

RECOMMENDED PRACTICES

- ✓ Consult your natural resource professional for permitting requirements and to determine which type of crossing is best suited for your particular situation.
- ✓ Use BMPs as detailed in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire* (and as required by RSA 482-A:3). Consult the latest version before harvesting timber. Also refer to *The Guide to New Hampshire Timber Harvesting Laws*. For stricter practices to protect aquatic organisms see *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality*.
- ✓ Locate landings, roads and skid trails to minimize the number of stream crossings.
- ✓ Construct during periods of no- or low-flow and in as short a period of time as possible.

4.4: Stream Crossings and Habitat

- ✓ Design the crossing to fit the stream channel. Locate crossings where:
  - Stream alignment is straight and has a uniform profile so as not to obstruct the flow of water. Avoid bends in the stream.
  - Banks are firm and level.
  - Road and trail approaches are reasonably level for a distance of 50 feet on each side of the crossing, avoiding sharp curves in the road.
- ✓ Crossings shouldn't be sited where there is an accumulation of instream downed wood or sediment. This indicates that instream wood will likely clog the inlet of the crossing.
- ✓ Design crossings to handle the largest streamflows. See *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality*, pages 45-47 for recommendations and easy calculations.
- ✓ Minimize the amount of water from the road entering the stream by:
  - Constructing the road so the grades approaching the crossings divert water from the stream.
  - Directing roadside ditches away from the stream well before the crossing.
  - Using water bars to divert road run-off from streams.
  - Using brush, slash and tops to stabilize skid-trail approaches.
- ✓ For temporary crossings:
  - Consider using a portable skidder bridge. See *A Guide for Constructing and Using Portable Skidder Bridges*.
  - Site the approach as carefully as you would for permanent crossings.
  - Remove the structure and stabilize the bank as soon after the harvest as ground conditions permit.
- ✓ Where possible, use bridges and culverts as the preferred method rather than stone fords. Span streams with a bridge in which the abutments extend beyond the top of the stream banks.
- ✓ When installing stone fords with a culvert:
  - Size the culvert wide enough to accommodate the passage of fish and other aquatic organisms.
  - Place the culvert at the deepest point of the stream.
  - Choose ford material that allows water to flow through it, so the ford doesn't act as a dam. Use a minimum of 6-inch angular stone anchored by large boulders on the downstream side.
  - Design the ford to minimize the risk that the addition of stone material will direct the stream around the ford during low or high flows, causing erosion.
  - Make the ford at the same elevation as the natural substrate at the ford location.
  - Protect entry points at the streambank from erosion due to the travel of equipment.
- ✓ Culvert Recommendations:
  - Avoid side-by-side culverts.
  - Size culverts to provide uninterrupted flow of water, sediment, downed wood and ice. There are two suggested methods to determine the minimum size of a round culvert. See pages 45-49 in *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality* or consult with the Natural Resources Conservation Service for assistance with using the watershed drainage method or visit *NH StreamStats*.
  - When conditions permit, install an emergency spillway adjacent to a culvert by making one section of the road lower in elevation so flood water goes over the road at that point instead of around the crossing. This spillway should have a stable base.

- Protect the upstream end of the fill around the culvert from erosion by placing rock headers.
- Install the culvert so it's in line with the existing stream. A maximum of 15 degree skew is acceptable as an exception where approach conditions are difficult.
- Align the approach and exit of the road perpendicular with the culvert with as little curvature as possible.
- To maximize aquatic-organism passage, consider several options to maintain a natural streambed. Techniques vary in effectiveness and cost and include:
  - Placing culverts in the natural channel.
  - Digging culverts into the streambed so the inside of the culvert has the same substrate as the natural streambed.
  - Using open-bottom culverts.

CROSS REFERENCES

4.1 Water Quality; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas.

ADDITIONAL INFORMATION

N.H. Administrative Rules Env-Wt 900. http://des.nh.gov/organization/commissioner/legal/rulemaking/documents/env-wt900adpt-pstd.pdf Accessed June 1, 2010.

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

RSA 482-A. *Fill and Dredge in Wetlands*. http://www.gencourt.state.nh.us/rsa/html/l/482-a/482-a-mrg.htm Accessed May 27, 2010.

Smith, S. (ed). 2005. *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality*. UNH Cooperative Extension, Durham N.H. http://extension.unh.edu/resources/representation/Resource000248_Rep267.pdf Accessed February 8, 2010.

Smith, S. 2009. *Guide to New Hampshire Timber Harvesting Laws*. UNH Cooperative Extension, Durham, N.H. 37 p.

US Geological Survey. *NH StreamStats*. http://water.usgs.gov/osw/streamstats/new_hampshire.html Accessed February 8, 2010.

Vermont Division of Forestry. 2008. *Wooden Portable Skidder Bridge Information Sheet*. http://www.vtfpr.org/watershed/portbridgebroc.cfm Accessed on January 21, 2009.

FOREST HEALTH

TOPICS IN THIS SECTION

5.1 Insects and Diseases
5.2 Invasive Plants
5.3 Ice and Wind Damage
5.4 Logging Damage

ADDITIONAL READING

The Stewardship of Northern Hardwoods: A Forest Owner's Handbook
Kim B. Adams, Douglas C. Allen, Paul D. Manion, and Lawrence P. Abrahamson
SUNY-College of Environmental Science and Forestry
1995

Forest Health and Protection
Robert L. Edmunds, James K. Agee, and Robert I. Gara
McGraw-Hill
2000

Diagnosing Injury to Eastern Forest Trees
Edited by J.M. Skelly, et al.
Agricultural Information Service, College of Agriculture Penn State University, and USDA Forest Service
1987

5.1 INSECTS AND DISEASES

BACKGROUND

Endemic populations of native insects and pathogens are important in healthy forest ecosystems. However, introduced non-native exotics can cause excessive damage.

Insects are prey items at the very bottom of the food chain. Along with other decay organisms, some insects transform dead and dying plant material (including trees) into nutrients that feed new plants. Insects and diseases become problems when populations reach out-of-balance, epidemic levels. Tree-growth loss and mortality can occur and the economic impact can be severe. The most devastating insect and disease outbreaks often occur when non-native pests are introduced into locations where they have no natural enemies. Throughout North America, exotic insects such as balsam woolly adelgid, gypsy moth, pear thrips, Asian longhorned beetle, and emerald ash borer have all caused growth loss and mortality. Exotic diseases such as Dutch elm disease, chestnut blight, and butternut canker have virtually eliminated their host species.

OBJECTIVE

Reduce undesired mortality and growth loss from native pests, limit introductions of exotic pests, and eradicate new introductions as they are detected.

CONSIDERATIONS

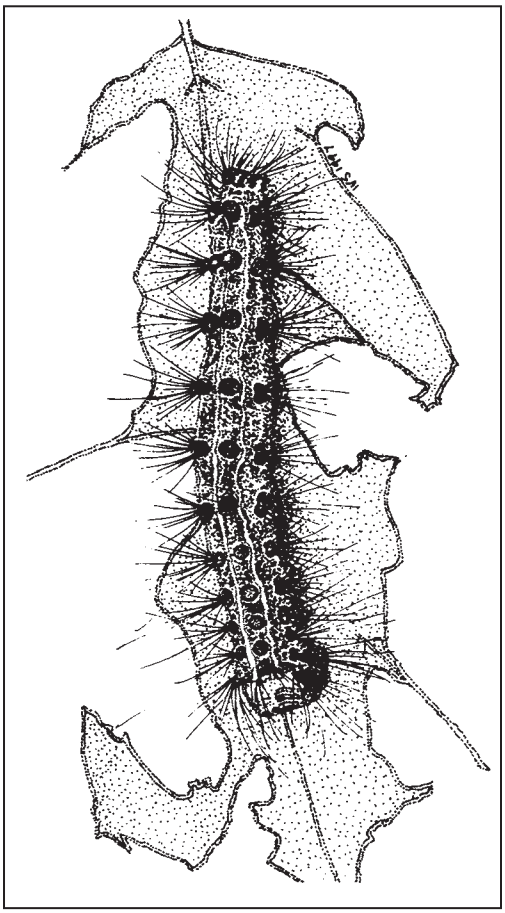
- Well-recognized benefits from natural-disturbance factors include the provision of dead and down woody material, snags and cavity trees for wildlife, and openings for regeneration. While native pests are part of naturally functioning ecosystems, many of the most destructive insect and disease problems are the result of exotic pests introduced into the state.
- While predators such as birds can't control outbreaks, they provide important constraints on insects at endemic population levels and can extend the period between outbreaks.
- Recommended pest control can conflict with other recommended practices. For example, removing trees with beech bark disease may conflict with recommendations to protect mast-producing beech showing evidence of bear use.
- Many regional and national activities have been implemented to limit damage by forest pests. Examples include introduction of biological controls, imposition of federal quarantines, and pheromone trapping.
- Exotic invasive pests found in neighboring states threaten New Hampshire's forests. Early detection will make the difference between success and failure with regard to their eradication. Knowing their signs and symptoms, their locations, and how they spread improves chances of detection and eradication. Internet searches and direct contact with state and federal forest health specialists can provide the latest information.
- State law (RSA 227-K:3) allows the director of the Division of Forests and Lands to designate control areas when localized infestations of exotic, non-native insects or diseases threaten to spread to adjacent lands. The law also requires landowners to take actions to control the infestation; if the landowner is unwilling, the State may take such actions.

- Forest-pest quarantines fall under the authority of the N.H. Dept. of Agriculture, Markets and Food and the N.H. Division of Forests and Lands (NHDFL).
- Pesticide applications in any form, from aerial applications to systemic applications, can have secondary consequences. Pesticide applications are strictly regulated by federal and state laws and may require several permits and licenses.
- The emphasis in this section is on silvicultural methods that may limit undue losses on individual ownerships. Where severe infestations from insects are already underway, regional biological or chemical control programs may be necessary. Maintaining populations of native predators such as birds and small mammals will help reduce the intensity of infestations.

RECOMMENDED PRACTICES

Defoliators

Defoliators feed on leaves or needles during the growing season. Common examples include spruce budworm and large aspen tortrix in the north, saddled prominent and forest tent caterpillar in central New Hampshire, and gypsy moth and hemlock looper in the southern part of the state. A forest diversified in both age structure and species composition limits susceptibility to defoliators. Most insects are host-specific and prefer one or two species of a particular age group (e.g., a large, uniform area of sugar maple is highly susceptible to forest tent caterpillars and a large area of mature fir to spruce budworm).



Gypsy Moth caterpillar

- ✓ Avoid partial harvests during an outbreak, as this will divert the epidemic insect population to fewer and more-exposed trees, and likely exacerbate defoliation and subsequent stress and tree decline.
- ✓ Don't partially harvest a stand until at least three years after the last major year of defoliation. After three years the weakest trees will be evident or dead. Until three years have passed, the defoliated stand is highly susceptible to residual logging damage. Defoliators reduce the amount of carbohydrates stored in the root system during the dormant season. Root damage and basal wounding from logging equipment compound the stress to residual trees and may cause growth reductions and branch dieback.
- ✓ Aerial pesticide applications are rare. When an outbreak is severe and the forest value exceptional, it may be appropriate but will require a special pesticide application through the N.H. Division of Pesticide Control. Contact the NHDFL forest health office for guidance.

Spruce Budworm: Increasing the proportion of spruce to fir and developing a mix of forest types and ages over several thousand acres will minimize spruce budworm. Consider the forest structure within a broader landscape rather than focusing on a single, small property.

- ✓ Spruce budworm prefers balsam fir and white spruce. Spruce budworm is most destructive and epidemic in 60-to-80-year-old stands with a high proportion of balsam fir. Approaches for

avoiding serious damage include (1) harvesting fir stands before they become overmature, (2) encouraging higher spruce-to-fir ratios through regeneration practices and early cultural work, (3) breaking up extensive stands of fir and spruce-fir with intervening hardwood or mixed-wood stands, provided that management objectives and site conditions permit, and (4) encouraging budworm predators.

- ✓ At least 49 bird species prey on budworm pupae, and 11 species are considered important predators at low to moderate levels. The most effective predators include: (1) in mature conifer mixtures—blackburnian warbler, golden-crowned kinglet, yellow-rumped warbler, and red-breasted nuthatch; (2) in brushy openings and edges—Nashville warbler, white-throated sparrow, and black-capped chickadee; and (3) in somewhat open, immature conifer stands and hardwood regeneration—magnolia warbler and solitary vireo.

Piercing-Sucking Insects

These insects are more chronic than the defoliators. Once infested, a stand remains infested for a long time. Hemlock woolly adelgid, balsam woolly adelgid, and elongate hemlock scale are non-native, exotic piercing-sucking insects.

- ✓ Though silvicultural practices don't result in true control, they can help reduce stand susceptibility to attack and vulnerability to damage.
- ✓ Proper stocking improves tree and stand vigor. Trees competing for growing space and nutrients are far more likely to succumb to chronic infestations.
- ✓ Harvest stands infested with balsam woolly adelgid in the winter because nymphs attached to tree tops can't survive. If the trees are cut in the summer, the insects are mobile enough to spread to uncut trees.
- ✓ Consult the quarantine map for hemlock woolly adelgid before harvesting hemlock. Any hemlock material from within the quarantine area needs to be certified clean of adelgid before shipment out of the zone (RSA 227-K). Hemlock stands can be certified clean of adelgid prior to harvesting by licensed foresters, UNH Cooperative Extension county foresters, NHDFL personnel, or other professionals specifically trained by the NHDFL.
- ✓ If a hemlock woolly adelgid infestation covers less than one-quarter acre, cut and burn the hemlock foliage before harvesting. If the infestation is larger than one-quarter acre, it's likely the infestation can't be eradicated before harvesting. The infested products must remain inside the quarantine area. Contact the NHDFL for further information and for mills and burn facilities inside the regulated area.
- ✓ Insecticides work well for these insects, however access and tree size may limit their use. Adelgid populations are most successfully treated with soil injections, soil drenches or basal bark treatments to limit exposure to nontarget insects. Contact the NHDFL forest health office for specific information on products, dosages and application methods.

Beech Bark Disease: Managing to reduce or eliminate beech bark disease will take several generations of silviculture. Some beech trees, recognized by their clean, smooth boles with a minimal presence of the white woolly scale, are resistant to the beech scale insect that precedes infection by the *Nectria* fungus.

- ✓ In thinnings, selection cuts, and other partial harvests, remove trees heavily infested with the white, woolly scale or red, small fruiting-bodies of the *Nectria* fungus, including those rough-barked trees that show evidence of previous beech bark damage. To minimize regeneration by root suckers from these nonresistant trees, avoid damage to beech roots by logging on snow and keep skidding activity away from the cut beech trees to the extent possible. Alternatively, when the clean-barked, resistant trees are removed, encourage root-suckering by logging during snow-

free season and allowing moderate skidding activity near these resistant trees or groups of trees. Summer-cut sprouts of diseased beech have low vigor and don't persist well as compared to regeneration of healthy northern hardwoods on the same site.

- ✓ To reduce the percentage of beech, use larger openings to regenerate less shade-tolerant species that will out-compete the beech sprouts. Winter harvesting also will reduce sprouting due to reduced root damage.
- ✓ Leave trees with evidence of bear-claw marks.

Wood Borers and Bark Beetles

Sugar maple borer, oak borer, *Ips* beetles and *Dendroctonus* beetles are native New Hampshire borers and beetles. They tend not to grow past endemic levels and only attack stressed, dying, and dead trees. White pine weevil is a native borer that does attack healthy trees. The number of non-native, invasive wood boring insects in North America such as Emerald ash borer, Asian longhorned beetle, and sirex woodwasp is growing. Infestations continue to spread closer to New Hampshire each year. Once infested with these exotic pests, trees rarely survive more than a few years.

Asian Longhorned Beetle

- ✓ Keep the forest in diversified species, properly stocked, and minimize logging stress such as soil compaction and mechanical damage to residual trees.
- ✓ The only treatment for heavily infested monocultures (e.g., red pine plantations) may be complete removal.
- ✓ In the event of an infestation by non-native exotics, follow recommendations for control developed for the specific pest.

White Pine Weevil: To avoid excessive white pine weevil injury in the regeneration, maintain partial overstory shade.

- ✓ Grow white pine seedlings and saplings in shade (40 to 80 square feet of basal area or in small openings less than one tree height in diameter) until they have attained at least one unweeviled log height (18 feet). Conifer shade may provide more protection than hardwood shade, since early spring weevil activity (before hardwood leaves are out) is the most damaging to terminals. In addition to the direct effects of shade, overstory trees reduce the size and vigor of the leader, making it less attractive to weevils.
- ✓ In young, even-aged stands experiencing weevil damage, maintain high stand density to minimize the deformations caused by weevil injury. An approximate spacing of less than 6 feet by 6 feet is required for maximum effect.

Root Diseases

Root diseases result from a large group of fungi that cause decay, stress, reduced growth, and death. Common examples are *Armillaria*, and *Heterobasidion annosum* (formerly *Fomes annosus*). Root-attacking fungi such as *Armillaria* are present in almost all forest soils. Damaging root-fungi attacks require favorable moisture and oxygen conditions, a point of entry into the host tree, and low tree vigor, which combine to make it difficult for the tree to defend itself.

- ✓ *Armillaria* travels from cut stumps to stressed trees through the maze of root grafts in the soil. Space harvests more than 10 years apart to minimize root-rot infections from previous timber harvests.
- ✓ Limit damage to the roots and boles of residual trees.

Stem-Canker Diseases

Stem-canker diseases are fungi that attack the stem, shoots and branches and cause lesions or dead areas on the stem. Common examples include *Nectria* canker, *Caliciopsis*, blister rust, chestnut blight, and *Eutypella* cankers.

- ✓ Remove trees with stem cankers. Spores are produced from the margins of infected areas and can infect surrounding trees.
- ✓ For rust diseases that require an alternate host, eliminating the nontimber alternate host is the best control. Gooseberries and currants should be absent within several miles of a young white pine stand.
- ✓ *Caliciopsis* canker on white pine appears like a black mold on the upper stems of the tree. Often lesions weep pitch in streaks. Thinning infected stands to allow more sunlight and warmer air conditions improves the vigor of the residual trees and reduces the moisture conditions needed by the fungi. Remove the trees with heaviest infections.

Foliage Diseases

Foliage diseases result from organisms that attack needles and leaves. Common examples include *Anthracnose*, needlecast fungi, tar spot, and sooty mold.

- ✓ Hardwood foliage diseases are generally less serious than softwood foliage diseases, because hardwoods will drop the infected leaves and refoliate in subsequent years. The specific conditions of moisture, temperature, and host-susceptibility are sporadic and most heavy infections in hardwood forests last just one year. No control is usually needed.
- ✓ Spores overwinter on fallen leaves. In an urban setting, reduce the annual inoculum by raking and removing infected leaves.
- ✓ Softwood foliage diseases most often affect older needles and lower needles on the live crown. Thin stands to reduce the amount of spores and to reduce high-moisture conditions around the base of the trees.
- ✓ Remove the most infected trees in the stand.

Heart Rots

Heart rots are the decay fungi that penetrate to the center of a tree and rot the core from the inside out. There are white rots that feed on lignin and cellulose and red rots that feed just on cellulose. The red rots leave a brown or red brittle material, while the white rots leave a white coloring where lignin was removed. Fruiting structures of these diseases are often shelf-like conks attached to the sides of the tree.

- ✓ Remove trees with conks during harvesting, if leaving them poses a risk to property or personal injury.
- ✓ Avoid logging damage, specifically broken branches in the residual stand, to minimize the entry points for wind-blown spores.

Other Diseases

Other diseases are viruses, mycoplasma-like organism (MLO), and bacteria. Ash yellows is an MLO. The microbe is thought to be carried from tree to tree by leaf hoppers. These insects spend a period of time in

open grassy areas which may explain why ash yellows is more common in urban settings than in the deep forest.

- ✓ There is no control for ash yellows. Cut declining ash with serious signs and symptoms such as witches' brooms and epicormic branching on the bole of the tree.

CROSS REFERENCES

2.1 New Hampshire Forest Types; 2.2 Forest Structure; 2.3 Regeneration Methods; 2.4 Managing for High-Value Trees; 6.2 Cavity Trees, Dens and Snags; 6.3 Dead and Down Woody Material.

ADDITIONAL INFORMATION

Forestry Images. http://www.forestryimages.org/insects.cfm Accessed March 7, 2010.

N.H. Division of Forests and Lands. *Forest Health homepage*. http://www.nhdfl.org/forest-health/ Accessed March 7, 2010.

RSA 227-K. *Forest Health*. http://www.gencourt.state.nh.us/rsa/html/NHTOC/NHTOC-XIX-A-227-K.htm Accessed May 27, 2010.

UNH Cooperative Extension. *Common Pests of NH Trees and Shrubs*. http://extension.unh.edu/fwt/forpest/compests.cfm Accessed August 2, 2010.

University of Georgia. *Center for Invasive Species and Ecosystem Health*. http://www.bugwood.org/ Accessed March 7, 2010.

USDA Forest Service—Northeastern Area. *Forest and Tree Health Publications and Fact Sheets*. http://www.na.fs.fed.us/pubs/misc.shtm Accessed March 7, 2010.

USDA Forest Service—Forest Health Protection. *Forest Insect and Disease Leaflets*. http://www.fs.fed.us/r6/nr/fid/wo-fidls/ Accessed March 7, 2010.

USDA Forest Service—*Forest Health Protection. Forest Health Management homepage*. http://www.fs.fed.us/foresthealth/management/index.shtml Accessed March 7, 2010.

5.2 INVASIVE PLANTS

BACKGROUND

Invasive plants can pose a threat to forest ecosystems and forest productivity. Foresters, landowners, and loggers can play important roles in slowing the spread of invasive species.

Invasive plants are non-native species that invade natural communities and develop self-sustaining populations. The start of many infestations is often tied to a disturbance, and once established, the invasive species spread into undisturbed landscapes. They out-compete native species, disrupting ecological processes, and cause a loss of economic value or output. The economic impacts, sometimes hard to discern directly, often result from the environmental impacts.

The N.H. Invasive Species Law (RSA 430:52 and N.H. Administrative Rules AGR 3800) defines an invasive species as "an alien species whose introduction causes or is likely to cause economic or environmental harm or harm to human health." These species come in a variety of forms, including trees, vines, shrubs, grasses, terrestrial herbaceous and aquatic.

As a group, invasive plants are generalists. Although there is at least one invasive plant for every habitat, many terrestrial invasives tolerate a wide variety of environmental conditions, allowing them to thrive at diverse sites. Glossy buckthorn successfully invades sunny and shady sites alike and tolerates both wet and dry conditions. Oriental bittersweet, a strangling woody vine, may languish in the shade of a forest until a canopy gap opens or its leading branch reaches the canopy. It grows rapidly across the forest canopy, strangling trees and weighing them down.

Table 3800.1
New Hampshire Prohibited Invasive Species List from N.H. Administrative Rules AGR 3800

Scientific Name	Common Name
Acer platanoides	Norway maple
Ailanthus altissima	tree of heaven
Alliaria petiolata	garlic mustard
Berberis thunbergii	Japanese barberry
Berberis vulgaris	European barberry
Celastrus orbiculatus	Oriental bittersweet
Centaurea biebersteinii	spotted knapweed
Cynanchum nigrum	black swallow-wort
Cynanchum rossicum	pale swallow-wort
Elaeagnus umbellata	autumn olive
Euonymus alatus	burning bush
Heracleum mantegazzianum	giant hogweed
Hesperis matronalis	dame's rocket
Iris pseudacorus	water-flag
Lepidium latifolium	perennial pepperweed
Ligustrum obtusifolium	blunt-leaved privet
Lonicera bella	showy bush honeysuckle
Lonicera japonica	Japanese honeysuckle
Lonicera morrowii	Morrow's honeysuckle
Lonicera tatarica	Tatarian honeysuckle
Microstegium vimineum	Japanese stilt grass
Polygonum cuspidatum	Japanese knotweed
Polygonum perfoliatum	mile-a-minute vine
Reynoutria × bohemica	bohemia knotweed
Rhamnus cathartica	common buckthorn
Rhamnus frangula	glossy buckthorn
Rosa multiflora	multiflora rose

Some impacts on forests include:

- Reducing the abundance, density, and diversity of tree seedlings.
- Displacing natural plant and animal communities or altering species composition.
- Competing with native species for space, nutrients, and water.
- Altering soils, which in turn may affect their ability to retain or shed water; may increase soil erosion.
- Increasing fire hazard.
- Acting as hosts for other damaging organisms.
- Decreasing the quality of forest habitats for native wildlife.

OBJECTIVE

Prevent the dispersal and establishment of invasive plants and mitigate their impacts on the forests.

CONSIDERATIONS

- Invasive plants are dispersed in many ways including by wildlife, horticulture, personal and recreational vehicles (e.g., all-terrain vehicles, bicycles), mowers and the activities of state and local road crews. Forestry (with its associated practices and equipment—skidders, trucks, mowers, etc.) is just one way invasive plants can be introduced and existing infestations exacerbated.
- State law prevents the sale, distribution, or transport of invasive species. RSA 430:51-57 states, "No person shall collect, transport, import, export, move, buy, sell, distribute, propagate or transplant any living and viable portion of any plant species, which includes all of their cultivars and varieties, listed in Table 3800.1, New Hampshire prohibited invasive species list." For example, the movement of viable seeds or fruits in the treads of heavy equipment or the transport and use of fill with invasives violates state law.
- Invasive plants thrive on disturbance, often requiring the combination of seed sources or vegetative propagule (plant pieces that root and sprout) and disturbance. Once established they can spread beyond the introduction site even in the absence of continued disturbance.
- Healthy forest ecosystems are less susceptible to infestation by invasive plants. Though careful silvicultural planning and practices can reduce or prevent invasive plant infestations, forestry practices can also create conditions suitable for invasive plants. These conditions occur when site disturbance exposes soil creating a seedbed, or tree removal releases invasives already present.
- Early detection (pre-operation survey) and rapid response (development and implementation of a control plan) can prevent further spread of invasive plants.
- Prevention and control can be costly. Costs can be silvicultural, as in the case of modifying prescriptions or the failure of planned regeneration, or direct payments to control invasives or clean equipment. The costs associated with invasive plant prevention and control should be evaluated against silvicultural objectives, and be commensurate with the threat posed.
- Cleaning equipment will help prevent the spread of invasive plants into areas not already infested. Clean equipment is visibly free of mud, seeds, berries, and other plant material. Cleaning equipment using pressure washing equipment and catchment basins to collect wash water as well as hydraulic fluids, oil, and fuel, though desirable, may not be practical and economically feasible.
- It's difficult to know that sand, gravel, mulch and fill materials are invasives-free. Hay can contain seeds of invasives. Though straw is generally considered invasives-free, it's significantly more expensive than hay and not always weed-free.
- Deer overpopulation and browsing pressure, combined with invasive plant infestations, can make it difficult to regenerate native plants and can hinder the growth of seedlings and saplings. Deer tend to selectively browse on native species, thereby giving invasive plants the advantage.
- Fire benefits many invasive plants and may result in their dominance in the regeneration layer.

RECOMMENDED PRACTICES

Develop a strategy for managing invasive plants based on owner objectives and the species and amount of invasives present. Methods exist for managing invasives prior to, during, or following a forestry project. Except as required by law, all these practices are voluntary.

Planning

✓ Conduct a pre-operation survey to determine whether invasive plants are present. This can be integrated into regular stand inventory and monitoring.

- ✓ Map infestations and use the mapped locations in planning harvest areas and skid trails, truck roads, and landing locations. Avoid placing transportation infrastructure and landings in infested areas.
- ✓ Reuse landings and roads at invasive-free sites, to limit new disturbance.
- ✓ Use invasives-free sand, gravel, mulch, and silt barriers.

Equipment Cleaning

- ✓ If operating at a site with invasive plants, inspect equipment to ensure that seeds, berries, roots or branches aren't transported to an uninfested location. Clean equipment using a broom, compressed air or pressure-washing before moving to a new location.
- ✓ Dispose of invasive debris in a manner that avoids further spread. Burning collected debris in a pile is the best disposal method. Seek necessary permits and otherwise comply with RSA 227-L.

Control

- ✓ Determine whether control is practical and ecologically feasible. Control may not be warranted for species that cause minimal interference with management objectives. Control may be impractical and costly for invasives present in large numbers, in which case avoiding them may be the best option.
- ✓ Determine if control should take place before, during, or after the project. Control small to moderate infestations of species known to cause severe economic or ecological damage before or immediately after starting the project.
- ✓ Three to five years of active control and monitoring are typically required to ensure effective control and depletion of seed reserves in the soil seed bank.
- ✓ Mechanical control can take many forms including hand pulling, digging, mowing, blading, and tilling. Due to its labor intensive nature and the large amount of soil disturbance it causes, manual control is best applied only to small numbers of plants in limited infestations.
- ✓ Biological control currently has limited application. The only widely available biological control is for purple loosestrife, an invasive that infests many roadsides, wetlands and landings.
- ✓ Chemical control is the most cost-effective method. A variety of techniques and chemicals are available. The technique and herbicide used depend on the size of the infestation and species, as well as the timing of the application. Common techniques include foliar or mist application with a backpack sprayer, basal bark treatments, frill treatments, and cut-stem or injection treatments. Refer to the *Invasive Plant Management Guide* by the Connecticut Invasive Plant Working Group for information on invasive species management, chemical selection and concentrations, and control strategies. Contact the N.H. Division of Pesticide Control for the necessary license and permit requirements.
- ✓ Chemical control typically requires follow-up monitoring and treatment. Without effective follow-up, initial treatments may only make the problem worse.

Operation

- ✓ Avoid or minimize the movement of equipment and machinery from infested into invasive-free areas, unless you clean the equipment before moving it. Operate in invasive-free areas first. Operate from areas of lesser to greater infestation.
- ✓ Locate skid trails, truck roads and landings in invasive-free areas.
- ✓ If soil disturbance is needed to achieve a silvicultural objective in an infested stand, limit the disturbance to the target area.

Close-Out and After

- ✓ To rehabilitate skid trails, truck roads and landings use a seed mix containing winter rye and both short- and long-lived native species. The traditional "conservation mix" often contains several undesirable, weedy species.
- ✓ Minimize the time between close of operations and rehabilitation to reduce the chance of invasive establishment.
- ✓ Monitor project area, especially transportation infrastructure and landings, for invasive plants for three to five years. If invasive plants are discovered, begin control efforts immediately.
- ✓ Closely monitor sites where seed, mulch, or fill materials were used. Focus follow-up monitoring efforts on high-traffic areas or where invasive control was conducted. These are some of the most likely locations of new infestations.
- ✓ Don't plant species suspected of being invasive during rehabilitation work. Problem plants not listed as invasive in New Hampshire have caused damage in other areas. Refer to the *Invasive Plant Atlas of New England*.

CROSS REFERENCES

2.3 Regeneration Methods; 3.1 Timber Harvesting Systems; 7.1 Natural Communities and Protected Plants.

ADDITIONAL INFORMATION

Connecticut Invasive Plant Working Group. *Invasive Plant Management Guide*. http://www.hort.uconn.edu/cipwg/art_pubs/GUIDE/guideframe.htm Accessed January 21, 2010.

Cygan, D. 2010. *Guide to Invasive Upland Plant Species in New Hampshire*. N.H. Dept. of Agriculture. http://extension.unh.edu/resources/files/Resource000988_Rep1134.pdf Accessed January 22, 2010.

Ewing, B., and C. Mattrick. 2006. *Field Manual of Invasive Plant Species for the Northeast*. New England Wild Flower Society, Framingham, Mass.73 p.

The Invasive Plant Atlas of New England. www.ipane.org Accessed January 21, 2010.

N.H. Administrative Rules AGR 3800. http://www.nh.gov/agric/rules/documents/AmendedInvasiveRules.pdf Accessed on July 23, 2010.

N.H. Dept. of Agriculture, Markets, and Food. *Invasive Species Program*. http://www.nh.gov/agric/divisions/plant_industry/plants_insects.htm Accessed January 21, 2010.

N.H. Dept. of Transportation. 2008. *Best Management Practices for Roadside Invasive Plants*. State of New Hampshire, Concord, N.H. 30 p.

RSA 227-L. *Woodland Fire Control*. http://www.gencourt.state.nh.us/rsa/html/xix-a/227-l/227-l-mrg.htm Accessed May 27, 2010.

RSA 430. *Insect Pests and Plant Diseases*. http://www.gencourt.state.nh.us/rsa/html/NHTOC/NHTOC-XL-430.htm Accessed May 27, 2010.

The Nature Conservancy. *The Global Invasive Species Team*. http://tncinvasives.ucdavis.edu/ Accessed January 21, 2010.

USDA Forest Service. 2001. *USDA Forest Service Guide to Noxious Weed Prevention Practices (version 1.0)*. http://www.fs.fed.us/database/feis/pdfs/weeds/GuidetoNoxWeedPrevPractices.pdf Accessed January 21, 2010.

USDA Forest Service. *Invasive Species Program*. http://www.fs.fed.us/invasivespecies/ Accessed January 21, 2010.

5.3 ICE AND WIND DAMAGE

BACKGROUND

Tornadoes, hurricanes, ice storms, and floods can damage the forest.

Although hurricane-size storms rarely strike New England, expect damaging wind storms every 15 to 30 years. Species and forest types vary greatly in resistance to wind damage. White pine is most susceptible—as much as 80 percent of the volume was damaged in the 1938 hurricane. Hemlock trees also were damaged. Spruce-fir (especially the fir) is next in susceptibility to losses from wind. Northern hardwoods are least damaged; the 1938 hurricane produced losses of about 10 to 20 percent, even in heavily damaged stands. Factors other than forest type also affect vulnerability to wind. They include:

- Exposure to wind. (Noticeable in the mountain notches that characterize central and northern New Hampshire.)
- Soil depth and soil moisture. (Shallow and wet soils are worst.)
- Stand age. (Large, overmature stands are most susceptible.)
- Stand density. (Heavily thinned stands are most at risk.)

OBJECTIVE

Prepare forests to withstand ice and wind damage and when damage occurs, make informed forest management decisions.

CONSIDERATIONS

- Damage from natural factors such as wind, snow, and ice regularly occur in New Hampshire's forests. This damage is a normal part of natural-ecosystem functioning and an important factor in creating a diverse forest structure by providing dead and down woody material, wildlife trees, and openings for regeneration.
- Microbursts, in-line winds, tornadoes, hurricanes, and ice-forming events can cause economic damage. No amount of silvicultural preparation can eliminate the risk of catastrophic damage.
- Healthy trees blown over with roots intact will remain alive and free of insects and pathogens for many months.
- Ice storms cause most forest damage at elevations between 1,000 and 3,000 feet and within hardwood stands. Softwood branches naturally point down. Under extreme weight they sag down and in rather than bend and break like hardwoods.
- It isn't necessary to quickly salvage standing, live, ice-storm-damaged trees. It takes many years for previously healthy trees to succumb to a single severe ice storm. Discoloration and decay travel from the damaged branches into the stem of the tree only a few inches to a few feet per year. Breaks in the main stem are more severe than breaks of the secondary branches. Decay fungi and rot will affect the product quality and strength of the tree.
- Salvaging trees damaged by an ice or wind storm can be difficult and dangerous; often only a portion of the original timber value is recouped.
- Fire hazard can increase with severe storms that accumulate large amounts of debris, if followed by severe fire weather.

RECOMMENDED PRACTICES

Wind Damage

- ✓ Maintain a diverse forest to spread the risk, especially by limiting the acreage in susceptible types such as mature white pine on wet soils.
- ✓ Consider the rooting depth, butt flair, crown size and soil profile when planning a partial harvest in overstocked stands. Trees growing for long periods in tight conditions or on shallow or wet soils are at risk of windthrow from moderate to severe wind. Limit partial harvests in susceptible stands to no more than one-third of the basal area, and perhaps leaving an uncut buffer on the windward side of the stand.
- ✓ Position thin strip cuts so that prevailing winds skip across the narrow width rather than down the full length of the strip, orienting strips at right angles to the prevailing winds. Position larger openings so that prevailing winds cross at the narrowest point.
- ✓ Remove high-risk trees that have stem cankers, forking tops, or signs of internal decay such as visible rot, cavities, or conks.
- ✓ Consider even-aged management in locations where repeated occurrence of wind damage is evident, e.g., stands naturally growing in mosaics of even-aged groups because of localized wet or shallow soils or exposure to high winds are candidates.
- ✓ Post-windstorm actions:
  - Determine the footprint of the storm.
  - Determine the percentage of trees blown over with roots intact versus trees broken above the stump, and salvage broken trees first. There is no need to immediately remove trees blown over with tops and roots attached.

Ice Damage

- ✓ In forests with signs of previous branch breakage and top dieback, remove trees with weak or hazardous branch structure. Trees with branches forked in a V-shaped crotch are weaker than those with the stronger U shape.
- ✓ Post-ice storm actions:
  - Determine the footprint of the storm.
  - Inventory to determine the percentage of trees damaged and the average amount of branch breakage by species; salvage according to the following guidelines:
    - Trees with less than 50 percent branch breakage are likely to recover, except for paper birch.
    - Trees with greater than 75 percent branch breakage and trees with any bole breakage below the live crown are unlikely to produce a high-quality tree for future harvest.

CROSS REFERENCES

2.1 New Hampshire Forest Types; 2.2 Forest Structure; 2.3 Regeneration Methods; 6.2 Cavity Trees, Dens and Snags; 6.3 Dead and Down Woody Material.

ADDITIONAL INFORMATION

Hauer, R.J., M.C. Hruska, and J.O. Dawson. 1994. *Trees and ice storms: The development of ice storm—resistant urban tree populations*. Special Publication 94-1. Dept. of Forestry, University of Illinois at Urbana-Champaign, Urbana, Ill. http://web.aces.uiuc.edu/vista/pdf_pubs/ICESTORM.PDF Accessed March 9, 2010.

Shortle, W.C., K.T. Smith, and K.R.Dudzik. 2003. *Tree Survival and Growth Following Ice Storm Injury*. USDA For. Serv. Res. Pap. NE-723. http://www.fs.fed.us/ne/newtown_square/publications/research_papers/pdfs/2003/rpne723.pdf Accessed March 9, 2010.

Shortle, W.C., and K.T. Smith. 1998. *Tree Biology and Ice Storm '98*. UNH Cooperative Extension, Durham, N.H. http://extension.unh.edu/resources/files/Resource000987_Rep1127.pdf Accessed June 7, 2010.

5.4 LOGGING DAMAGE

BACKGROUND

Excessive damage to residual trees during a timber harvest can negate the intended benefits of forest improvement operations.

Activities associated with felling, winching, and skidding can damage 20 to 40 percent of the residual trees (trees left behind).

Young trees may be bent or broken during felling or crushed by harvesting equipment. Branches and tops of residual trees may be broken during felling, reducing crown area and eventually tree vigor. Valuable lower trunks of larger trees may be wounded, allowing entry of fungi or insects that cause wood discoloration and decay. Injuries resulting in exposed sapwood wounds of 100 square inches or greater are likely to develop decay. Approximately 80 percent of skidding injuries are from bark scraped from the butt log of residual trees.

Skidding can cause root damage, allowing entry of rot-causing microorganisms. Repeated passes of heavy equipment over certain types of soils, especially during wet conditions, can compact soil air spaces, impeding root growth. Most healthy forest soils maintain about 50 percent solids, 25 percent air space and 25 percent water by volume. When these ratios change through compaction, roots are damaged and their growth restricted, erosion and run-off increase due to decreased permeability, and changes in soil temperature and microbial action disrupt soil nutrient cycling.

Logging may also combine with other stress factors to make individual trees (and eventually entire stands) more susceptible to dieback. Poor vigor invites attacks by insect pests and diseases. Also, though a stand may not be physically damaged, removing trees may reduce the stand's ability to withstand wind.

OBJECTIVE

Control and minimize logging damage to residual trees, and reduce the total area of soil compacted during harvest operations.

CONSIDERATIONS

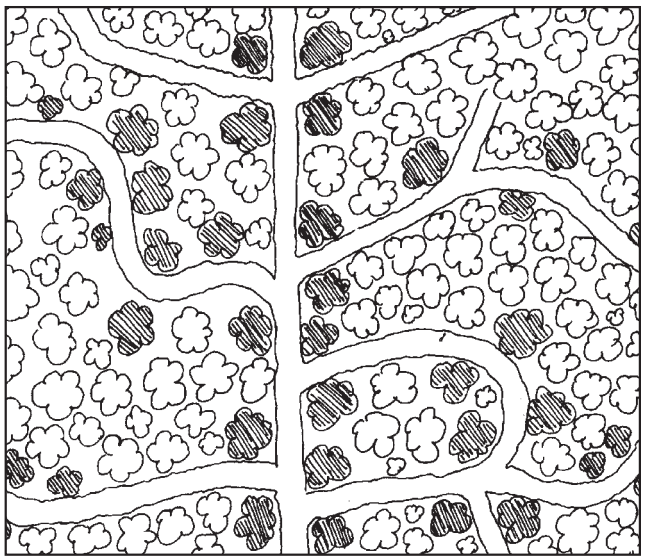
- Research indicates experienced operators can limit damage to the residual stand to 10 percent or less.
- Minimizing damage depends equally on supervision, skid trail locations, and care in felling and skidding.
- More damage occurs when bark is loose during spring and early summer; take extra caution if you can't avoid harvesting during these times.
- Certain species (e.g. paper birch and balsam fir) are more susceptible to damage than others.
- Trees growing on very dry, wet, or windy sites, as well as those that have a history of insect or disease attacks are less likely to survive logging damage.
- Elements contributing to compaction include site conditions such as soil texture (particle size), soil moisture, unevenness of the ground, and slope. The number of passes and equipment characteristics also contribute. These include total weight of the equipment, vibration, speed, pressure on the soil (pounds per square inch or psi), tire- or track-tread design, and operator

experience. Logger training, experience, attitude, and motivation are more important than equipment size in minimizing logging damage.

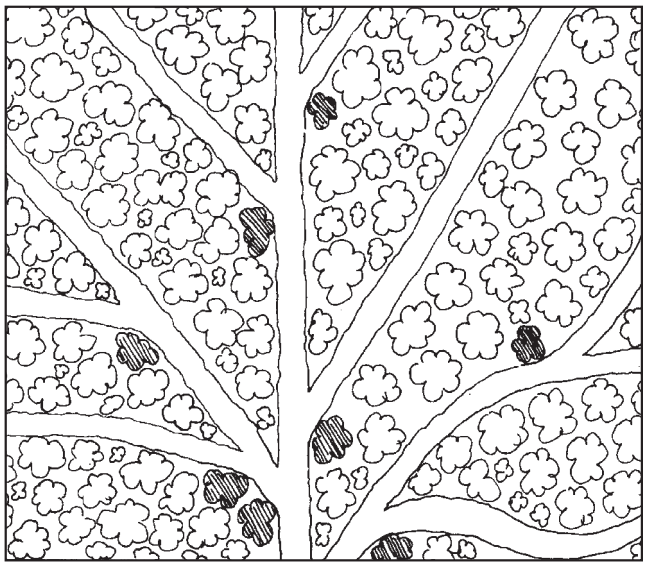
- Wet soils and fine-textured soils compact more readily than dry and or coarse soils.
- Soil compaction affects the type, productivity, and timing of natural regeneration.
- Forest floor scarification is often desired to promote regeneration.

RECOMMENDED PRACTICES

- ✓ Plan and mark skid trails and landings to accommodate the equipment, as well as skidding needs of future harvests. Reuse existing trails. For partial harvests keep the area dedicated to skid trails at or below 20 percent of the total harvest area.
- ✓ Use loggers skilled in proper directional felling, winching, and skidding procedures. Ask for references.
- ✓ Include contract provisions that provide incentives to minimize damage, and impose sanctions in the event of careless damage to the residual stand.
- ✓ Use equipment appropriate for the size and density of the trees, soil, and site conditions.
- ✓ Use branches (slash) in skid trails as a protective road bed.
- ✓ Use "bumper" trees along skid trails to protect residual trees.
- ✓ Harvest trees on sensitive or wet soils when the ground is during frozen or dry.
- ✓ Use group or patch cutting to reduce damage to the residual stand. Under this method trees can be felled toward newly created openings, rather than toward the residual stand.
- ✓ Work around pockets of advanced regeneration. Harvesting when a heavy snow cover is present will help protect small seedlings and saplings.
- ✓ Avoid harvesting heavily defoliated stands for two or three growing seasons to minimize stress on the trees.
- ✓ Avoid exposing adjacent uncut stands to prevailing winds.



Too many bumper trees, poor road layout



Fewer bumper trees, better road layout

- ✓ Monitor the harvest to make sure the operation is being properly conducted.

CROSS REFERENCES

2.3 Regeneration Methods; 3.1 Timber Harvesting Systems; 3.2 Logging Aesthetics; 3.3 Aesthetics of Skid Trails, Truck Roads and Landings; 3.5 Soil Productivity; 5.1 Insects, Diseases.

ADDITIONAL INFORMATION

Bennett, K. P. (tech. coordinator). 2001. *Proceedings of Residual Stand Damage Workshop*. UNH Cooperative Extension. http://extension.unh.edu/resources/files/Resource000410_Rep432.pdf Accessed March 11, 2010.

WILDLIFE HABITAT

TOPICS IN THIS SECTION

ADDITIONAL READING

Landowner's Guide to Wildlife Habitat: Forest Management for the New England Region
Richard M. DeGraaf, Mariko Yamasaki, William B. Leak, and Anna M. Lester
University Press of New England
2005

Technical Guide to Forest Wildlife Habitat Management in New England
Richard M. DeGraaf, Mariko Yamasaki, William B. Leak, and Anna M. Lester
University of Vermont Press and University Press of New England
2006

New England Wildlife: Habitat, Natural History, and Distribution
Richard M. DeGraaf and Mariko Yamasaki
University Press of New England
2001

Guide to Wildlife Habitats of Maine
Edited by Cathy Elliott
University of Maine Cooperative Extension
1988

Wildlife, Forests and Forestry: Principles of Managing Forests for Biological Diversity
Malcolm L. Hunter, Jr.
Prentice-Hall
1990

Forester's Guide to Wildlife Habitat Improvement
Scot Williamson
UNH Cooperative Extension
1993 (second edition)

New Hampshire's Living Legacy: The Biodiversity of the Granite State
Edited by James Taylor, Thomas Lee, and Laura Falk McCarthy
N.H. Fish and Game
1996

Biodiversity in the Forests of Maine: Guidelines for Management
Gro Flatebo, Carol Foss, and Steven Pelletier
Edited by Catherine Elliot
University of Maine Cooperative Extension
1999

6.1 MAST

BACKGROUND

Mast is critical to wildlife survival.

Fruits, nuts, and seeds of woody plants are called *mast* when referring to their use by wildlife for food. *Hard mast* refers to nuts and seed and *soft mast* refers to fruits and berries. Seeds can regenerate the forest immediately following a natural disturbance or in conjunction with a harvest, but during most of the life of the forest, the majority of the seeds don't germinate and grow into seedlings—most of the time they are eaten by wildlife as mast, the focus of this chapter.

Masting cycles, insects and disease, plant species, plant age, tree diameter and dominance, weather, and genetics all affect mast production. "Masting" refers to the natural cycle in which trees and shrubs produce abundant seeds one year, followed by a year or more where mast production is moderate or low. Plant species, weather, and genetics are believed to control masting cycles. Genetics likely play the most important role in determining how much mast any individual tree or shrub is capable of producing. Some individual plants produce regular, abundant mast crops, while others consistently produce poor crops. Few physical features of plants allow managers to identify genetically superior mast-producing plants—even these plants don't produce superior crops every year. In general, mature plants exposed to full sunlight, with little competition from surrounding plants, will be most likely to produce abundant mast crops when all the other conditions affecting mast production are favorable. Insect damage can reduce tree vigor or damage young fruits, resulting in at least a temporary reduction in the amount of mast

Hard Mast

American beech, hickory, and red, white and black oak are important in the diets of white-tailed deer, black bear, wild turkey, ruffed grouse, wood duck, and more than a dozen other mammals and birds. Beechnuts are an important autumn food source for black bears in northern New England. Beech trees begin heavy nut production at about 50 years or 8 inches in diameter at breast height (DBH) and produce good crops at 2- to 8-year intervals.

Red oaks bear heavy acorn crops at 2- to 5-year intervals, reaching peak production at 19 to 22 inches DBH. White oaks bear heavy crops at 4- to 10-year intervals, and peak in production at 24 to 30 inches DBH. There is considerable variation among trees, but individual trees tend to produce consistently good or poor acorn crops. White oak acorns are more palatable than red and black oak acorns, because the former contain lower tannin levels. Ash, birches, maples, and conifers are also important sources of hard mast. Sources of hard mast have changed during the last century; most notably, when chestnut blight eliminated the American chestnut.

Soft Mast

Black cherry is the primary soft-mast producer and provides an important food source for bears, small mammals, and 28 bird species. While 10-year old saplings may produce fruit, peak production occurs between 30 and 100 years of age. Good crops occur at 1- to 5-year intervals, although black cherries usually produce some fruit every year.

Black cherry trees may vary widely in fruit production, making the production history of individual trees an important consideration when selecting trees for harvest or retention. Other important sources of soft mast include pin and choke cherries, wild apples, mountain ash, shadbush (also called serviceberry or juneberry), brambles (blackberries and raspberries), dogwoods, viburnums, blueberries, hackberries, elderberries, and grapes.

Sources of soft mast have changed with increases in non-native invasive shrubs such as autumn olive, barberry, buckthorn, honeysuckle, and multiflora rose. Some studies suggest berries produced by non-native plants may have a lower nutritional value than those from native plants, but this depends on the species being compared. Invasives raise many other concerns regarding their impact on wildlife habitat. Landowners and forest managers are encouraged to take appropriate measures to eliminate and control the spread of these plants.

OBJECTIVE

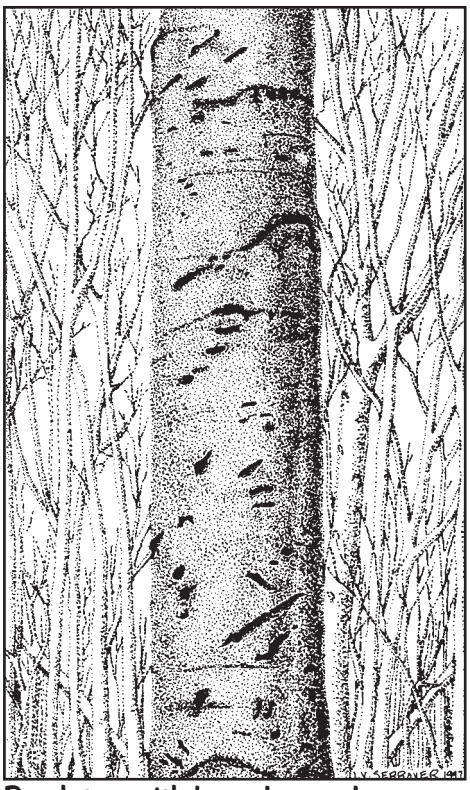
Manage mast-producing trees and shrubs for a continuous source of wildlife food and quality seed for regeneration.

CONSIDERATIONS

- The diversity and amount of mast lessens as you travel north.
- Individual oak, beech and black cherry trees may be poor timber quality but an invaluable source of mast. Such trees may have greater value left for wildlife than harvested for wood products.
- Beech bark disease may affect management decisions in infected stands.
- Understory or edge shrubs such as highbush blueberry, huckleberry, maple-leaved viburnum, hazelnut, silky dogwood, and northern wild-raisin (witherod) are an important source of mast and their mast production can often be improved simply by removing overtopping trees.
- It is illegal to plant non-native invasive such as multiflora rose, winged euonymus, non-native honeysuckle species, autumn olive, and other species per RSA 430:51-57.

RECOMMENDED PRACTICES

- ✓ When managing stands with multiple mast-producing species, maintain the diversity of mast sources.
- ✓ Manage oak and beech stands on long rotations (100 to 125 years), growing trees to greater than 18- to 20-inch diameters to maximize acorn production and timber value. Maintain oak in well-stocked stands by retaining vigorous trees with dominant crowns.
- ✓ Retain beech trees with bear claw marks on the trunk or clumps of broken branches in the crown. Retain beech older than 40 years in stands supporting wild turkeys.
- ✓ Improve mast production by leaving dominant and codominant trees with healthy crowns. Remove neighboring trees that have crowns touching the crowns of the trees you are saving. Remove competing trees from at least three sides to provide gaps into which the trees you retain can expand their crowns
- ✓ When harvesting stands with black cherry, retain some trees with high fruit production or any tree that shows evidence of use by bears (e.g., clumps of broken branches in the crown).



Beech tree with bear claw marks

- ✓ Retain wild apple trees and gradually release them from competition.
- ✓ Retain mountain ash when harvesting timber at high elevations.
- ✓ Whenever possible, avoid harvesting mast stands during spring (April through May) and fall (September through November), foraging periods favored by bears and other wildlife.
- ✓ Consider identifying high-quality hard-mast sites as "mast-producing areas" devoted specifically to long-term mast production for wildlife.
- ✓ Retain softwood "fingers" extending into mast stands and dense, brushy growth around them to provide wildlife with protective cover. This is important when managing near old apple orchards.
- ✓ Allow log landings to regenerate naturally to promote the growth of mast-producing shrubs such as brambles and strawberries. Encourage brambles by retaining down woody material in and around the landing.
- ✓ Favor the regeneration and maintenance of natives over non-natives. When planting mast-producing shrubs, select native species.

CROSS REFERENCES

2.3 Regeneration Methods; 2.4 Managing for High-Value Trees; 5.1 Insects and Diseases; 5.2 Invasive Plants; 6.4 Overstory Inclusions; 6.5 Permanent Openings; 6.9 Deer Wintering Areas; 6.10 Woodland Raptor Nest Sites.

ADDITIONAL INFORMATION

Elliott, C.A. 1988. *A Forester's Guide to Managing Wildlife Habitats in Maine*. University of Maine Cooperative Extension, Orono, Maine.

RSA 430:51-57. *Invasive Species*. http://www.gencourt.state.nh.us/rsa/html/XL/430/430-mrg.htm Accessed May 26, 2010.

6.2 CAVITY TREES, DENS AND SNAGS

BACKGROUND

Retaining snags (dead or partially dead standing trees) and den trees (live trees with existing cavities) helps maintain populations of wildlife that require cavities.

Ten species of New Hampshire forest birds excavate cavities for nesting and roosting. Another 15 birds and 18 mammals use natural or excavated cavities in forests for nesting, roosting, or denning. In addition, the brown creeper nests under loose flaps of bark, attached at the top, on standing dead trees. Meeting the needs of these many different species requires a variety of cavity-tree sizes (Table 1). While cavity trees of any size have value for smaller-bodied wildlife such as the black-capped chickadee and tufted titmouse, trees larger than 18 inches in diameter at breast height (DBH) accommodate larger-bodied animals and are used by more species. Due to past agricultural and timber harvesting practices, cavity trees larger than 24 inches in diameter are uncommon.

OBJECTIVE

Maintain cavity and den trees, particularly trees with diameters exceeding 18 inches.

CONSIDERATIONS

- U.S. Occupational Safety and Health Administration (OSHA) regulations regarding the removal of dangerous trees may conflict with recommendations in this section. OSHA requires the removal of all snags (i.e., standing dead or dying trees) by mechanical or other means. If the tree is to be left standing, it must be marked, and no work can occur within two tree lengths of the tree, unless the employer demonstrates a shorter distance won't create a hazard for an employee.
- Cavity trees account for a very small percentage (less than 10 percent) of the standing tree in most forests.
- Broken large limbs in hardwood crowns provide smaller-diameter cavities over time. These cavities are often difficult to spot from the ground.
- Sawtimber and large-sawtimber snags remain standing longer than pole-size snags.
- Snags provide various substrates on which woodpeckers and other bark gleaners forage for insects. Snags also grow lichens, mosses, liverworts and fungi upon which many small mammals forage.
- Riparian zones, roadside buffers, scenic areas, and uncut patches contribute to snag-retention goals for an ownership.
- Snags and cavity trees are created in forest stands of all ages when natural disturbances such as wind and ice break tree branches or damage entire trees. Unmanaged forest stands or those managed on a rotation long enough to allow some trees to mature and die of natural causes often contain a greater proportion of snags and cavity trees than younger stands, and are more likely to contain large diameter (18+ inches) trees.
- Even distribution of snags may be desirable for some species, but there are many benefits to encouraging clumps of snags. Uniformity isn't always operationally practical or desirable.
- Landowners interested in retaining and recruiting snags and cavity trees greater than 24 inches in diameter may have to make an intentional effort to leave some trees uncut during a timber harvest. On smaller ownerships it may be necessary to manage snags on an acre-by-acre basis. On larger landholdings, it's usually more practical to take an approach that incorporates the broader surrounding landscape, emphasizing snag retention on some areas, while not on other areas.

RECOMMENDED PRACTICES

- ✓ In areas under uneven-aged management:
  - Retain a minimum of six live cavity trees and/or snag trees per acre, with one exceeding 18-inches DBH and three exceeding 12-inches DBH.
  - When lacking such cavity trees, retain live trees of these diameters with defects likely to lead to cavity formation.
- ✓ In areas under even-aged management:
  - Leave an uncut patch for every 10 acres harvested, with patches totaling 5 percent of the area. Patch size may vary from a minimum of one-quarter acre. Riparian zones and other buffers can help satisfy this goal.
  - Focus retention patches with the following trees as their nuclei:
    - Existing cavity trees exceeding 18-inches DBH or active den trees.
    - Broken-topped live trees exceeding 12-inches DBH.
    - Secure standing dead trees, especially those with top-attached bark flaps.
    - Living, large aspen and white pine, red spruce, eastern hemlock, sugar maple, beech, yellow birch, elm and oaks. Except for aspen, these trees will persist for long periods as standing dead trees.
  - ✓ Retain large-diameter snags.
  - ✓ Retain live trees with existing cavities.
  - ✓ Include the species, diameter and condition (e.g. living or dead) of snags and cavity trees as part of a forest inventory.

CROSS REFERENCES

2.2 Forest Structure; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 6.1 Mast; 6.3 Dead and Down Woody Material; 6.4 Overstory Inclusions.

ADDITIONAL INFORMATION

Elliott, C.A. 1988. A *Forester's Guide to Managing Wildlife Habitats in Maine*. University of Maine Cooperative Extension, Orono, Maine.

USDL Occupational Safety and Health Administration. http://www.osha.gov/SLTC/etools/logging/userguide/safety_health/treeharvestingplan/treeharvestingplan.html Accessed February 22, 2010.

Table 1:
Minimum Tree Diameters for Cavity-Using Species

6- 8"
Downy woodpecker*
Black-capped chickadee*
Boreal chickadee*
Tufted titmouse
House wren
Winter wren
Eastern bluebird
6-12"
Northern saw-whet owl
Hairy woodpecker*
Yellow-bellied sapsucker*
Red-breasted nuthatch*
White-breasted nuthatch
Brown creeper
Chimney swift
Southern flying squirrel
Northern flying squirrel
Ermine
12-18"
Eastern screech-owl
Three-toed woodpecker*
Black-backed woodpecker*
Northern flicker*
Great crested flycatcher
Northern long-eared bat
Indiana myotis
> 18"
Wood duck
Common goldeneye
Hooded merganser
Common merganser
Turkey vulture
Barred owl
Pileated woodpecker*
Silver-haired bat
Gray squirrel
Red squirrel
Porcupine
American marten (pine marten)
Fisher
Long-tailed weasel
> 24"
Little brown bat
Big brown bat
Gray fox
Black bear
Raccoon

** = primary cavity excavators*

6.3 DEAD AND DOWN WOODY MATERIAL

BACKGROUND

Dead and down woody material (logs, stumps, limbs and upturned tree roots) in various stages of decay serves many critical functions.

Dead and down woody material, often referred to as coarse wood material (CWM) or coarse woody debris, is important for nutrient retention and cycling, as nurse logs for regenerating trees and understory plants, and as wildlife habitat. Large (18+ inches) hollow or rotten logs and stumps generally have the greatest value. Softwood stands usually contain more and longer-lasting down woody material than hardwood stands. Maintaining snags and cavity trees will also serve to maintain CWM, as these trees eventually fall over.

Coarse woody material is used by more than 30 percent of the region's mammals, 45 percent of the amphibians, and 50 percent of the reptiles. It's used as a feeding site by rodents, shrews, black bears, and woodpeckers and provides shelter for many small mammals. Seventeen mammal species, including black bear, otter, mink, fisher, weasels, and deer mouse either den or hunt in or under downed logs. CWM creates moist microhabitats used by amphibians. Downed logs create pools and riffles in streams that provide important fish habitat, as well as basking and nesting locations for turtles, waterfowl, mink, and otter. Several ground-nesting birds (including juncos and winter wrens) nest in upturned tree roots. Dead and down woody material provides habitat for many other organisms including insects and other invertebrates, mosses, fungi, and lichens.

OBJECTIVE

Manage for coarse woody material by retaining material that currently exists and allowing its accumulation where it is missing.

CONSIDERATIONS

- The amount of CWM is low in many forests, because of past land use. As New Hampshire forests mature, the supply of this material is naturally increasing as older trees die and fall over. However, more use of entire trees through chipping (whole-tree or biomass harvesting) or other techniques such as firewood cutting that leave less CWM in the woods may reduce the supply of this material on certain woodlots.
- Dead and down woody material is a natural component in forests. It is created in forest stands of all ages when natural disturbances such as wind and ice break tree branches or damage entire trees. Forests that aren't managed, or those managed on a rotation long enough to allow some trees to mature and naturally die often have a greater proportion of CWM material than younger stands, and are more likely to contain large diameter (18+ inches) material.
- Recruiting and retaining this material requires a conscious effort, especially when harvesting.
- CWM may have minimal economic value as biomass.

- CWM can provide a favorable microclimate for regeneration. It can protect developing tree seedlings from deer and moose browsing when the trees are young and vulnerable to browsing damage.

RECOMMENDED PRACTICES

- ✓ Avoid damaging existing CWM, especially large (18+ inches), hollow or rotten logs and rotten stumps.
- ✓ Leave cull material from harvested trees, especially sound, hollow logs, in the woods. Leave some cull material in the woods during whole-tree or biomass harvests. Return large pieces of cull material bucked-out on the landing to the woods.
- ✓ Avoid disrupting downed logs in and adjacent to streams, ponds and wetlands.
- ✓ Avoid disrupting upturned tree roots from May through July to protect nesting birds.
- ✓ Maintain or create softwood inclusions in hardwood stands to provide a supply of longer-lasting down woody material.
- ✓ Collect information about the type and abundance of CWM as part of a forest inventory.

CROSS REFERENCES

2.2 Forest Structure; 3.1 Timber Harvesting Systems; 3.2 Logging Aesthetics; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 4.4 Stream Crossings and Habitat; 5.3 Ice and Wind Damage; 6.2 Cavity Trees, Dens and Snags; 6.4 Overstory Inclusions.

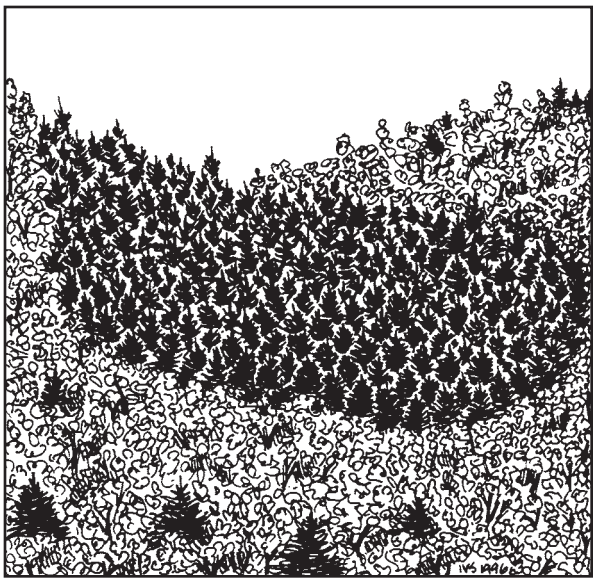
ADDITIONAL INFORMATION

DeGraaf, R., M. Yamasaki, W. B. Leak, and A. M. Lester. 2006. *Technical Guide to Forest Wildlife Habitat Management in New England*. University of Vermont Press and University Press of New England, Burlington, Vt. 305 p.

6.4 OVERSTORY INCLUSIONS

BACKGROUND

Maintaining or creating inclusions of overstory that are distinct from the surrounding forest type can greatly increase the habitat diversity of otherwise uniform areas.



Overstory inclusions are small patches of forest distinct from the surrounding forest but too small to be mapped or treated separately. A patch of hemlock in a pure hardwood stand, or patches of oak in a pine stand would qualify as examples of overstory inclusions.

Inclusions provide feeding, nesting, and shelter that may not occur in continuous stands of a single forest type. More than 25 percent of New England's bird species and a lesser number of mammals use overstory inclusions in one way or another. Deer, moose and some furbearers are attracted to softwood inclusions within hardwood stands. Such inclusions may be important for facilitating movement of these animals during deep snow conditions.

Inclusions may range in size from just a few trees to more than an acre. The value of a minor inclusion increases in proportion to how different it is from the surrounding forest. Even a single softwood tree such as a hemlock, large-crowned spruce, or a large white pine within a pure hardwood stand, can greatly increase the variety of available habitats.

OBJECTIVE

Maintain and regenerate inclusions of softwood cover in predominantly hardwood stands and inclusions of hardwood cover in predominantly softwood stands.

CONSIDERATIONS

- Applying different treatments to small inclusions may be uneconomical if these treatments require different equipment or techniques.
- Small volumes of some species derived from harvesting inclusions may not be marketable.
- Removing surrounding cover may put inclusions at risk of to blowdown, sunscald, and other damage.
- Inclusions may result from either small-scale site differences or variations in the past disturbances of a stand. Natural succession may work against the maintenance of these areas, especially if advanced regeneration of the surrounding dominant vegetation is present. Maintenance and regeneration of inclusions will be more practical where inclusions result from relatively permanent site factors, rather than from variations in disturbance history across a uniform site.

RECOMMENDED PRACTICES

- ✓ Create inclusions in large uniform stands if site conditions allow.
- ✓ Where inclusions exist, develop prescriptions to maintain or regenerate them in their current type. Inclusions shouldn't necessarily receive the same prescription as the rest of the stand.
- ✓ Leave inclusions unharvested if the inclusion is:
  - Relatively unique to the area.
  - Small (one-quarter acre or less) and the volume of timber generated from its treatment will be limited.
  - From small-scale differences in site conditions that may be sensitive to disturbance (such as wet areas or shallow soils over ledge).
- ✓ Leave a buffer around softwood inclusions to provide wind protection. The buffer should be at least 2 to 3 tree-heights wide on the side exposed to prevailing winds. Don't remove more than 25 percent of the basal area within this buffer.
- ✓ Inclusions can often be incorporated with other desired habitat features such as a seep, vernal pool, or a large legacy tree.
- ✓ On larger ownerships, locate and map inclusions (e.g., with a GPS) for monitoring purposes.

CROSS REFERENCES

6.1 Mast; 6.7 Aspen Management; 6.9 Deer Wintering Areas; 7.2 Seeps; 7.3 Vernal Pools.

ADDITIONAL INFORMATION

DeGraaf, R., M. Yamasaki, W. B. Leak, and A. M. Lester. 2006. *Technical Guide to Forest Wildlife Habitat Management in New England*. University of Vermont Press and University Press of New England, Burlington, Vt. 305 p.

Hunter, M.L., Jr.1990. *Wildlife, Forests and Forestry: Principles of Managing Forests for Biological Diversity*. Prentice-Hall, New York, N.Y. 370 p.

6.5 PERMANENT OPENINGS

BACKGROUND

Permanent openings up to a few acres in size and dominated by grasses, forbs, brambles, or shrubs provide valuable habitat for many wildlife species.

Nonforested uplands and wetlands cover a small portion of New Hampshire, but they may contribute a disproportionately high share of wildlife habitat. They provide necessary habitat for about 22 percent of New England's wildlife species and seasonally important habitat to nearly 70 percent, including "species of greatest conservation need" such as eastern towhee and New England cottontail.

Some guidelines suggest maintaining 3 to 5 percent of forest land in permanent openings. The value of these openings depends on the surrounding landscape. They are more beneficial in large areas of continuous forest cover than in areas with a mixture of forest and nonforest habitats.

Permanent openings in a managed forest include (1) remnant meadows, pastures, or orchards on abandoned agricultural land, (2) log landings and roads created during timber harvesting and maintained afterward, and (3) openings where herbaceous forages are planted and maintained as wildlife food plots.

OBJECTIVE

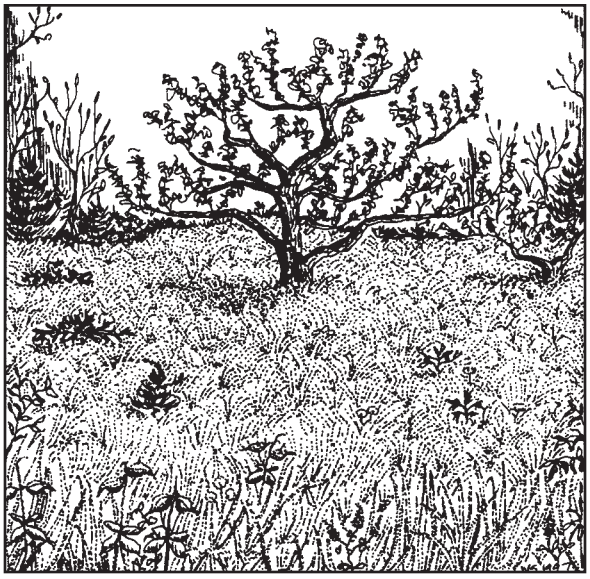
Create or maintain permanent openings dominated by grasses, forbs, or shrubs within forest-dominated upland landscapes.

CONSIDERATIONS

- Openings with a combination of grasses, forbs, brambles, and fruiting shrubs attract and support a greater diversity of wildlife than openings containing less plant diversity.
- Site conditions affect the ability of any given site to support a diversity of plants and structural conditions. Even slight variations in soil moisture or type can result in different plants. Old fields occurring on productive agricultural soils generally revert to a greater diversity of plants and support higher stem densities than do upland forests recently cleared. High stem density is a critical factor in determining habitat quality for species such as American woodcock and New England cottontails.
- Maintaining permanent openings involves a cost. It is usually cheaper to maintain an existing field than to convert a forest into an herbaceous opening. Removing stumps and rocks significantly increases the cost and may require a permit from the N.H. Dept. of Environmental Services. Forest openings maintained as shrub openings often regenerate faster and support greater plant diversity when the stumps aren't removed. Financial assistance may be available to help create and maintain permanent openings.
- It is often more practical, efficient, and cost-effective to create temporary openings as part of regular timber sales, creating new openings in each successive harvest, rather than to create and maintain permanent openings. Small temporary openings can be created by patch cutting trees as part of an annual firewood harvest (6.6 Temporary Openings).
- Openings less than 2 acres usually don't attract wildlife species that don't already occur in the vicinity, though chestnut-sided warblers and common yellowthroats are attracted to small openings. Small openings increase the amount and type of foraging and cover available to species already present.

- Openings 5 acres and larger are most likely to attract and support species not already present, especially when created in extensively forested landscapes.
- All openings eventually revert back to trees if they aren't maintained
- Maintaining permanent openings removes some land from timber production. Seeded log landings and woods roads maintained as openings benefit wildlife and remain available for use in future harvests.
- Prescribed fire can maintain permanent openings. Conditions in which fire can be used are specific (e.g., wind speed, temperature, humidity, fuel load) and often unpredictable (7.4 Pine Barrens). Permits are required and trained personnel are needed to plan and oversee the burn. The Natural Resources Conservation Service (NRCS) or UNH Cooperative Extension (UNHCE) can provide more information.

RECOMMENDED PRACTICES



✓ Contact the UNHCE wildlife specialist or a N.H. Fish and Game wildlife biologist for site-specific recommendations such as (1) where to locate openings, (2) the appropriate size to meet your objectives, (3) options for creating and maintaining openings, and (4) information about financial assistance programs.

✓ Maintain existing fields, old-fields, wet meadows, pastures, or orchards to develop and keep the type of plants and plant structure desired.

- Mow openings with grasses or other nonwoody vegetation at least once every three years to keep woody plants from dominating. The plants desired and the site growing conditions determines mowing frequency.
- Maintain shrub openings by periodically removing individual trees as they begin to overtop the shrubs. Mowing shrub openings often isn't needed once desired shrubs dominate. Remove non-native, invasive shrubs.

✓ Mow openings after August 1 since most wildlife have completed breeding and the young are fledged. Specific management objectives may dictate mowing earlier or later than August 1.

✓ Rotary mowers (e.g., brush hog), forestry mowers (e.g., brontosaurus, skid-steer mounted mowers), and hand tools (e.g., chainsaw, brush saw) are commonly used to maintain permanent openings.

- Allow shrub openings maintained with a rotary mower to grow to the point that, if they were to grow any longer, they would be difficult to mow—this usually means mowing about once every 5 years. Rotary mowers mow material up to 1-inch diameter efficiently.
- Mow shrub openings with a forestry mower about once every 6 to 10 years, depending on the specific mower and how fast the shrubs and trees are growing. Forestry mowers mow woody material larger than 1-inch diameter, with the largest mowers capable of efficiently mowing trees up to 6 inches.

- Use chainsaws and brush saws to remove individual trees or small groups of trees as soon as they begin to overtop desired shrubs. Brush saws are generally effective at mowing trees up to 1 inch.

✓ Mowing part of the opening one year and the remainder a year or more later maintains a diversity of plant heights and types.

✓ Retain old apple trees and prune and release them to maintain their vigor.

Recommendations for establishing new openings

✓ Orient openings to incorporate a variety of soil types. For example, orient the opening to run across, rather than parallel, to changes in soil types.

✓ Locate openings so they abut habitat edges such as wetlands, fields, and power lines. These nonforest habitats often contain plants and structure similar to what will regenerate in the openings. Locating openings adjacent to these habitats increases the functional area occupied by that structure and tends to provide a greater benefit than a similar size opening located within a closed-canopy stand.

✓ Retain hard and soft mast trees and shrubs, large-diameter trees, and snags along the edges of the openings.

✓ Retain pockets of softwoods along the edges as year-round cover. For example, patches of dense, young white pines along the edges of openings often attract eastern towhees and Nashville warblers that otherwise might not use the openings.

✓ Make the perimeter of the opening irregular to maximize the amount of edge.

✓ Keep slash, coarse woody material, and other cover objects intact in most openings to minimize the effects of soil-drying on amphibians and to provide temporary cover, nesting sites, and perches while the cut regenerates.

✓ Remove slash from openings created specifically as singing grounds or nesting and foraging cover for woodcock as it is difficult for woodcock to forage and move through slash.

✓ When clearing forested sites, cut trees as low to the ground as practical to ensure full use of harvested trees, to allow for brush hogging, or to ensure browse remains as accessible for as long as possible (i.e., sprouts from tall stumps grow beyond browsing height faster than those from short stumps). Some large stumps and rocks may need removal. If you don't have a way to keep woody plants from invading, removing stumps will be a wasted effort.

✓ To convert forest to herbaceous opening, stump and grade to create a suitable seedbed and allow for regular mowing; follow seeding recommendations below.

✓ Clear landings and selected woods roads of debris, level and smooth the ground. Plant with a recommended seed mix only if necessary to stabilize the soil, meet wildlife objectives, or improve aesthetics. Otherwise let natural vegetation establish itself. Contact the NRCS or UNHCE for information on site-specific seeding options.

- If landings and woods roads are planted to high-quality forages such as clovers, chicory, or brassicas, apply lime and fertilizer according to a soil test before planting.
- Don't spread hay on areas planted to high-quality forages. Hay will introduce weeds and compete with desirable forages.
- Clover plots require mowing at least three times a year. If mowing only once a year, select a less expensive seed mixture with a combination of perennial grasses and forbs such as clover, vetch, and birdsfoot trefoil.

✓ Don't plant invasives, and regularly inspect openings for invasive plants introduced by birds or other means.

CROSS REFERENCES

3.3 Aesthetics of Skid Trails, Truck Roads and Landings; 5.2 Invasive Plants; 6.6 Temporary Openings; 6.13 Wildlife Species of Greatest Conservation Need; 7.4 Pine Barrens.

ADDITIONAL INFORMATION

DeGraaf, R., M. Yamasaki, W. B. Leak, and A. M. Lester. 2006. *Technical Guide to Forest Wildlife Habitat Management in New England*. University of Vermont Press and University Press of New England, Burlington, Vt. 305 p.

Olson, D., and C. Langer. 1990. *Care of Wild Apple Trees*. UNH Cooperative Extension, Durham, N.H. 8 p.

Tubbs, C.H., and L.J. Verme. 1972. *How to Create Wildlife Openings in Northern Hardwoods*. USDA For. Serv. NA—State and Private Forestry. 6 p.

6.6 TEMPORARY OPENINGS CREATED BY FOREST MANAGEMENT

BACKGROUND

Shrubland wildlife species are rapidly declining in New England.

Many wildlife species such as black racer and milk snakes, woodcock, brown thrasher, whip-poor-will, chestnut-sided warbler, common yellowthroat, eastern towhee, indigo bunting, New England cottontail, meadow vole, and meadow jumping mouse require grass- and shrub-dominated early successional habitat for shelter and forage throughout the year. Early successional wildlife habitats (young trees and shrubs) have become very uncommon in much of the northeast, largely due to the maturation of the forests. These habitats are ephemeral and created through some type of human or natural disturbance (e.g., forest management clearcuts, periodic hurricanes, fire, beaver activity, and insects). Coastal and valley-bottom forests, historically exposed to disturbances from windthrow and fire are far less available as habitat today due to development and fire suppression. Today's forests are often shaped by public desire to view extensive, unbroken forests in all directions, making the presence of big patches and gaps of vibrant shrubby forest regeneration created through even-aged management far less likely on the landscape.

OBJECTIVE

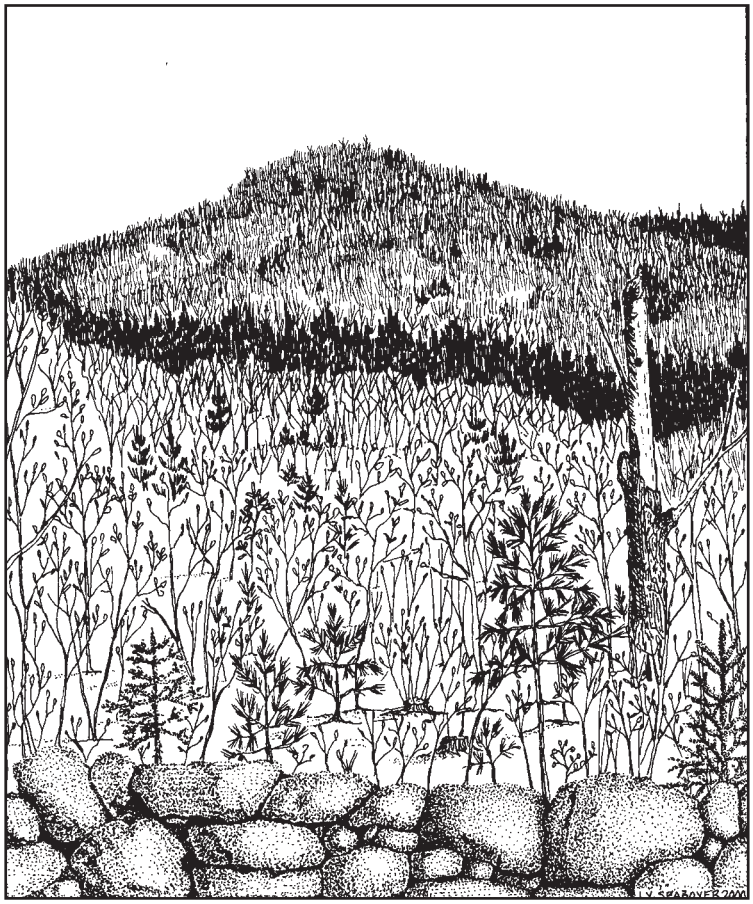
Provide a sufficient range of early successional habitat through regenerating shade-intolerant forest types.

CONSIDERATIONS

- Integrated timber and wildlife habitat management can efficiently and cost-effectively create early successional habitat.
- Larger regenerating patches attract more species of early successional wildlife than smaller regenerating patches. To attract and support early successional birds, the minimum effective patch size probably exceeds 2½ acres and spans the gap between the maximum size of group selection cuts (2 acres) and small clearcuts (10 acres).
- Shade-intolerant tree species (aspens, pin cherry, and paper birch) are best regenerated by clearcut, patch, and large group selection practices during the snow-free season.
- Use of clearcuts by early successional birds peaks around 10 years post-cut, and generally disappear from clearcuts within 20 years. A more frequent re-entry schedule than every 20 years can help maintain the occurrence of such ephemeral habitat.
- Isolated patches of early successional habitat in extensively forested landscapes are likely to have lower rates of shrubland bird occupancy than forested landscapes with higher percentages of early successional habitat.
- Statewide estimates to optimize early successional habitat for the array of early successional wildlife suggest a goal of 5 to 20 percent of the landscape in an early successional condition. This goal includes regeneration (0-to-10-year age class) and permanent openings with all properties contributing.

RECOMMENDED PRACTICES

- ✓ Develop habitat-composition goals for a property that include young forest as well as mature and older forest for a broad diversity of wildlife over time.
- ✓ Increase the use of group selection, patch and clearcut methods to diversify a closed canopy, increasing the gap size whenever possible.
- ✓ Regenerate shade-intolerant and mid-tolerant trees using shorter rotations, larger cuts, and site scarification.
- ✓ To increase the effective area of available early successional habitat spatially and over time, locate new groups, patches and clearcuts adjacent to temporary and permanent openings (i.e. utility corridor rights-of-way, scrub-shrub wetlands, frost pockets, and brushy old-fields).



CROSS REFERENCES

2.3 Regeneration Methods; 6.5 Permanent Openings; 6.7 Aspen Management; 6.8 Beaver-Created Openings; 7.4 Pine Barrens.

ADDITIONAL INFORMATION

DeGraaf, R., M. Yamasaki, W. B. Leak, and A. M. Lester. 2006. *Technical Guide to Forest Wildlife Habitat Management in New England*. University of Vermont Press and University Press of New England, Burlington, Vt. 305 p.

6.7 ASPEN MANAGEMENT

BACKGROUND

Aspen (also known as poplar or popple) stands are the preferred habitat for ruffed grouse, woodcock, Nashville warbler, beaver and other wildlife.

Although aspen is one of the most widely distributed forest types in North America, it is relatively uncommon in New Hampshire covering approximately 2 percent of the state's forest area. Aspen, including trembling aspen and big-toothed aspen, occurs chiefly as a "pioneer" forest type, often growing in close association with white birch. Pioneer types are the first to colonize disturbed areas such as burns and field edges. Big-toothed and trembling aspen are extremely intolerant of shade. They need full sunlight to grow. Disturbances such as fire or clearcutting are needed to regenerate shade-intolerant species such as aspen and white birch. In the absence of disturbance, aspen is replaced by more shade-tolerant trees, e.g., spruce, fir, white pine, or northern hardwoods.

OBJECTIVE

Maintain or expand the aspen type to enhance wildlife habitat diversity.

CONSIDERATIONS

- Aspen seed is extremely small and light. It can be blown long distances but requires exposed mineral soil for successful germination.
- Aspen typically regenerates by root-suckering. When an area containing aspen is clearcut, dormant buds on the roots sprout, often producing several thousand suckers per acre. Because they have an established root system, the suckers (collectively called a clone) may grow 4 feet or more the first year.
- All flowers on an individual tree are the same sex. Male aspens have larger buds and provide more valuable food for ruffed grouse.
- Trembling aspen stands reach maturity and begin to deteriorate at about 40 years old, though deterioration may begin at age 30 on poor sites or age 50+ on good sites. At maturity, aspen trees are generally 10 to 16 inches in diameter at breast height, depending on the quality of the site. Big-toothed aspen grows longer and larger than trembling aspen.
- Once aspen is gone, it is difficult to get it back, requiring cutting aspens to regenerate aspen from root suckers.
- A number of insects and diseases attack aspen. The only feasible method of dealing with them is to keep aspen stands vigorous by harvesting them at an appropriate rotation age.
- Aspen stands managed as feeding and nesting cover for woodcock or grouse are often 1 to 5 acres. Aspen openings as large as 10 to 20 acres are valuable for other early successional songbirds and mammals.
- Older and overmature aspen provide potential nest sites for pileated woodpeckers and other cavity nesters.

RECOMMENDED PRACTICES

- ✓ To regenerate aspen when a stand has at least 10 to 20 square feet of basal area per acre of aspen:
  - Harvest stands before the trees mature and begin to decline in vigor. Fast-growing, pole-sized trees sprout more vigorously than older, slower-growing trees.
  - Create openings with a diameter at least 1½ times as large as the height of surrounding trees to allow sunlight to reach the ground.
  - Clearcut nearly all of the stand; ideally, cut all stems 1-inch diameter and greater to ensure direct sunlight and to stimulate the best root-suckering response. The number of root-suckers is directly proportional to the number of aspen stems removed.
  - Cut aspen when dormant (late autumn through early spring), and avoid disturbance to aspen roots to maximize the density of root-suckers.
- ✓ To increase aspen where it occurs in very small groups or as individual trees mixed with other species such as growing along old woods roads, skid trails, and landings:
  - Locate openings following the above recommendations, so as to cut some, but not all of the aspens.
  - To maximize sunlight and heat exposure to roots and root-suckers, locate openings southwest of the aspens that are kept.
  - Expand these openings in subsequent harvests.
- ✓ Establishing aspen where none exists is more difficult and may require site preparation to enhance the germination and survival of seedlings.
- ✓ Where possible, retain downed logs at least 12 inches in diameter for ruffed grouse drumming.

CROSS REFERENCES

2.1 New Hampshire Forest Types; 2.3 Regeneration Methods; 5.1 Insects and Diseases; 6.4 Overstory Inclusions; 6.6 Temporary Openings Created by Forest Management; 6.8 Beaver-Created Openings.

ADDITIONAL INFORMATION

DeGraaf, R., M. Yamasaki, W. B. Leak, and A. M. Lester. 2006. *Technical Guide to Forest Wildlife Habitat Management in New England*. University of Vermont Press and University Press of New England, Burlington, Vt. 305 p.

Vermont Fish and Wildlife Dept. 1986. *Model habitat guidelines for deer, bear, hare, grouse, turkey, woodcock and non-game wildlife*. The Leahy Press, Montpelier, Vt. 64 p.

6.8 BEAVER-CREATED OPENINGS

BACKGROUND

Beavers add to habitat diversity through their foraging and dam-building activities.

Openings created by beavers follow a predictable cycle of change. Beaver-created openings progress from newly flooded areas, to open water ponds, to open meadows containing scattered small trees and shrubs. Each of these stages provides habitat for a variety of wildlife. Frogs, turtles, waterfowl, great blue herons, swallows, otter, mink, and moose regularly use the open-water stage. Geese, grouse, woodcock, woodpeckers, common yellowthroats, yellow warblers, bog lemmings, bears, deer, and moose use the open-meadow stage. Through their damming activities, beavers have served a historically important role as a natural form of disturbance, creating young forest habitat required by many wildlife species.

Beaver flowages (i.e., flat water behind the dam) also influence water quality, as dams trap sediments, and open meadows slow seasonal run-off. As a result, beaver flowages play an important role in nutrient cycling. During the open-water stage, nutrients enter beaver flowages. Where flowages stagnate, nutrients drop out of the water and accumulate in the organic matter at the bottom. When beavers abandon flowages and water levels drop, organic matter dries and decomposes, allowing grasses and forbs to colonize. In time, shrubs and trees reoccupy these meadows. Beavers are attracted back to the site by this abundant food. Beavers create a dam, and the cycle begins again.

OBJECTIVE

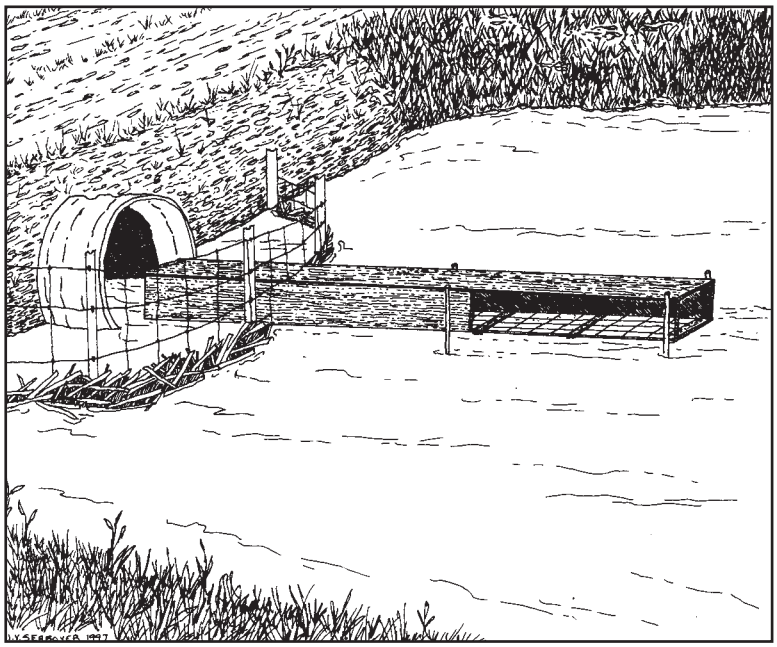
Maintain adequate food supplies for beavers along wetland drainages where beaver-dam-building and subsequent wetland openings are desired, and where water levels can be controlled to minimize damage to roads and personal property.

CONSIDERATIONS

- The highest-quality habitat for beavers occurs where shallow-gradient streams flow through wide valleys dominated by hardwood forests:
  - Stream gradients in occupied habitats are always less than 12 percent. Gradients less than 3 percent are optimal.
  - Valley (drainage) widths greater than 150 feet wide are optimal.
  - Hardwood buds, leaves, current annual twig growth, and cambium are required food for beavers. Streams and wetlands with hardwoods (especially aspen) growing within 100 feet of the water's edge are most suitable. Hardwood saplings less than 3 inches in diameter are preferred food from late summer through winter.
  - Aquatic plants including waterlily, duck potato (arrowhead), waterweed, pondweed, and duckweed are important foods in spring through summer.
- Large beaver flowages may be especially valuable for providing habitat for birds that require scrub-shrub habitats.
- Beavers can become a nuisance and have a negative economic impact to property owners when their tree-cutting and dam-building exceed acceptable levels. Numbers within a colony can grow to exceed the available food supply, resulting in starvation and site abandonment. Hunting or trapping can be used to remove nuisance beavers or to keep numbers within a colony low to extend the length of time beavers will occupy a site.

- Hunting or trapping beavers and disturbing beaver dams are activities regulated under RSA 210:9. Property owners can give written permission and access to licensed trappers during the regular trapping season. Outside the legal season, N.H. Fish and Game (NHF&G) can provide the name of a local trapper who can remove nuisance animals under state supervision. When beaver-dam removal is warranted, landowners can employ methods that remove dams gradually to release impounded water slowly without causing erosion and siltation.
- Harvesting more than 50 percent of the basal area near a beaver flowage may require a variance to the basal area law (RSA 227-J:9).

RECOMMENDED PRACTICES



✓ Whenever possible, allow beaver dam-building activities to occur unimpeded in order to maintain natural water flow and forest-disturbance patterns that maintain a high level of habitat diversity beneficial to a wide variety of wildlife.

✓ To control flooding by beavers:

- Determine the maximum acreage of flooding acceptable, and set an appropriate water-control device at that level.
- Maintain water depths at least 5 to 6 feet deep to allow beavers to access their lodge and travel under the ice during the winter. Beavers will likely abandon sites where water level is lowered to the point that ice forms to the pond bottom.
- A permit from the N.H. Dept. of Environmental Services (NHDES) may be required to install a beaver pipe.
- Consult with NHF&G or UNH Cooperative Extension for plans for water-control devices.
- Perform at least annual maintenance on any device to ensure it is working properly and that it hasn't become plugged or buried by beavers.

✓ Consider using stone fords for stream crossings when a solid maintenance-free base is needed. Consult with the Natural Resource Conservation Service or the NHDES for permitting requirements.

✓ Maintain beavers at an active flowage, or encourage beavers to colonize an unoccupied flowage, by regenerating aspen and other hardwoods in small patches or strips in and adjacent to flat, wide riparian corridors. Locate patches or strips up to 1 acre to maximize the amount of young forest growth within 100 feet of the water's edge (4.3 Forest Management in Riparian Areas). Create additional openings as needed to maintain an adequate supply of preferred food for beavers.

✓ If beavers are removing food faster than it grows, work with a local trapper to remove two to four beavers from the flowage annually to reduce the number of animals the food supply supports, thereby extending the length of time beavers are able occupy the flowage.

- ✓ Where safety allows, leave dead standing trees within and adjacent to beaver flowages.
- ✓ Consult with the NHF&G for additional information about RSA 210:9 and the N.H. Division of Forests and Lands about RSA 227-J:9.

CROSS REFERENCES

2.3 Regeneration Methods; 4.1 Water Quality; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 4.4 Stream Crossings and Habitat; 6.5 Permanent Openings; 6.6 Temporary Openings Created by Forest Management; 6.7 Aspen Management; 6.12 Heron Colonies.

ADDITIONAL INFORMATION

Laramie, H.A., Jr. and S.W. Knowles. 1985. *Beaver and Their Control—Wildlife Fact Sheet 10*. UNH Cooperative Extension, Durham, N.H. 4 p.

RSA 210:9. *Protection of Beaver*.
http://www.gencourt.state.nh.us/rsa/html/NHTOC/NHTOC-XVIII-210.htm Accessed May 26, 2010.

RSA 227-J. *Timber Harvesting*. http://www.gencourt.state.nh.us/rsa/html/xix-a/227-j/227-j-mrg.htm Accessed May 27, 2010.

Smith, S. 2009. *Guide to New Hampshire Timber Harvesting Laws*, UNH Cooperative Extension, Durham, N.H. 37 p.

Williamson, S.J. 1993. *Forester's Guide to Wildlife Habitat Improvement* (2nd ed). UNH Cooperative Extension, Durham, N.H.

6.9 DEER WINTERING AREAS

BACKGROUND

White-tailed deer in New Hampshire live near the northern limit of their geographic range. Because of severe winters, deer require special habitats to survive.

The winter survival of white-tailed deer is related to their ability to occupy "wintering areas" when deep snow limits food availability and deer mobility. Special habitat characteristics of deer wintering areas allow deer to maximize their daily food intake and minimize the amount of energy they expend to move, keep warm, and avoid predators.

Deer wintering areas (DWAs) consist of two basic habitat components:

(1) The core shelter area—dense, mature softwood that provides cover, improving the deers' ability to move in the snow.

(2) Other habitats that provide accessible forage within or adjacent to the core area. These habitats might be hardwood stands, mixed hardwood-softwood stands, or nonforest habitats such as fields or wetlands.

The term "deer wintering area" refers to the entire area deer occupy during winter, not just the dense-softwood cover—though the cover is critical and often the most difficult component to establish and maintain.

Most DWAs occur at elevations below 2,000 feet in lowland softwood stands such as spruce-fir and northern white cedar in the north, or eastern hemlock in the south. DWAs are often associated with watercourses and riparian areas, since these forest types grow there. Only about 3 percent of New Hampshire's land base meets the habitat requirements for deer wintering.

Deer use of wintering areas varies within and between winters, based mainly on differences in snow depth. Deer move into wintering areas when snow depth exceeds 10 to 12 inches, and they primarily use the core shelter area when snow depth exceeds 16 to 20 inches. During mild winters deer may range far from softwood shelter or not use a wintering area at all. Some wintering areas aren't used annually by deer, but these habitats are still critical when winter conditions are severe.

In northern New Hampshire, it isn't uncommon for some deer to travel more than 20 miles between the habitat they use in autumn and the DWA they use each year. Northern deer generally "yard" in large numbers and remain within or close to the cover provided by extensive softwood stands all winter long.

In southern New Hampshire, where winter conditions are less severe, deer often make short-distance movements during winter storms or periods of severe cold. They find refuge in small stands or patches of dense softwood cover near or within the habitat they use during autumn. They often don't yard in the same numbers or for the same length of time as deer in the north. As a result, DWAs in the north are often large, characterized by softwood stands exceeding 100 acres, while those in the south are often much smaller. Softwood stands covering less than a few acres provide temporary cover.

OBJECTIVE

Manage existing deer wintering areas to provide deer with functional shelter, softwood travel lanes to access food and escape predators, and a continuous supply of accessible browse.

CONSIDERATIONS

- Refer to the following comprehensive guides for in-depth coverage of DWA ecology and management options: Gill 1957, Boer 1978, Telfer 1978, Reay et al. 1990, Voigt et al. 1997, OMNR 2000, NBDNR 2002, Pekins and Tarr 2009, Pratte 2009. Full listings follow below in "Additional Information."
- N.H. Fish and Game (NHF&G) provides maps of known DWAs. Because locations of wintering areas change over time, a field evaluation of the current habitat conditions is recommended before conducting any work within a known or potential DWA.
- Maintaining DWAs on working forest land requires identifying sites where core shelter and forage can develop over time. The location of core shelter areas doesn't need to be static. Timber harvesting can be used to shift the location of these stands over time, to ensure they don't become overmature and lose their ability to provide functional shelter.
- Deer need to access adequate food throughout winter to offset their energy expenditure. This is best provided in DWAs with core shelter areas highly interspersed with forage areas and connected by corridors of mature softwoods. This allows deer to move among all habitats under a variety of snow conditions.
- It isn't clear how large a softwood stand needs to be to provide functional winter cover for deer. Experience and the existing research provide some considerations:
  - As you move from southern New Hampshire north, deer likely require larger core shelter areas due to differences in winter severity.
  - Wherever snow depth regularly exceeds 16 to 20 inches, individual core shelter areas should probably exceed 25 acres.
  - In the south, pockets of softwoods as small as 1 acre may provide functional cover, especially when crown closure in these stands approaches 100 percent.
  - Small-acreage softwood stands may effectively provide cover from cold temperatures or improve their access to forage. These stands may be ineffective in protecting deer from predators if the stands aren't large enough to enable deer to establish complex trail networks throughout the wintering area.
- Hemlock and northern white cedar provide the best winter cover for deer due to their superior ability to intercept snow. Spruce and balsam fir are important cover, but require denser stands to intercept the same amount of snow. Pines must grow in stands with considerably more than 70 percent crown closure to reduce snow depth.
- Hardwoods provide little to no cover for deer during winter. Hardwood stands on south- to west-facing slopes are important, though. During the day, deer often bed in these stands to be warmed by the sun's heat. Sun and wind often expose fallen acorns and beechnuts, which are among the highest-quality winter foods.
- After deer learn the location of their wintering area from their mothers, they generally return to it for life and are reluctant to abandon it for a new one. Focus on enhancing or expanding existing DWAs before attempting to create new ones.

- The aggregation of small DWAs on multiple ownerships provides a significant portion of the winter range of deer in New Hampshire.
- All forms of softwood silviculture can be compatible with DWA management, as long as mature softwood stands previously managed for cover are harvested only when regenerating stands have grown and are able to immediately replace the cover being removed.
- Maintaining stands within the DWA for a balanced age-class distribution provides habitat for a diversity of wildlife, reduces the susceptibility of softwood stands to common insect pests (e.g., spruce budworm), and allows for a continued yield of forest products.
- Landowners for whom DWA management is a priority may have to reduce or delay timber harvests on a portion of their land to develop the softwood age classes or establish harvest rotations required to create and maintain functional core shelter areas. Such accommodations may increase the administrative costs of harvesting and require landowners to defer income.
- Because of deer browsing, regenerating many hardwood trees and some softwoods (e.g., hemlock, cedar) can be difficult in stands located in and adjacent to DWAs. Options for reducing this impact include (1) focused hunting, (2) locating openings away from wintering areas, and (3) providing a number of browsing opportunities for deer each time you cut trees. Make a number of openings, rather than a single opening, so browsing isn't concentrated within a single area.
- The potential negative impacts of providing deer with supplemental food during winter outweigh the potential benefits.
  - Supplemental food concentrates deer in unnaturally high densities, leading to significant overbrowsing of natural foods around feeding sites. Even where supplemental food is provided, deer rely on natural browse for most of their daily food needs. Overbrowsing may reduce the overall ability of the wintering area to meet the needs of deer.
  - Supplemental feeding cause deer to alter their annual migration patterns. They concentrate their activity near residential areas and away from historic wintering areas that provide cover.
  - Supplemental feeding sites may increase the risk of deer contracting and spreading serious diseases such as chronic wasting disease and bovine tuberculosis.

RECOMMENDED PRACTICES

General recommendations for managing DWAs

- ✓ Contact NHF&G to find out whether known DWAs occur on your land and for assistance planning timber harvests in known or potential DWAs.
- ✓ Develop and maintain a balanced distribution of timber age classes across the DWA to maintain a constant supply of core shelter.
- ✓ Maintain "functional" core shelter on at least 50 percent of the DWA at all times. Functional shelter is provided by softwood stands at least 35 feet tall with softwood crown closure between 65 to 70 percent.
- ✓ Throughout the remainder of the DWA, maintain forage areas that provide a steady, abundant source of accessible browse by clearcutting 1- to 5-acre openings using a 40-year rotation and 10-year cutting cycle. Locate browse cuts within 100 feet of core shelter areas.
- ✓ Throughout the DWA, maintain strips of closed-canopy softwoods as travel corridors that connect core shelter areas with forage areas. Integrate these strips with riparian management zones. Create strips at least 100 to 300 feet wide and managed with uneven-aged silviculture to maintain softwood crown closure greater than 75 percent.

- ✓ Winter is generally the best season to harvest timber from DWAs since deer forage on fallen tree tops and tree lichens, and skid trails improve deer mobility. Summer logging is preferred when soil scarification is required to regenerate desired softwood species such as hemlock, spruce and fir.
- ✓ Protect advanced softwood regeneration. Lay out skid trails and incorporate harvesting technologies and techniques that have a lower impact to advanced regeneration (3.1 Timber Harvesting Systems).
- ✓ Avoid or limit disturbance to deer within the DWA during winter by routing all truck roads, skid trails, and recreational trails around, rather than through, core shelter areas. Locate new trails used during the winter (e.g., snowmobiling, skiing, snowshoeing) as far away as possible from core shelter areas—ideally so deer don't see trail users.

Forest-Type Specifics

- ✓ In spruce-fir stands, uneven-aged management using group selection is the preferred method for managing DWAs and is especially important in softwood stands smaller than 100 acres. Make group openings between 20 to 40 feet in diameter. Rotation age targets are 70 years for fir and 100 years for spruce.
- ✓ Suitable options for even-aged systems in spruce-fir stands depend upon advanced regeneration. If advanced regeneration is present, conduct an overstory removal. If regeneration is absent, use a two-cut shelterwood system or strip clearcutting to stimulate seedling growth.
- ✓ Favor spruce over fir because spruce is longer-lived, generally more root-firm, and less susceptible to common insect pests.
- ✓ Favor hemlock when possible since it provides the best cover of all the softwood species. Managing hemlock stands may be difficult. Seek professional advice. Refer to Tubbs (1978) and Reay (1985) for details on hemlock silviculture.
- ✓ Release advanced hemlock regeneration and establish browse by removing competing hardwoods around the core cover area.
- ✓ If DWA management is a priority, manage hemlock core shelter areas with at least a 150-year rotation. Hemlock is very long-lived. Older hemlock found growing in many DWAs tend to have poor timber quality.
- ✓ If advanced hemlock regeneration is present, conduct a single removal of the overstory trees in areas scheduled for regeneration. If there is inadequate regeneration, a two- or three-stage harvest is recommended.
- ✓ If harvesting in the summer, scarify the soil and remove advanced hardwood regeneration.
- ✓ In DWAs less than 10 acres, retain most or all of the hemlock to ensure the long-term production and maintenance of functional deer shelter.
- ✓ Northern white cedar can be extremely hard to regenerate because it grows slowly and is also a highly preferred browse species. If a cedar DWA is encountered, contact NHF&G for details on management options.

CROSS REFERENCES

2.1 New Hampshire Forest Types; 2.2 Forest Structure; 2.3 Regeneration Methods; 2.4 Managing for High-Value Trees; 3.1 Timber Harvesting Systems; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 6.4 Overstory Inclusions; 6.5 Permanent Openings; 6.6 Temporary Openings Created by Forest Management.

ADDITIONAL INFORMATION

Boer, A.H. 1978. Management of deer wintering areas in New Brunswick. *Wildl. Soc. Bull.* 6(4): 200-205.

Gill, J. D. 1957. *Review of deer yard management*. Bulletin No. 5. Maine Dept. of Inland Fisheries and Wildlife, Augusta, Maine.

New Brunswick Dept. of Natural Resources. 2002. *Standards and guidelines for management of deer wintering areas on Crown Land*. NBDNR, Fredericton, N.B. 28 p.

N.H. Fish and Game Dept. 2001. *More harm than good: Here's why the New Hampshire Fish and Game Department urges you to not feed the deer*.
http://www.wildlife.state.nh.us/Wildlife_Journal/WJ_sample_stories/WJ_f01_More_Harm.pdf Accessed March 11, 2010.

Ontario Ministry of Natural Resources. 2000. *Significant wildlife habitat technical guide*. OMNR, Queens Printer for Ontario, Toronto, Canada. 139 p.

Pekins, P. J., and M. D. Tarr. 2009. A *critical analysis of the winter ecology of white-tailed deer and management of spruce-fir deer wintering areas with reference to northern Maine*.
Cooperative Forestry Research Unit. Res. Rep. RR-08-02. Orono, Maine. 154 p.

Pratte, J. J. 2009. *Guidelines for managing deer wintering areas in northern, western and eastern Maine*.
Maine Dept. of Inland Fisheries and Wildlife.
http://www.maine.gov/ifw/wildlife/species/pdfs/DWA_Guidelines_2.4.10.pdf Accessed June 8, 2010.

Reay, R.S. 1985. Compatibility of Timber Management and Wintering Deer in Hemlock Stands. In proceedings of joint conference of New England Chapter of the Society of American Foresters, Maine Chapter of the Wildlife Society, and Atlantic International Chapter of the American Fisheries Society, Portland, Maine.

Reay, R.S, D.W. Blodgett, B.S. Burns, S.J. Weber, and T. Frey. 1990. *Management Guide for Deer-Wintering Areas in Vermont*. Vermont Dept. of Forests, Parks and Recreation, and Vermont Dept. of Fish and Wildlife. 35 p.

Telfer, E.S. 1978. Silviculture in Eastern Deer Yards. *For. Chron.* 54: 203-208.

Tubbs, C.H. 1978. *How to Manage Eastern Hemlock in the Lakes States*. USDA For. Serv. Pub. North Central Forest Experiment Station. 2 p.

Voigt, D. R., J.D. Broadfoot, and J.A. Baker. 1997. *Forest management guidelines for the provision of white-tailed deer habitat (version 1.0)*. Ontario Ministry of Natural Resources, Queen's Printer for Ontario, Toronto, Canada. 33 p.

6.10 WOODLAND RAPTOR NEST SITES

BACKGROUND

Suitable nest sites are limited for woodland-nesting raptors. These birds can be sensitive to human disturbance and habitat changes in the vicinity of nests. Continued existence of these birds depends on an adequate supply of potential nest trees.

Accipiters (sharp-shinned and Cooper's hawks, and northern goshawk) build large stick nests on large branch fans of white pines next to the tree bole, and in multipronged "basket" forks (where three or more large branches meet) of mature hardwoods at different canopy heights. They often reuse the same nest in successive years, or build a new nest in another nearby tree. Goshawks build nests in the base of the canopy often in areas with prior goshawk nesting. Sharp-shinned and Cooper's hawks tend to build their nests higher in the canopy. Sharp-shinned hawks tend to nest in younger, dense forest stands; Cooper's hawks nest in more open forests. Goshawks nest in more mature forests in or near large white pines.

Buteos such as red-tailed, red-shouldered, and broad-winged hawks build large stick nests in "basket" forks of mature hardwoods and on large branch fans of white pines that are often near the edges of open, nonforest areas such as upland openings, marshes, beaver ponds and old woods roads. Red-shouldered hawks nest in mature woodlands near water or wetlands.

Ospreys nest on dead or dead-topped trees, most often in white pines but occasionally in other tall softwoods. Osprey often nest near large lakes, wetlands or stream riparian zones, but may occasionally nest in upland settings some distance from open water.

Bald eagles usually nest within half a mile of water along shorelines of large lakes and estuaries in large white pines or hardwoods. Both osprey and bald eagle nests are typically used for years or even decades, with pairs adding new nesting material each year.

Cavity-nesting owls (barred, long-eared, saw-whet, and screech) use a range of sizes of cavity trees in forested and riparian areas. Great horned owls commonly occupy large stick nests built by red-tailed hawks, crows, ravens, herons, and squirrels. Barred and long-eared owls may also use stick nests.

Excessive human activity near raptor nests in the early weeks of the breeding season may cause a pair to abandon the site; or if later in the nesting cycle, may cause an incubating or brooding female to flush from the nest, leaving eggs or nestlings vulnerable to fatal chilling or predation.

OBJECTIVE

Manage for suitable nest trees and potential replacement nest trees for woodland-nesting raptors and avoid disturbance of nesting pairs during the breeding season.

CONSIDERATIONS

- Cooper's hawk, northern goshawk and red-shouldered hawks are New Hampshire species of greatest conservation need.
- The number of nesting pairs of ospreys statewide has steadily increased to 68 in 2008 from the early 1980s, when 10 to 20 pairs nested in Coos County near the Androscoggin River. Though ospreys were removed from the state-threatened list in 2008, they remain a New Hampshire species of greatest conservation need.

- The number of bald eagle nesting pairs steadily increased to 15 in 2008 since bald eagles resumed nesting in New Hampshire in 1988. Bald eagles were removed from the federally threatened list in 2007 and remain on the state-threatened list and as a species of greatest conservation need.
- No regional surveys assess the status of owls.
- Identifying woodland raptor nests can be difficult without the birds' presence and activity. Active nests can be difficult to determine outside of the nesting season (mid-February through the end of July). Multiple raptor nests indicate areas where past raptor nesting has occurred. Active nest trees are often discovered during harvesting.
- Because of their poor form (from a timber-value perspective), potential raptor nest trees may be removed during timber stand improvement.
- While northern goshawks will aggressively defend their nest sites, some raptor species such as red-tailed and broad-winged hawks can tolerate nest disturbances better than other species.
- Nesting raptors may tolerate vehicular traffic on regularly used roads. However, all-terrain vehicle (ATV) traffic on otherwise unused roads and trails can be a disturbance factor.
- Great horned owls prey on both adult and nestling hawks and can discourage some hawk nesting attempts in landscapes with a significant open, nonforest component.

RECOMMENDED PRACTICES

- ✓ Look for stick nests in sawtimber-size white pine and hardwoods along woods roads and trails, near water and forest openings.
- ✓ Avoid recreational use of logging roads adjacent to active nests during the raptor nesting season (mid-February through the end of July). Trails may be temporarily rerouted around nesting areas.
- ✓ Retain trees containing large stick nests and some potential nest trees, especially those hardwoods with multipronged "basket" forks, and large cavity trees (6.2 Cavity Trees, Dens and Snags).
- ✓ In clearcuts, leave a group of several large trees for each 5 to 10 acres to ensure future availability of mature trees for nest sites. These clumps also can serve cavity-nesters' needs.
- ✓ Where raptor nests are found, leave a partially closed canopy using either single tree management or a small uncut buffer of at least a chain (66 feet) around the nest trees, leaving more than just the nest tree(s).

- ✓ Minimize nesting-season disturbances around active nests.
  - Temporarily limit forest management activities (tree cutting, road construction, etc.) within 10 chains (660 feet) of active raptor nests during mid-February through the end of July; with the understanding that tolerance levels are highly variable among raptor species and individuals of a given species and that each situation can be different.
  - If nests are discovered during harvesting, continue working in another area, if possible, while the birds are nesting and until the young raptors have fledged.
- ✓ For bald eagles, avoid human activity within 5 chains (330 feet) of active nests from February 1 to August 31. Contact the Nongame and Endangered Wildlife Program at N.H. Fish and Game for assistance when planning a harvest within one-quarter mile of a nest. Refer to timber operations and forestry-practices guidelines in National Bald Eagle Management Guidelines.
- ✓ Though peregrine falcons aren't tree-nesters, minimize potential recreational and rock-climbing disturbance around cliff-nesting sites during the breeding season.

CROSS REFERENCES

2.2 Forest Structure; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 6.2 Cavity Trees, Dens and Snags; 6.13 Wildlife Species of Greatest Conservation Need.

ADDITIONAL INFORMATION

Elliott, C.A. 1988. *A Forester's Guide to Managing Wildlife Habitats in Maine*. University of Maine Cooperative Extension, Orono, Maine.

USDI Fish and Wildlife Service. 2007. *National bald eagle management guidelines*. http://www.fws.gov/pacific/eagle/NationalBaldEagleManagementGuidelines.pdf Accessed February 23, 2010.

6.11 BALD EAGLE WINTER ROOSTS

BACKGROUND

Wintering eagles need secure hunting perches, predictable food sources, and sheltered roosting areas.

Eagles stand more than 3 feet tall and have a 6- to 7½-foot wing span, requiring large trees for suitable perches. Trees with large, widely spaced branches provide the structure these large raptors can use. Large shoreline trees adjacent to open water provide perch sites from which eagles can scan the water for food, and to which they return with prey to eat. Stands of mature conifers, particularly white pine, sometimes mixed with large hardwoods, provide sheltered roosting areas where eagles spend the night and periods of inclement weather. These roosts are characterized by large-diameter white pines spaced far apart to allow easy access into the roost and provide sufficient overhead cover. Roost trees are often found on easterly facing, steeper slopes so the birds can roost out of the prevailing winds.

Winter roost sites are typically located near foraging areas (i.e., ducks, geese, fish, and roadkill), though they may be some distance from the shore. Roosts must provide protection from the wind and from extreme cold, as well as open access to perch sites. Winter is stressful because cold temperatures increase energy demands and food can be difficult to obtain. Eagles spend many winter hours perching quietly in protected locations.

Eagles vary in their tolerance of human activity, depending on the individual eagle, the particular roost or perch, and even the individual human involved. Human activity near roosts and perches can interfere with foraging and disturb eagles from protected perches, increasing energy demands and sometimes forcing eagles to perch in exposed locations.

Winter bald eagle counts in New Hampshire increased since 1982 from two to a record 67 in 2008. Wintering bald eagles occur in limited areas, usually near open water, though they sometimes roost up to half a mile from water in the Lakes Region, the Great Bay area, and along open stretches of the Androscoggin, Merrimack, and Connecticut rivers.

OBJECTIVE

Manage for structural habitat features (i.e., tree-branching patterns and stand densities) of shoreline perch trees and night roost areas. Avoid human disturbance of these sites from December through March.

CONSIDERATIONS

- Consistently used roost and perch sites are limited in number and extent and are documented from annual monitoring.
- Winter eagle roosts are difficult to recognize when the eagles aren't present.

RECOMMENDED PRACTICES

- ✓ Maintain large trees, particularly large white pines, along shorelines of large rivers, lakes, and estuaries, for perching, nesting and roosting.
- ✓ In the vicinity of a known roost, consult the Nongame and Endangered Wildlife Program at N.H. Fish and Game for help when planning a harvest.

6.11: Bald Eagle Winter Roosts

- ✓ Avoid harvesting in stands where eagles are known to roost.
- ✓ Avoid routing recreational or skid trails and truck roads in the immediate vicinity of known and potential night roosts and day perches.
- ✓ Permanently protect remaining undeveloped shorelines on major water bodies.

CROSS REFERENCES

4.3 Forest Management in Riparian Areas; 6.10 Woodland Raptor Nest Sites.

ADDITIONAL INFORMATION

N.H. Fish and Game. *Bald Eagle Profiles*.
http://www.wildlife.state.nh.us/Wildlife/Wildlife_profiles/profile_bald_eagle.htm Accessed February 23, 2010.

6.12 HERON COLONIES

BACKGROUND

Herons nest in colonies (colonial nesters) in mature trees in or near wetlands. Nesting birds tend to be very sensitive to human disturbance.

Great blue herons are large wading birds that nest in colonies of several to many pairs. Nesting colonies usually are found near wetland and shoreline feeding areas, though they occasionally will nest at some distance from wetland feeding areas. Most southern New Hampshire nests occur in dead trees in beaver ponds. North Country nests are usually in live white pines that tower above the surrounding treetops. Heron colonies also may occur in mature live hardwoods on upland sites. Heron colonies come and go over time; often as nesting snags fall and trees lose their branches or as a nearby food source changes.

Human activity in the vicinity of a nesting colony during the breeding season may lead to low productivity or abandonment; distance from human settlements appears to be a significant factor in colony site selection. Great blue herons will flush from nests in response to intrusions at distances of roughly 400 to 600 feet early in the breeding season (April through May) before incubation has begun, and at distances of roughly 100 to 300 feet during incubation and nestling periods.

OBJECTIVE

Prevent disturbance or loss of heron nesting colonies.

CONSIDERATIONS

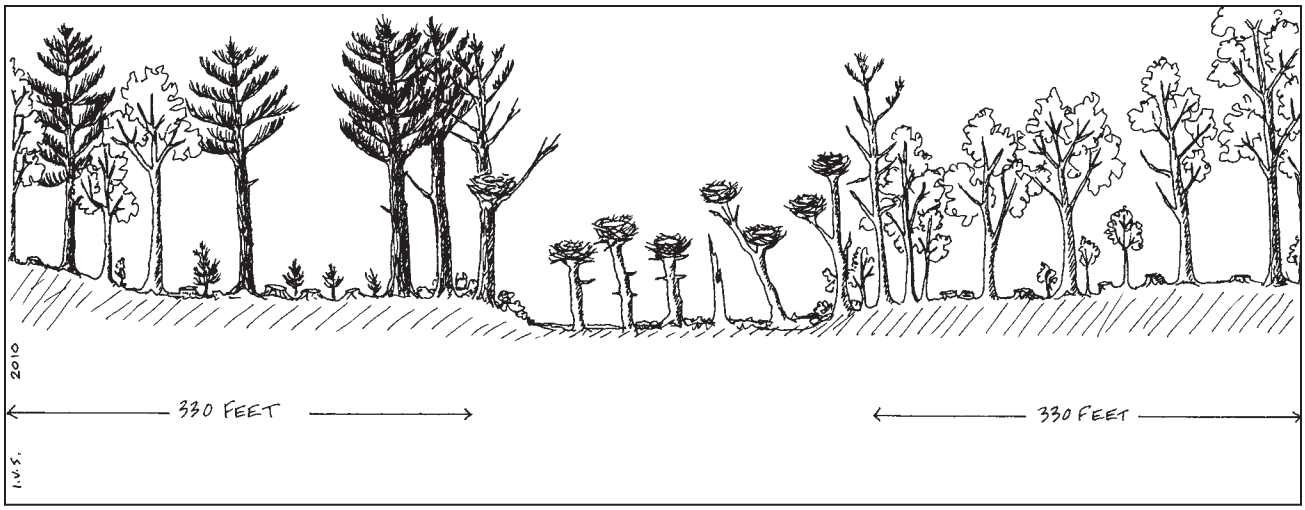
- Information on location and numbers of great blue heron colonies across the state is lacking. Most of the known colonies are located south of the White Mountains.
- Great blue herons are protected, as are all migratory birds, under the federal Migratory Bird Act of 1918.
- Given the short sight distances of the birds and the dynamic nature of nesting colonies in the northeast, past recommended buffers appear to be larger and more restrictive than needed to protect heron colonies.
- Road construction in the vicinity of a nesting colony may result in nest abandonment. Nesting herons may tolerate vehicle traffic on existing roads, but pedestrians visible from nests often present more of a problem than traffic.

RECOMMENDED PRACTICES

✓ Within roughly 330 feet (5 chains) of an active, occupied heron colony:

- Refrain from cutting live or dead nest trees.
- Locate roads and trails outside the buffer. If not possible, avoid road construction, harvesting, and recreational activity during the breeding and nesting season (April through August).
- Limit harvest activity to single tree or small group selection harvests outside the breeding and nesting season.

- ✓ Increase the buffer distance if conditions make it likely that nesting birds might be disturbed beyond the 330 foot buffer.
- ✓ Report heron-colony locations to the Nongame and Endangered Wildlife Program at N.H. Fish and Game or NH Bird Records.



CROSS REFERENCES

4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 6.8 Beaver-Created Openings.

ADDITIONAL INFORMATION

Elliott, C.A. 1988. *A Forester's Guide to Managing Wildlife Habitats in Maine*. University of Maine Cooperative Extension, Orono, Maine.

Migratory Bird Act of 1918. http://www.fws.gov/laws/lawsdigest/migtrea.html Accessed on February 23, 2010.

N.H. Bird Records. http://www.nhbirdrecords.org Accessed on February 23, 2010.

6.13 WILDLIFE SPECIES OF GREATEST CONSERVATION NEED

BACKGROUND

Species of greatest conservation need (SGCN) are those wildlife species whose populations are declining or naturally rare and whose continued existence requires some action.

For many species, the reduced availability of habitat contributes to their decline. Especially sensitive to habitat change are those with needs that can be met only by specific habitat characteristics such as a particular plant community, a particular hydrologic or temperature regime, or a particular size of habitat patch. Forest management activities can enhance, degrade or maintain the habitat of certain species.

Some of the SGCN are listed as threatened or endangered under the N.H. Endangered Species Conservation Act (RSA 212-A) and have some regulatory protection. Others are listed in the *New Hampshire Wildlife Action Plan*, with recommendations for conservation actions that can help prevent them from declining and being listed under the Act. Modification in routine silvicultural operations may benefit these species. These decisions are best made on a site-specific basis.

OBJECTIVE

To sustain wildlife species of greatest conservation need in habitats where they occur and restore habitats that enable them to recover their populations.

CONSIDERATIONS

- N.H. Fish and Game (NHF&G) has legal authority regarding all wildlife—game, nongame and endangered or threatened species. NHF&G maintains the list of New Hampshire's endangered and threatened wildlife. The list identifies the most imperiled wildlife in the state. NHF&G uses it to determine protection and management actions necessary to ensure the survival of the state's endangered and threatened wildlife. The list is available through the NHF&G and is included in the Appendix (which also shows what other chapters in this manual address the needs of SGCN).
  - Endangered wildlife are those native species in danger of becoming extinct in New Hampshire because of loss or change in habitat, over-exploitation, predation, competition, disease, disturbance, or contamination by pollutants.
  - Threatened wildlife are those native species likely to become endangered in the near future if conditions surrounding them begin or continue to decline.
- Actions that result in a "take" of a documented state threatened or endangered species (listed in FIS 1000 per RSA 212-A) are prohibited. It's important to understand the needs of those species and incorporate them into land-management plans and activities.
- The specialized habitat needs of rare wildlife make it difficult to identify general guidelines and recommended practices. Guidelines need to be species-specific and applied where the species is known or likely to occur. Specific habitat-management techniques for some species can be found in DeGraaf et al. (2007), other chapters in this manual, and the Habitat Stewardship Series by UNH Cooperative Extension.

- Some modification of forestry practices may be necessary to conserve, protect, or enhance the habitat for rare species. In many cases, simple modifications of routine forestry operations will satisfy species needs. These modifications may involve changing the timing (after nesting) or season (frozen ground) of the operation. They may include selecting a different silvicultural technique or changing the individual trees that are cut. In some situations leaving the area uncut may be the best option.
- Targeting management for one particular species may not meet the needs of other desired species.

RECOMMENDED PRACTICES

- ✓ To find what SGCN species could live on your property, based on habitat and geographic location, check the *Wildlife Action Plan* and documents by NHF&G, UNH Cooperative Extension and others. DeGraaf and Yamasaki (2001) is a resource for natural history information.
- ✓ Survey your property for species and habitats. Check with the N.H. Natural Heritage Bureau for any documented threatened or endangered wildlife species. Ask NHF&G biologists for advice, especially if planning a timber harvest. Incorporate habitat management for SGCN species into your management plan and management activities.
- ✓ When possible, look beyond property boundaries to consider landscape-scale opportunities, including working with neighbors to conserve SGCN species.
- ✓ Each wildlife species has specific habitat requirements, making general recommended practices difficult to identify. A few selected species that use forested habitats are discussed in other chapters. See appendix, *Wildlife Species of Greatest Conservation Need*, for those species and where to find that information. Check the species profiles in the *Wildlife Action Plan (Appendix A)* for basic habitat needs. Seek other resources on habitat needs from NHF&G, the U.S. Fish and Wildlife Service, or UNH Cooperative Extension.

CROSS REFERENCES

4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 6.2 Cavity Trees, Dens and Snags; 7.3 Vernal Pools; 7.4 Pine Barren; 7.5 Old-Growth Forests; 7.6 High-Elevation Forests; Appendix—Wildlife Species of Greatest Conservation Need.

ADDITIONAL INFORMATION

Beattie, M., C. Thompson, and L. Levine. 1993. *Working with Your Woodland: A Landowner's Guide (2nd ed.)*. University Press of New England, Hanover, N.H. 279 p.

Bryan, R. 2007. *Focus Species Forestry: A guide to integrating timber and biodiversity management in Maine*. Maine Audubon and Maine Dept. of Conservation and others. http://www.maineaudubon.org/conserve/forest/focusspecies.shtml Accessed February 23, 2010.

Clyde, M. E., D. Covell, and M. Tarr. 2004. *A Landowners Guide to Inventorying and Monitoring Wildlife in New Hampshire*. UNH Cooperative Extension. http://extension.unh.edu/resources/files/Resource000418_Rep440.pdf Accessed February 23, 2010.

DeGraaf, R., M. Yamasaki, W. B. Leak, and A. M. Lester. 2006. *Technical Guide to Forest Wildlife Habitat Management in New England*. University of Vermont Press and University Press of New England, Burlington, Vt. 305 p.

DeGraaf, R., M. Yamasaki, W. B. Leak, and A. M. Lester. 2005. *Landowner's Guide to Wildlife Habitat: Forest Management for the New England Region*. University Press of New England, Lebanon, N.H. 128 p.

DeGraaf, R. M. and M. Yamasaki. 2001. *New England Wildlife: Habitat, Natural History and Distribution*. University Press of New England, Lebanon, N.H. 482 p.

N.H. Fish and Game. *Endangered and Threatened Wildlife of New Hampshire*. http://www.wildnh.com/Wildlife/Nongame/endangered_list.htm Accessed February 23, 2010.

Foss, C.R. (ed.). 1994. *Atlas of Breeding Birds of New Hampshire*. Arcadia. Dover, N.H.

N.H. Administrative Rules FIS 1001. *Conservation of Endangered and Threatened Species*. http://www.gencourt.state.nh.us/Rules/state_agencies/fis1000.html Accessed June 2, 2010.

N.H. Fish and Game. 2005. *New Hampshire Wildlife Action Plan*. http://www.wildnh.com/Wildlife/wildlife_plan.htm Accessed February 23, 2010.

Oehler, J. D., D. Covell, S. Capel, and R. Long. 2006. *Managing Grasslands, Shrublands, and Young Forest Habitats for Wildlife: A Guide for the Northeast*. Northeast Upland Habitat Technical Committee, Massachusetts Division of Fisheries and Wildlife. http://www.wildlife.state.nh.us/Wildlife/Northeast_Hab_Mgt_Guide.htm Accessed February 23, 2010.

Patmos, W. 1995. *New Hampshire's Native Trees, Shrubs, and Vines with Wildlife Value*. UNH Cooperative Extension. http://extension.unh.edu/resources/files/Resource000427_Rep449.pdf Accessed February 23, 2010.

RSA:212-A. *Endangered Species Conservation Act*. http://www.gencourt.state.nh.us/rsa/html/XVIII/212-A/212-A-mrg.htm Accessed June 2, 2010.

Sepik, G., R. Owen, and M. Coulter. 1981(reprinted 1994). *A Landowner's Guide to Woodcock Management in the Northeast*. University of Maine. http://www.umaine.edu/mafes/elec_pubs/miscrepts/ne_woodcock.pdf Accessed February 23, 2010.

University of Maine Cooperative Extension. *Wild Apple Trees for Wildlife in Habitats: A Fact Sheet Series on Managing Lands for Wildlife*. http://www.umext.maine.edu/onlinepubs/PDFpubs/7126.pdf Accessed February 23, 2010.

UNH Cooperative Extension. 2008-2010. *Habitat Stewardship Brochure Series: New Hampshire Wildlife Action Plan*. http://extension.unh.edu/Wildlife/HabitatStewardshipSeries.htm Accessed February 23, 2010.

USDI Fish and Wildlife Service. *New England Field Office homepage*. http://www.fws.gov/newengland/ Accessed February 23, 2010.

Winne, R., F. Mitchell, and E. Snyder. 1997. *Protecting and Enhancing Shorelands for Wildlife*. UNH Cooperative Extension. http://extension.unh.edu/resources/files/Resource000428_Rep450.pdf Accessed February 23, 2010.

Yorke, D. 1995. *Wildlife Habitat Improvement Series*. UNH Cooperative Extension. http://extension.unh.edu/resources/resource/453/Wildlife_Habitat_Improvement_Series Accessed February 23, 2010.

SENSITIVE AREAS

TOPICS IN THIS SECTION

ADDITIONAL READING

Natural Communities of New Hampshire
Daniel Sperduto and William Nichols
N.H. Natural Heritage Bureau, Dept. of Resources and Economic Development
2004

The Nature of New Hampshire: Natural Communities of the Granite State
Daniel Sperduto and Ben Kimball
N.H. Natural Heritage Bureau
University Press of New England
In press

7.1 NATURAL COMMUNITIES AND PROTECTED PLANTS

BACKGROUND

Protecting and conserving natural communities and threatened and endangered plants is essential to maintain native biodiversity.

Natural communities are recurring assemblages (groups) of species found in particular physical environments. Familiar examples include ***hemlock - beech - oak - pine forest***, and sugar maple dominated ***rich mesic forest***. The N.H. Natural Heritage Bureau (NHNHB) recognizes 193 natural communities, of which 42 are wooded uplands and 38 are wooded wetlands or floodplain forests.

NHNHB evaluates the ecological significance of natural communities and assigns a quality rank. Quality ranks are a measure of the ecological integrity of a community relative to other examples of that community. The rankings are based on community size, ecological condition, and landscape context (i.e., where the community is located). Exemplary communities include (1) all viable occurrences of rare natural community types, and (2) higher-quality examples of more common communities. Exemplary natural communities occupy only a small part of New Hampshire.

New Hampshire has about 1,500 species of native vascular plants, about 25 percent of which are protected by the New Hampshire Native Plant Protection Act (RSA 217-A). Another three plants are protected by the federal Endangered Species Act, only one of which—small whorled pogonia—occurs in forests.

Many threatened and endangered plants occur in nonforested habitats such as marshes, riverbanks, and alpine areas. Threatened and endangered forest plants are largely restricted to uncommon habitat types. Black maple, river birch, hackberry, and jack pine are four threatened or endangered tree species that may reach harvestable size. Black maple typically occurs with sugar maple on moist, rich soils of river bottoms in mixed hardwood forests in southern New Hampshire. River birch is restricted to streambanks and other moist places. Hackberry usually occurs on rich, moist sites along streambanks or on floodplains. Jack pine occurs on only a few acidic rocky summits at moderately high elevations in the White Mountains, and in lakeshore settings north of the mountains.

Rich Woods

Rich woods are a special subset of hardwood forest communities. These communities share a diverse assemblage of plants restricted to nutrient-rich conditions. Many of New Hampshire's rare plants occur in rich woods. Sugar maple, white ash, and a species-rich herbaceous layer are hallmarks of rich woods. Ferns, perennial forbs, and sedges are abundant, including many species that flower in early spring, but few shrubs grow in rich woods. In New Hampshire, rich woods typically occur in south-facing locations associated with bedrock types that weather to form enriched soils, a combination of conditions infrequent in the state.

The New Hampshire Native Plant Protection Act, RSA 217-A, protects and conserves plants for human needs and enjoyment, the interests of science, and the state's economy. The NHNHB administers the Act, including collecting and analyzing data on the status, location, and distribution of rare or declining native plants and exemplary natural communities, as well as developing and implementing measures for their protection, conservation, enhancement, and management.

Small Whorled Pogonia

Small whorled pogonia is a federally threatened orchid. It grows in ***hemlock - beech - oak - pine forests*** along with Indian cucumber root, New York fern, partridgeberry, downy rattlesnake plantain, and witch hazel. As of 2008, NHNHB identified 49 populations, although only six have good or excellent viability. The plant tolerates some disturbance and persists in stands managed for timber. Habitat management experiments (e.g., canopy thinning) may maintain population viability, but the long-term beneficial effects haven't been confirmed.

The NHNHB is not a regulatory agency, and its statute specifically gives private property owners the right to take protected plant species on their own lands. The statute directs state agencies to avoid jeopardizing the continued existence of any protected plant species. Prohibited acts include exporting or importing protected species into or out of New Hampshire, transporting protected species within the state, and taking, possessing, and selling any protected species from public property or property of another.

The Endangered Species Act applies to federally listed threatened and endangered species, three of which occur in New Hampshire as of 2009. Rights and prohibitions resemble the New Hampshire Native Plant Protection Act, though the right to take protected species on one's own property is less explicit.

OBJECTIVE

Maintain natural communities and threatened and endangered plants.

CONSIDERATIONS

- Most exemplary natural communities and threatened and endangered plants occur in distinct, small patches in the forest and conflicts with forestry operations are rare. Adoption of appropriate silvicultural and timber harvesting techniques can avoid or minimize impacts. Knowledge of the effect of various forestry practices is limited, but expanding.
- Protecting natural communities and plants may reduce harvest volume and increase planning costs, resulting in a reduced income.
- Some natural communities and plants depend on disturbance (e.g., fire or timber harvest) for their maintenance. Disturbance suppression, combined with succession, may alter or eliminate species or communities.
- Threatened and endangered and other uncommon plants may grow in nonexemplary communities.
- The N.H. Dept. of Environmental Services wetland permit applications require determining if the NHNHB has identified threatened and endangered plants or exemplary natural communities in the wetland. Applicants can use the DataCheck Tool on the NHNHB website to determine whether a plant or community is potentially impacted, or contact the NHNHB.
- Identifying certain threatened and endangered species and natural communities requires specialized training. The NHNHB website includes a list of threatened and endangered plants by habitat type and a photo index of natural communities.
- Working with NHNHB helps avoid or minimize impacts and eliminates or reduces permit effort, cost, and restrictions.

RECOMMENDED PRACTICES

- ✓ Look for threatened and endangered plants and exemplary natural communities during field visits or forest inventories; include your findings and recommendations for their protection and conservation in your management plan.
- ✓ Look for areas with distinct vegetation or extreme site conditions (e.g., very dry, wet, or nutrient-rich) when surveying or working in a harvest area. Contact NHNHB early in your planning for help to determine the presence or absence of protected species and communities in a harvest area.
- ✓ Avoid excessive changes in stand composition and structure, crown closure, forest floor characteristics, and other stand conditions if harvesting in areas with threatened and endangered species and exemplary natural communities. When possible, harvest during the nongrowing season. In general, focus management on communities rather than individual species.

CROSS REFERENCES

1.3 Forest Management Planning; 2.1 New Hampshire Forest Types; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 7.2 Seeps; 7.3 Vernal Pools; 7.4 Pine Barrens; 7.5 Old-Growth Forests; 7.6 High-Elevation Forests.

ADDITIONAL INFORMATION

USDI Fish and Wildlife Service. *Endangered Species Act of 1973*. http://www.fws.gov/laws/lawsdigest/esact.html Accessed June 8, 2010.

Maine Natural Areas Program Rare Plant Fact Sheets. http://www.maine.gov/doc/nrimc/mnap/features/plantlist.htm Accessed February 27, 2010.

N.H.Natural Heritage Bureau. http://www.nhdfl.org/about-forests-and-lands/bureaus/natural-heritage-bureau, Accessed February 27, 2010.

RSA 217-A. 1987. N.H. *Native Plant Protection Act*. http://www.gencourt.state.nh.us/rsa/html/XIX/217-A/217-A-mrg.htm Accessed May 27, 2010.

Sperduto, D.D., and W.F. Nichols. 2004. *Natural Communities of New Hampshire*. N.H. Natural Heritage Bureau, Dept.of Resources and Economic Development, Concord, N.H. 229 p.

7.2 SEEPS

BACKGROUND

Seeps are small, critical habitats only detected through site visits.

Seeps or seepage wetlands are springs, pools, or other wet places where groundwater naturally comes to the surface. Soils in seeps remain saturated for all or part of the growing season and often stay wet all winter. Surface waters often percolate back into the ground through porous layers of sand or gravel, but on hillsides, seeps may be headwaters for small streams.

There are five broad categories of seep communities: (1) seepage marsh (2) riverside seep (3) seepage swamp (4) seepage forest and (5) forest seeps.

(1) Seepage marshes occur in association with wetland borders, in headwaters, and along stream drainages.

(2) Riverside seeps occur along larger rivers with outcrops, open bedrock, cobble, sand, or silt substrates.

(3) Circumneutral (i.e., having water around neutral pH) seepage swamps are rare features of coastal lowlands characterized by red maple, black ash, and swamp saxifrage.

(4) ***Northern white cedar seepage forests*** and ***northern hardwood seepage forests*** (characteristic trees include sugar maple, yellow birch, and balsam fir) occur in northern New Hampshire.

(5) Forest seeps occur throughout the state in stream headwaters, on hillside slopes, along swamp margins, and on steep faces of river terraces. Trees are similar to the surrounding forest, and herbaceous vegetation is abundant, diverse, and variable. ***Acidic Sphagnum forest seeps*** are a notable type, most frequent in red spruce, black spruce, and balsam fir forests at higher elevations in the White Mountains and further north.

Trees aren't a significant part of seepage marshes and riverside seeps. Seepage swamps, seepage forests, and forest seeps are typically small (less than or equal to 1/10-acre) inclusions within upland forests, isolated from larger wetlands. Seepage swamps and forests occur over bedrock or till, on seasonally saturated sloping transitions between uplands and flat swamps, and on lower mountain slopes.

Seep waters may remain underground for many years, producing clean waters and warmer temperatures than typical surface waters in winter and cooler-than-typical surface waters in summer. Seep habitats are important for animals and plants because their flow may keep the water from freezing during winter and they are the first to green up in the spring. Black bear prefer seeps as important food sources in the spring and summer. Deer and moose seek seeps for food, water, and occasionally elements like calcium or sodium that may be present in the groundwater.

Northern dusky and two-lined salamanders prefer seep habitats, and they in turn attract predators such as skunk, raccoon, and river otter. Woodcock and robins depend on seeps for water and food (e.g., earthworms, insect larvae) after migrating and as a refuge after early spring snowstorms. Ruffed and spruce grouse are attracted to seeps for water during the winter and fresh plant food in the spring. Wild turkeys favor seeps in winter.

Seeps located adjacent to streams or rivers maintain coldwater habitats for trout and salmon during summer months when warmer water can result in fish mortality. These same sites also foster fish survival in the winter by creating a warmer environment than would normally occur. Trout and salmon abundance is related to seeps and groundwater upwelling in streams and rivers.

Several rare plants are associated with seeps. For example, calcareous riverside seeps provide habitat for six rare plants including the endangered Garber's sedge, hair-like beak-rush, and muskflower. ***Acidic Sphagnum forest seeps*** and ***circumneutral hardwood forest seeps*** are particularly rich in rare plants.

OBJECTIVE

Avoid direct impacts to seeps and minimize disturbance to the adjacent forest during timber harvesting.

CONSIDERATIONS

- Some seeps meet the statutory definition of wetland and are subject to state wetlands regulations.
- The N.H. Natural Heritage Bureau can help when planning forestry activities near seeps to avoid or minimize impacts to rare plants and exemplary natural communities.
- Removing surface soils by road construction or other activities may inadvertently create seeps that then become subject to regulation by the N.H. Dept. of Environmental Services.
- Harvesting near seeps may alter the natural community.

RECOMMENDED PRACTICES

- ✓ Delineate seeps before harvesting.
- ✓ Maintain a vegetated buffer around seeps to prevent sedimentation, increased water temperature, and increased drying from reduced shading.
- ✓ Locate roads and skid trails in the spring or summer when seeps are most visible.
- ✓ Conduct selection harvesting or uneven-aged management near seeps when the ground is frozen.
- ✓ Keep tree tops and slash out of seeps and wildlife trails that access seeps.
- ✓ Minimize the interruption of groundwater flow by adhering to best management practices (BMPs).

CROSS REFERENCES

4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 7.1 Natural Communities and Protected Plants; 7.6 High-Elevation Forests; 7.7 Steep Slopes.

ADDITIONAL INFORMATION

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

Sperduto, D.D., and W.F. Nichols. 2004. *Natural Communities of New Hampshire*. N.H. Natural Heritage Bureau, Dept. of Resources and Economic Development, Concord, N.H. 229 p.

Taylor, J., T.D. Lee, and L.F. McCarthy (eds). 1996. *New Hampshire's Living Legacy: The Biodiversity of the Granite State*. N.H. Fish and Game Dept. Non-Game and Endangered Wildlife Program, Concord, N.H. 98 p.

7.3 VERNAL POOLS AND THE SURROUNDING FOREST

BACKGROUND

Vernal pools and the adjacent forest provide critical habitat for numerous wildlife species, but vernal pools are easily overlooked because they are small and dry seasonally.

Vernal pools form in shallow depressions or basins, and may appear as simple pools of water, with little or no vegetation growing in them. To be considered a vernal pool, the pool can't have a permanently flowing outlet and it must hold water for at least two months after spring ice-out (See N.H. Administrative Rules Env-Wt 101 for the official state definition).

Vernal pools differ from other wetlands in that they have a seasonal cycle of flooding and drying—this cycle determines what wildlife use vernal pools. Many flood, then dry each year, though some pools may hold water for several years between drying.

Vernal pools are unique wetlands that provide critical habitat for several amphibian and reptile species. Fish are major predators in wetlands, but they are unable to maintain viable populations in vernal pools (because the pools dry up). As a result, vernal pools provide critical breeding habitat for amphibians whose tadpoles and larvae are especially vulnerable to fish predation. These species include spotted salamanders, blue-spotted/Jefferson salamanders, wood frogs, and the state-endangered marbled salamander.

Other non-amphibian species use vernal pools. Fairy shrimp, small crustaceans, require vernal pools for all life stages. State-endangered Blanding's turtles and state-threatened spotted turtles feed on amphibian eggs in vernal pools and also use them for basking, mating and overwintering. These turtles also use vernal pools as stopover habitat when migrating, because pools provide moist refuge and abundant food. Many mammals, birds and snakes also forage at vernal pools, including song birds, wood ducks, ribbon snakes, bats, and raccoons.

While vernal pools offer essential habitat for many wildlife species, the forest surrounding the pools is equally important. For example, wood frogs and the salamanders that breed in vernal pools spend more than 11 months in the forest.

OBJECTIVE

Manage vernal pools and the surrounding forest to provide amphibian, invertebrate, and turtle habitat by maintaining pool hydrology, water quality, forest-floor integrity, and sufficient canopy cover.

CONSIDERATIONS

- Many vernal pools meet the statutory definition of wetland and are subject to state wetlands regulations pertaining to timber harvesting.
- Marbled salamanders and Blanding's turtles are listed as endangered, and spotted turtles as threatened species by the State of New Hampshire, and are protected under the N.H. Endangered Species Conservation Act. The N.H. Natural Heritage Bureau can tell you if these or other listed species have been documented on or near your property.
- In preparation of a timber harvest, it may be necessary to mark the perimeter of vernal pools when they contain water in the spring, so they can be identified during the dry season or during winter.

- When a vernal pool fills with water, how long it holds water, and the type and abundance of amphibians and invertebrates it supports can all change dramatically from year to year. Animals that use the pools are adapted to this variation. Though some species may not be present at a particular pool in a given year, that pool and its surrounding forest may still be high-quality habitat.
- Although reptiles and amphibians are small, they travel long distances. Juvenile wood frogs and salamanders may disperse to vernal pools as far as one-half to several miles from the pool in which they were born. These movements maintain genetic variability within amphibian populations and recolonize sites where local amphibian populations are gone.
- The vernal pool and the surrounding forest make up the functional vernal pool system, but each serves different functions. Breeding habitat includes the vernal pool basin and a forested buffer extending 200 feet from the pool edge. The pool basin is the physical breeding location for vernal-pool-dependent species and a nursery for their eggs and larvae. The buffer helps protect the pool's water quality by filtering sediment and pollutants, providing shade, and slowing surface run-off. The buffer also provides leaf litter, which serves as the foundation of the vernal pool food chain and as shelter for adult and metamorphic amphibians immediately after they emerge from the pool. Core habitat extends from the breeding habitat out 950 feet from the pool edge. It provides habitat for amphibians of all ages during the nonbreeding season and provides aestivating and basking habitat for spotted and Blanding's turtles.
- The lack of long-term studies in the northeast means we still lack much knowledge about the specific effects of timber harvesting on vernal-pool-dependent reptiles and amphibians. Relevant research and experience suggests that within the core habitat:
  - Excessive compaction or scarification of the soil during timber harvesting may reduce leaf litter and burrows and reduce the amount of suitable upland habitat available to wood frogs and mole salamanders (i.e. spotted, blue-spotted/Jefferson, and marbled salamanders). Maintaining natural topography maintains the volume and timing of water reaching vernal pools.
  - Vernal-pool-dependent amphibians and reptiles are most sensitive to disturbances that alter water quality or temperature within the pools, alter the length of time the pools hold water, or alter the air and soil temperature in the forest surrounding the vernal pools.
  - Wetland buffers intended to protect water quality may be too narrow to allow amphibians to complete their entire life cycles.
  - The effects of temporary forest openings are less in a forested landscape than in a developed one.
  - As forest-opening size increases, the negative effects of habitat drying and increased soil and air temperature also increase. However, the specific effects of opening size vary and aren't completely understood. In most cases the negative effects of timber harvesting on vernal-pool-dependent species are temporary and decrease with time as the forest regenerates.
  - Canopy cover reduced below 55 percent will probably have at least a temporary negative affect on vernal-pool-dependent amphibians—until the canopy or understory cover fill in.
  - Openings such as wildlife food plots, pastures, fields, and landings create barriers to reptile and amphibian dispersal because they are often hot and dry. These openings are most likely to create barriers when they are located directly between adjacent wetlands.
  - Vehicle ruts can reduce the length of time a pool holds water by directing water away from the pool. Ruts at any distance from a pool can create breeding "traps" for amphibians, since wood frogs and salamanders will often deposit eggs in ruts. Most ruts dry too quickly to allow the eggs to develop completely.

RECOMMENDED PRACTICES

- ✓ Mark the locations of vernal pools before a harvest and preferably in early spring when vernal pool waters are highest. Alert equipment operators. Include locations and management recommendations in the forest management plan.
- ✓ Locate openings such as landings, main skid trails, roads, wildlife food plots, pastures, and fields as far as reasonably possible from vernal pools. Avoid locating permanent, nonforest openings directly between two adjacent vernal pools.
- ✓ In the vernal pool basin:
  - Avoid running machinery through vernal pool basins, even during dry periods, to avoid changing the pool's ability to hold water.
  - Avoid adding slash (woody material) to vernal pools. Where significant amounts of slash fall into the pool, remove it by hand or some other low-impact method. If the pool contains water, leave the slash until the dry season. Removing it when the pool holds water can disrupt amphibian egg and larval development.
  - Avoid removing trees with crowns immediately overtopping any portion of the pool to maintain water temperature and nutrient inputs.
- ✓ Within 200 feet of a vernal pool:
  - Limit tree removal to individual trees or small groups of trees. Locate groups where advanced regeneration or shrub cover occurs to help maintain shady conditions after the overstory is removed.
  - Avoid removing stumps, stones, or other large cover objects.
  - Maintain as much of the existing understory vegetation (i.e., small trees, shrubs, herbaceous ground cover) as possible.
  - Limit the activity of heavy equipment.
  - Locate main skid trails and truck roads outside this buffer.
  - Avoid applying herbicides or insecticides.
- ✓ Beyond 200 feet:
  - Limit the area that is scarified, stumped, or regraded to that necessary to accomplish silvicultural or wildlife objectives.
  - Retain as much existing dead and down woody material, stumps, stones and leaf litter as possible.
  - Avoid or minimize rutting by following best management practices (BMPs). When possible, harvest on frozen ground (preferable) or in dry summer conditions.
  - Retain as much understory vegetation as possible where its removal isn't required to meet other objectives.

CROSS REFERENCES

3.1 Timber Harvesting Systems; 4.1 Water Quality; 4.2 Wetlands; 6.3 Dead and Down Woody Material; 6.13 Wildlife Species of Greatest Conservation Need.

ADDITIONAL INFORMATION

Calhoun, A.J.K., and P. deMaynadier. 2004. *Forestry Habitat Management Guidelines for Vernal Pool Wildlife*. MCA Tech. Pap. No. 6, Metropolitan Conservation Alliance. Wildlife Conservation Society. 32 p.

Marchand M.(ed.). 2004. *Identification and Documentation of Vernal Pools in New Hampshire*. N.H. Fish and Game Dept., Concord, N.H. 70 p.

N.H. Administrative Rules Env-Wt 101.
http://www.gencourt.state.nh.us/Rules/state_agencies/env-wt100-800.html Accessed on May 27, 2010.

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

RSA:212-A. *Endangered Species Conservation Act*.
http://www.gencourt.state.nh.us/rsa/html/XVIII/212-A/212-A-mrg.htm Accessed June 2, 2010.

Tarr, M., and K. Babbitt. 2009. *The Importance of Hydroperiod in Wetland Assessment: A guide for community officials, planners, and natural resource professionals*. UNH Cooperative Extension, Durham, N.H. 23 p.

7.4 PINE BARRENS

BACKGROUND

Pine barrens are a rare, fire-dependent natural community that support unique flora and fauna.

Pitch pine - scrub oak woodlands, commonly known as pine barrens, are one of New Hampshire's rarest natural communities. These unique forests make up less than half of one percent of the state's landcover. Historically pine barrens were more prevalent, with large pine barrens ecosystems found in the Ossipee River watershed and lower Merrimack River Valley. Today, they exist as scattered fragments.

Pine barrens are characterized by:

- The presence and preponderance of "hard" pine in the overstory, including pitch pine and occasionally red pine.
- An understory that can include dense thickets of scrub oak and low-growing shrubs such as blueberries.
- Grassy openings with herbaceous plants such as wild blue lupine.

Barrens require periodic recurring fires for maintenance and regeneration. The plants and animals found in these ecosystems are uniquely adapted to this disturbance. For example, the thick bark of a pitch pine protects the cambium and prevents girdling during a fire. Such adaptations provide a competitive advantage in fire-prone areas. Without periodic burning, species less tolerant of fire can gain a foothold and displace the pine barrens species.

Pine barrens are home to numerous uncommon species, many of which are restricted to pine barrens habitats. They support more than 50 rare plant and animal species, including a number of rare and declining ground- and shrub-nesting birds and numerous uncommon invertebrates. Whip-poor-will, eastern towhee, and the federally protected Karner blue butterfly are just a few of the well-known, yet uncommon species.

OBJECTIVE

Maintain unique pine barrens natural communities for a variety of uncommon wildlife and plant species, and to protect important groundwater resources.

CONSIDERATION

- Pine barrens require disturbance to: (1) regenerate pitch pine and other pine barrens species, (2) remove fire-intolerant species, and (3) maintain structural diversity.
- Prescribed burning most closely mimics the natural disturbance regime in pine barrens.
- Plants less tolerant of fire than hard pines are common in many pine barrens due to the lack of fire. White pine, American beech, red maple, red and white oak, and aspen are the most common to encroach. These species increase the canopy cover, resulting in changes to the understory. Scrub oaks and other understory shrubs are shade-intolerant and decline with increasing canopy cover. Pitch pine regeneration is suppressed by the lack of suitable conditions created by fires for seed germination.

- Various uncommon wildlife species require the plants and diverse forest structure of pine barrens. Many of the rare invertebrates depend upon just one or two plant species to serve as their host. For example, the caterpillar of the highly uncommon pine pinion moth feeds exclusively on pitch pine needles. Similarly, ground- and shrub-nesting birds depend upon the patches of bare mineral soil and dense shrubby thickets for nesting.
- The limited commercial value of pitch pine creates a financial incentive to convert pine barrens to white pine, a species able to grow on these soils.
- The sand and gravel deposits where pine barrens are found often comprise stratified drift aquifers, highly productive areas for groundwater recharge and storage. Stratified drift aquifers are easily contaminated because they lack a protective bedrock cap.
- The vegetation in pine barrens is highly flammable. Many plants have flammable oils enabling them to burn with high intensity even during the growing season. Without periodic fires, fuels can accumulate to dangerous levels; wildfires may threaten human life and property and cause significant ecological damage. Because of fire suppression, many pine barrens now have high fuel loads and represent serious fire hazards during periods of drought.

RECOMMENDED PRACTICES

- ✓ Maintain pine barrens natural communities. Avoid converting them to other forest types.
- ✓ Provide a diversity of habitat niches by maintaining heterogeneity in the forest canopy and understory. Maintain forest openings, edges and dense stands. The understory should include thickets of tall shrubs (e.g. scrub oak), carpets of low-growing ericaceous (heath) shrubs, grassy openings, and patches of exposed mineral soil. Minimize overstory shading on the shrub layers.
- ✓ Although prescribed burning may not be practical in all areas, a combination of prescribed burning and mechanical treatments is the preferred disturbance method. In the absence of fire, substitute partial timber harvesting and mowing of shrub layers.
- ✓ Use timber harvests to:
  - Remove fire-intolerant species (e.g., white pine, red maple) to favor hard pines and other pine barrens species.
  - Create openings in the canopy, even when the stand is dominated by pitch pine, to encourage the growth of shrub layers in the understory.
  - Scarify the soil to promote the regeneration of pitch pine and other pine barren species. Time harvests to coincide with good pitch pine seed years.
- ✓ Limit the disturbance of any given discrete patch to no more than 20 to 25 percent in the same year. Leave some areas undisturbed within any 20-year period. If the patch extends onto other ownerships, coordinate management across ownerships to the extent possible.
- ✓ For invertebrates, maintain adequate abundance of food plants, especially scrub oak, pitch pine, blueberries, sweet fern, sand cherry, pin cherry, wild lupine, and New Jersey tea.
- ✓ For whip-poor-will and common nighthawk, create areas of reduced litter to provide suitable nesting habitat.
- ✓ For shrub-nesting birds, provide shrubs high enough for nests 3 to 6 feet above the ground.
- ✓ Minimize activities during the bird-breeding season (mid-May to early July).
- ✓ Prior to conducting management, have a plan for hazardous materials spill prevention and control.

- ✓ Reduce fuel and protect neighboring property.
  - Reduce canopy and shrub fuels, especially next to developed areas.
  - Create fuel breaks.
  - Use whole-tree harvesting techniques.
  - Have fire extinguishers available during management activities.
  - Thoroughly check the harvest area for small fires prior to leaving the site. This is particularly important during times of high fire danger in the spring and late summer, especially when the State Fire Class Danger Rating is above 4.
- ✓ Contact the N.H. Division of Forests and Lands, N.H. Fish and Game, the USDA Forest Service, the Natural Resources Conservation Service, The Nature Conservancy, or UNH Cooperative Extension for information. Prescribed fire can maintain and restore pine barrens, but it requires highly specialized expertise, planning, personnel, and equipment.

CROSS REFERENCES

3.1 Timber Harvesting Systems; 7.1 Natural Communities and Protected Plants.

ADDITIONAL INFORMATION

N.H. Natural Heritage Bureau. 2008. *Biodiversity Tracking and Conservation System (BIOTICS) database*. N.H. Dept. of Resources and Economic Development, Concord, N.H.

N.H. Fish and Game. 2005. *New Hampshire Wildlife Action Plan*. http://www.wildnh.com/Wildlife/wildlife_plan.htm Accessed February 23, 2010.

Sperduto, D.D., and W.F. Nichols. 2004. *Natural Communities of New Hampshire*. N.H. Natural Heritage Bureau, Dept. of Resources and Economic Development, Concord, N.H. 229 p.

7.5 OLD-GROWTH FORESTS

BACKGROUND

New Hampshire's old-growth forests are unique, valuable, and endangered natural resources requiring protection and conservation.

The forest that greeted New Hampshire's original European settlers exists today only as scattered remnants. Known as old growth, virgin, primeval, or ancient forests, they escaped harvesting or other human modification over the last 350 years. Carbonneau (1986) identified only 12 old-growth forest sites totaling about 3,000 acres—less than one-tenth percent of forest in the state. More old growth likely occurs as small patches at high elevations and on steep, less-accessible areas. Threats to old growth include timber harvests, acid rain, and invasive insects.

Old-growth forests exhibit ecosystem stability and little or no evidence of human disturbance. They have many or all of the following characteristics.

- Abundant old trees with long trunks free of lower branches, deeply furrowed or plated bark, signs of heartwood decay, large prominent root structures, flattened crowns with protruding dead limbs and large thick limbs, and trunks often showing a twist that develops with age.
- Abundant dead and downed logs in all stages of decomposition.
- Abundant moss and lichens on standing trees and downed logs.
- Abundant dead standing trees (i.e., snags).
- Large and small canopy gaps due to fallen trees.
- An undulating forest floor from pits and mounds where trees have fallen and decomposed.
- Multiple vegetation layers (e.g., canopy, understory trees, shrub, and ground cover) and diverse age classes.
- Undisturbed soils, and in some forest types, a relatively thick humus layer.
- A predominance of late-successional trees (i.e., shade-tolerant trees).
- A relative absence of multi-stemmed trees (i.e., coppices).
- No signs of human disturbance (e.g., cellar holes, stone walls, wire fence, roads, stumps).

Spruce, hemlock, yellow birch, beech, and sugar maple are the typical canopy species. Second growth or regenerating forests can also develop old-growth characteristics if sufficient time passes to obscure the effects of disturbance. In the northeast, at least 200 years is required to develop old-growth forest structure, although old-growth traits begin to develop at 100 years.

OBJECTIVE

Preserve and maintain the integrity of existing old-growth stands and allow the development of old-growth characteristics where possible.

CONSIDERATIONS

- Managing to retain or develop old-growth characteristics may entail a financial loss.
- Maintaining or restoring old-growth forest requires long-range planning and commitment.
- Establishing small patch reserves or extending harvest rotations helps develop old-growth characteristics in previously harvested stands.
- Forestry professionals, the N.H. Division of Forests and Lands and UNH Cooperative Extension can help landowners identify and manage old-growth forests.

RECOMMENDED PRACTICES

- ✓ Identify and locate old-growth and late-successional forests on managed lands.
- ✓ Include old-growth considerations in forest management plans.
- ✓ Protect and conserve old-growth stands and allow them to develop naturally.
- ✓ Consider restoring areas of old growth within managed forests by allowing stands to develop naturally. Candidate stands include late-successional stands with old-growth characteristics, stands on inaccessible or inoperable terrain, or within riparian management zones. Restored stands should be at least 5 to 10 acres to ensure old-growth structure and function.
- ✓ If permanent areas for old growth are desired but can't be established, manage for old-growth attributes by:
  - Deferring cutting one to two rotations (about 80 to 160 years), or otherwise lengthening the rotation.
  - Leaving large-diameter living and dead standing trees and large-diameter woody material on the ground.
  - Using single tree or group selection.

CROSS REFERENCES

2.2 Forest Structure; 2.3 Regeneration Methods; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 6.2 Cavity Trees, Dens and Snags; 6.3 Dead and Down Woody Material.

ADDITIONAL INFORMATION

Bennett, K. P. (tech. coordinator). 2005. *Moving Toward Sustainable Forestry: Lessons from Old Growth Forests*. Natural Resource Network Report. UNH Cooperative Extension, Durham, N.H. 82 p.

Carbonneau, L. 1986. *Old-Growth Forest Stands in New Hampshire: A Preliminary Investigation*. M.Sc. thesis, University of New Hampshire, Durham, N.H.

D'Amato, A., and P. Catanzaro. undated. *Restoring Old-Growth Characteristics*. UMass Extension, Amherst, Mass. 18 p.

D'Amato, A., and P. Catanzaro. undated. *A Forest Manager's Guide to Restoring Late-Successional Forest Structure*. UMass Extension, Amherst, Mass. 8 p.

Lapin, M. 2002. *Old-Growth Forests: A Literature Review of the Characteristics of Eastern North American Forests*. Vermont Natural Resources Council, Montpelier, Vt. 22 p.

Whitman, A., and J. M, Hagan. 2009. *A Revised Rapid-Assessment Late-Successional Index for Common Northeastern Forest Types*. Manomet Center for Conservation Studies, Brunswick, Maine.

7.6 HIGH-ELEVATION FORESTS

BACKGROUND

High-elevation forests are rare, distinct, and important ecosystems.

High-elevation forests occupy about 4 percent of New Hampshire. They are relatively undisturbed by human activities. Almost all high-elevation forests are on conservation lands, protected by conservation easements, or subject to zoning ordinances.

Soils are shallow and usually well- to moderately well-drained, nutrient-poor, acidic, and fragile. Shallow rooting disposes high-elevation forests to frequent windthrow. This natural disturbance is an important factor in determining forest structure. Linear patches of wind-induced mortality, called fir waves, are common in balsam fir stands. Moisture levels are high due to increased rainfall, snow, and cloud intercept. Moist conditions sometimes support ***acidic Sphagnum forest seeps*** (a wetland community found at high elevations).

A truncated growing season and harsh climate favor slow-growing conifers. The N.H. Natural Heritage Bureau (NHNHB) recognizes two conifer forest communities that are restricted to high-elevations, and one that occurs at lower elevations as well:

- A ***high-elevation balsam fir forest*** community typically occurs between about 3,500 to 4,500 feet, and locally higher or lower depending on site conditions such as topography and degree of exposure. Balsam fir dominates, although heartleaf birch and red spruce may be present. Moss and liverwort form a deep, spongy carpet over thick humus.
- A ***high-elevation spruce - fir forest*** community occurs from about 2,500 to 4,000 feet. Red spruce and balsam fir are the dominant species, with some heartleaf, paper, and yellow birch. The woody understory is sparse and mosses and liverworts are abundant.
- ***Montane black spruce - red spruce forest*** is an uncommon and rare community that occurs from 2,000 to 3,000 feet. Soils are wetter than in the other two high-elevation forest communities and the vegetation of the community resembles that of ***lowland spruce - fir forest***. This community occurs around heath woodlands and fens in high-elevation valleys in the White Mountains and the North Country.

High-elevation forests are important for wildlife. These forests are core habitat for the state-threatened American marten and American three-toed woodpecker. New Hampshire is within the range of the state-endangered and federally threatened Canada lynx. Lynx are associated with dense, undisturbed boreal forests with a mix of mature conifer stands and shrubby openings. Fir waves produce these early successional patches at these elevations. In New Hampshire, signs of lynx are occasionally documented in the White Mountain National Forest. Bicknell's thrush breeding is restricted to montane spruce-fir forests in New Hampshire, New York and parts of Quebec. Wildlife common to high-elevation forests include moose, deer, black bear, fisher, and spruce grouse.

Several rare plants occur in high-elevation forests. The state-threatened heart-leaved twayblade, Loesel's twayblade, and northern comandra occur in spruce-fir and balsam fir communities. The state-watch species Pickering's bluejoint occurs in ***acidic Sphagnum forest seeps***.

OBJECTIVE

Maintain the long-term ecological integrity of high-elevation forests.

CONSIDERATIONS

- Acid deposition is a threat to these forests.
- Thin soils, sensitivity to (and slow recovery from) physical disturbance, importance to wildlife, scarcity, and susceptibility to acid deposition, support careful management.
- The Coos County Unincorporated Towns Planning Board designated lands above 2,700 feet in elevation, or with slopes in excess of 60 percent over 10 acres, as Protected District 6 (PD6) zones. Forest management activities in PD6 zones require a permit from the Coos County Planning Board.
- Nutrient-poor soils of high-elevation forests may be especially sensitive to the removal of nutrients in wood harvests. Furthermore, acid rain exacerbates the leaching of nutrients through the soil. Minimizing soil erosion and leaving branches and needles on-site can minimize nutrient loss.
- Shallow, fragile soils render high-elevation forests sensitive to disturbance. Soil erosion and compaction can harm existing trees and limit the potential for stand regeneration.
- Pushing stands to older ages provides a more complex structure for American marten and three-toed woodpecker.
- Leaving mountain ash encourages black bear, American marten, fisher, and numerous bird species who favor the fruits. Moose favor the bark throughout winter months.
- Land below 2,700 feet may exhibit characteristics of high-elevation forests including shallow soils, steep slopes, and spruce-fir dominance. Adapt the following recommendations to lower elevation sites exhibiting high-elevation characteristics.

RECOMMENDED PRACTICES

✓ When planning or conducting harvests:
  - Apply best management practices, or more rigorous practices. Refer to *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. Consult the latest version before harvesting timber.
  - Avoid pockets of old-growth forest.
  - Lay out the harvest during snow-free conditions.
  - As possible, schedule harvests for winter conditions.
  - Avoid removing limbs and tops from the harvest site.
  - Clearcutting should generally be avoided. Consult with N.H. Division of Forests and Lands and N.H. Fish and Game for guidance if clearcutting is necessary.
  - Leave large cull and cavity trees on-site.
  - If planning uncut reserve zones, incorporate prominent ridgelines, game trails, ledge outcrops, older stands, complex stands, wetlands, streams, and seeps.

✓ Direct management on high-elevation lands towards maintaining or increasing the proportion of softwoods.

✓ Direct spruce-fir management toward the following composition and structure goals:
  - At least 60 percent of the management area remains in stands with an average tree diameter of 4 inches or greater.
  - No more than 30 percent of the area with an average tree diameter less than 4 inches or without adequate stocking.
  - Designate at least 10 percent to remain unharvested.

✓ Consult with NHNHB to minimize impacts to protected plant species or exemplary natural communities and N.H. Fish and Game to minimize impact on protected wildlife.

CROSS REFERENCES

2.3 Regeneration Methods; 3.5 Soil Productivity; 6.2 Cavity Trees, Dens and Snags; 7.1 Natural Communities and Protected Plants; 7.2 Seeps; 7.5 Old-Growth Forests; 7.7 Steep Slopes.

ADDITIONAL INFORMATION

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

Sperduto, D.D., and W.F. Nichols. 2004. *Natural Communities of New Hampshire*. N.H. Natural Heritage Bureau, Dept. of Resources and Economic Development, Concord, N.H. 229 p.

7.7 STEEP SLOPES

BACKGROUND

Steep slopes are especially vulnerable to erosion.

Extra care is needed when harvesting on steep slopes. Good judgment is needed when determining harvest size and timing, when selecting the appropriate silvicultural method and harvesting system, and when laying out skid trails and truck roads. Proper use of best management practices (BMPs) is needed during harvest operations and closeout. These guidelines are found in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire* published by the N.H. Dept. of Resources and Economic Development, Division of Forests and Lands.

OBJECTIVE

Limit erosion and maintain water quality and drainage patterns, ecological integrity and habitat, and aesthetics on steep slopes.

CONSIDERATIONS

- According to the Natural Resources Conservation Service (NRCS) *Important Forest Soils Group* (see appendix), operators may begin to experience equipment limitations on slopes between 25 to 35 percent. Slopes greater than 35 percent are considered to have severe equipment limitations.
- For the purposes of this document, steep refers to slopes greater than 25 to 35 percent and more than 300 feet long.
- Logging equipment and techniques continue to develop, enabling logging on steep slopes.
- Some logging equipment may be better suited to operating on steep slopes and may have less impact to the ground, resulting in less erosion.
- Skid trails and forest roads create more erosion potential than any other harvest activity, particularly on steep slopes. Proper skid-trail and truck-road layout, installation, use, and maintenance minimize erosion, even on steep slopes.
- Steep slopes often contain seeps and intermittent streams that are important to seasonal run-off but that may not be apparent at some times of the year. Intermittent streams can fill rapidly with fast-moving water during rain storms or at wet times of the year, and may cause serious erosion, water-quality, and drainage-pattern problems if they are compromised during harvest activities.
- The size of the harvest area and the silvicultural techniques used can drastically change the forest cover, resulting in less interception and water uptake, which may result in increased run-off on steep slopes.
- Steep slopes may contain thin, fragile, and unique soils, uncommon plants, and exemplary natural communities and habitats.
- Steep slopes are often visible to surrounding viewsheds, and the choice of silvicultural techniques may impact the aesthetic appeal of a harvest.

RECOMMENDED PRACTICES

- ✓ Apply BMPs. Refer to *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. Consult the latest version before harvesting timber.
- ✓ Select a harvesting system appropriate for the terrain and conditions.
- ✓ Schedule harvests when the ground is dry or frozen to minimize impacts.
- ✓ Increase buffer widths and riparian management zones along wetlands, streams, rivers, ponds, and lakes on slopes greater than 25 percent.
- ✓ Reduce the potential for increased run-off and erosion, as well as possible impacts on surrounding viewsheds, by minimizing the use of clearcuts and reducing the size of openings on slopes greater than 35 percent, except when a well-established understory is present or when salvage operations are necessary.
- ✓ Lay out skid trails and truck roads before the start of operations. Identify intermittent streams in the harvest area and minimize crossings. To help slow down and spread out run-off, avoid long, continuous skid trails. Use the natural contours of the land to establish breaks in the grade and to create small bends and turns.
- ✓ During the course of the operation apply liberal amounts of slash and tree tops to help stabilize skid trails.
- ✓ Monitor weather forecasts throughout the operation and prepare skid trails in advance of heavy rains. Construct temporary water bars and suspend operations in severe weather, when erosion potential is the greatest.
- ✓ When operations are completed, close out skid trails and truck roads as soon as possible. Remove temporary crossings and install water bars and ditches as recommended by the BMPs. Seed and mulch skid trails and truck roads to further stabilize exposed areas.

CROSS REFERENCES

3.1 Timber Harvesting Systems; 3.2 Logging Aesthetics; 3.3 Aesthetics of Skid Trails, Truck Roads and Landings; 3.5 Soil Productivity; 4.1 Water Quality; 4.3 Forest Management in Riparian Areas; 7.1 Natural Communities and Protected Plants; 7.2 Seeps.

ADDITIONAL INFORMATION

N.H. Dept. of Resources and Economic Development, Division of Forests and Lands. 2004. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. State of New Hampshire. http://extension.unh.edu/resources/files/Resource000247_Rep266.pdf Accessed March 13, 2010.

Vt. Dept. of Forests, Parks and Recreation. 2006. *Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont*. State of Vermont. Waterbury, Vt. 51 p.

7.8 CULTURAL RESOURCES

BACKGROUND

Cultural resources include the many forms of evidence left by people who once inhabited the land. They can be damaged inadvertently during logging operations.

Knowing about cultural resources can provide important links to the past. They might have religious significance, provide information to archeologists, be of interest to the local historical society, or provide an attraction for visitors.

Cultural resources include stone walls, cellar holes, sugar shacks, logging camps, old dam sites, cemeteries, Native American ceremonial grounds, or the trash dumps of old farmhouses. Landscapes—combinations of structures and sites that convey a sense of a time or lifestyle—can also be considered as cultural resources. Old farmsteads with overgrown fields, apple orchards, lilac bushes, and buildings or cellar holes are a good example.

The key to protecting cultural resources is to identify clues on the ground and plan management activities accordingly.

OBJECTIVE

Protect cultural resources during harvesting operations.

CONSIDERATIONS

- In some cases it may be impossible not to damage a cultural resource.
- Native American sites and cemeteries have certain legal protections (RSA 227-C).
- Stone walls along scenic roads may have legal protection, depending on whether the town has designated the road as scenic under RSA 231:157-158. Stone walls serving as boundaries are protected under RSA 472:6.

RECOMMENDED PRACTICES

✓ When evaluating a property for timber, include cultural-resource locations and issues.

✓ Management strategies around the cultural feature may include:

- No disturbance.
- Minimal disturbance (e.g., felling but no equipment).
- Low-level disturbance using light equipment or operating on frozen ground.

✓ Flag the area and show the logger the areas to protect.

- ✓ Fell trees away from cellar holes, quarry sites, or other depressions with historic significance, and don't pile slash or garbage in them.
- ✓ Avoid skidding over stone bridges or culverts. Use a deck to cover old culverts, if existing roads and bridges are used.
- ✓ Use existing stone-wall openings (barways) when possible. Limit the number of new openings and cut only the minimum width necessary. Leave openings for future use or restore the wall when work is completed.
- ✓ Protect wells by installing concrete well covers whenever possible.
- ✓ When a cultural resource can't be protected from damage, photograph the site and mark its location on a map for future historians.
- ✓ Contact the N.H. Division of Historical Resources for additional advice about documenting cultural resources.

CROSS REFERENCES

3.1 Timber Harvesting Systems; 6.5 Permanent Openings.

ADDITIONAL INFORMATION

RSA 227-C. *Historic Preservation*. http://www.gencourt.state.nh.us/rsa/html/xix/227-c/227-c-mrg.htm Accessed May 27, 2010.

RSA 231:157-158. *Scenic Roads*. http://www.gencourt.state.nh.us/rsa/html/NHTOC/NHTOC-XX-231.htm Accessed May 27, 2010.

RSA 472. *Boundary Lines*. http://www.gencourt.state.nh.us/rsa/html/XLVII/472/472-mrg.htm Accessed May 27, 2010.

Sanford, R., D. Huffer, and N. Huffer. 1994. *Stonewalls and Cellarholes: A Guide for Landowners on Historic Features and Landscapes in Vermont's Forests*. Vermont Agency of Natural Resources. http://www.historicvermont.org/programs/stonewall%20and%20cellarhouse_pub_screen.pdf Accessed March 13, 2010.

FOREST PRODUCTS

TOPICS IN THIS SECTION

8.1 Timber Products
8.2 Nontimber Forest Products
8.3 Maple Sugaring
8.4 Ecosystem Services as an Emerging Market

ADDITIONAL READING

Working with Your Woodland: A Landowner's Guide
Mollie Beattie, Charles Thompson, and Lynn Levine
University Press of New England
1993 (second edition)

8.1 TIMBER PRODUCTS

BACKGROUND

Under most circumstances, it is financially advantageous for landowners to manage their forests so they grow and market the highest value timber products possible.

Forest growth refers to the volume of wood or biomass that a site produces over a period of time. Yield is the marketable timber volume available for harvest (or harvested) at a given point in time or during a particular period. Many factors influence forest growth and how much timber is ultimately produced. Factors include site and soil conditions, species composition, forest health, and forest management activities. Both past and present natural disturbances and management activities, as manifested in stand structure, play a major role in yield.

Timber products commonly generated from New Hampshire's forests include sawtimber (veneer, sawlogs, bolts), cordwood (firewood and pulp), and biomass (chipwood). Sawtimber is usually the most valuable product by volume. For example, a trailer load of veneer may be worth 100 times the value of an equal volume of chipwood. Sawtimber is measured and sold per thousand board feet (MBF). Firewood is usually sold by the cord. Pulp and chipwood are usually weighed and sold by the ton.

Trees that produce mostly firewood, chips, pulp, or pallet sawlogs are considered low-grade. All forests contain low-grade wood. Although low-grade trees can be valuable for wildlife, managing to favor the growth of well-formed, healthy, vigorous trees provides more options and revenue over the long term than stewarding a forest replete with low-value products such as firewood.

Silvicultural management influences the tree-density, species composition, and the structural characteristics of a forest stand. Providing tree crowns with adequate space may accelerate the trees' growth rate. Forest landowners can optimize value growth by providing adequate space to valuable and potentially valuable trees. Stocking guides can help determine optimal stand densities for particular forest types (2.4 Managing for High-Value Trees). Refer to *Summary of Growth Rates and Yields of Common New Hampshire Forest Types* in the appendix for expected growth rates.

For landowners, the point of sale for timber is usually as the tree stands on the stump. "Stumpage" value is the value of standing timber before it is cut; this is the value landowners are paid when they sell timber. Once the tree is harvested, processed, and transported to market, timber is valued as "delivered" value. The value added by the logger's labor and use of equipment covers the logger's production cost and profit. This value-added is the difference between delivered and stumpage values.

Sawtimber is processed into more valuable products depending on the species and how clear, straight, and defect-free the wood is. Logs are downgraded by the number and kind of defects (knots, curves in the stem, rot, etc.). Poor-quality tree sections that aren't marketable as logs may be processed and sold as firewood, pulp, chipwood, or left in the woods.

A variety of factors affects the value of wood products, including (1) supply and demand for different species and grades of wood, (2) harvesting costs, (3) distance from markets, and (4) seasonality, which affects wood flow and logging costs.

OBJECTIVE

Manage for high-value timber products.

CONSIDERATIONS

- Considering forest growth provides a framework for devising a realistic timber-yield plan. To remain sustainable, timber yield typically doesn't exceed forest growth over the planned harvest cycle. Attempts to sustain production of quality timber by simple rules such as keeping harvest equal to growth is only possible after the stand structure becomes balanced at an optimum level (2.2 Forest Structure). Keeping harvest equal to growth may not allow for other practices in this publication and may be difficult on smaller ownerships.
- Forest growth rates are typically optimal on moist, fertile soils. As soil fertility decreases, there are fewer nutrients to support potential growth relative to a more productive site. However, a poor site for one species may be adequate for another.
- A forest inventory provides baseline information about present timber volumes and projected growth. Future inventories can reference the baseline inventory to determine if forest harvesting is occurring at a sustainable level.
- Sawtimber is usually more valuable—often dramatically—than firewood, pulp, or biomass chips.
- For landowners, stumpage value is usually the relevant value for selling timber.
- While all forests contain at least some low-quality, low-value wood, it isn't financially advantageous to deliberately grow poor-quality trees. Silvicultural management to favor the growth of high-quality, high-value timber products results in the greatest financial return from the forest over the long term.
- Decisions about how to utilize and process a harvested tree can greatly impact the financial return from any given timber sale. Similarly, the type of logging equipment used and the care taken to operate a timber harvest may affect the future value of the forest's residual trees.
- Several sources publish the general value of wood products including the N.H Dept. of Revenue Administration and N.H. Timberland Owners Association (NHTOA). However, stumpage values are specific to the situation, with regard to timber quality and quantity, logging costs, distance to market, and other factors. Moreover, markets fluctuate rapidly, and information from published sources may become quickly outdated.
- Specialty markets exist and may continue to emerge that provide alternatives to traditional timber forest products.
- Managing for high-value timber products may not be possible due to site constraints from soils and current forest cover, or may conflict with other important forest resources. Application of specific practices depends on the site and the landowner's priorities.

RECOMMENDED PRACTICES

- ✓ Seek professional help. (See below for listings of licensed foresters and certified loggers). Consider hiring a licensed forester to inventory, develop a forest management plan, and/or prepare a timber sale, including selecting and marking trees for harvest and sale. RSA 227-J:15 requires a timber sale contract.
- ✓ Refer to 2.4 Managing for High-Value Trees for silvicultural recommendations and refer to other chapters for information and guidance on integrating managing high-value trees with other important resources.
- ✓ Adjust harvest plans—consistent with the goals of the management plan—to take advantage of fluctuating markets for certain wood products.

CROSS REFERENCES

1.1 First Steps in Forest Management; 1.2 Setting Objectives; 1.3 Forest Management Planning; 2.1 New Hampshire Forest Types; 2.2 Forest Structure; 2.3 Regeneration Methods; 2.4 Managing for High-Value Trees; 3.1 Timber Harvesting Systems; 6.2 Cavity Trees, Dens and Snags; other chapters addressing specific landowner objectives; appendix *Summary of Growth Rates and Yields of Common New Hampshire Forest Types*.

ADDITIONAL INFORMATION

Bennett, K. P. 2010. *Directory of Licensed Foresters Providing Service to Forest Landowners in New Hampshire*. UNH Cooperative Extension, Durham, N.H. http://extension.unh.edu/fwt/dir/index.cfm Accessed on August 2, 2010.

N.H. Dept. of Revenue Administration. *Average Stumpage Values*. http://www.nh.gov/revenue/munc_prop/avgstumpval.htm Accessed May 27, 2010.

N.H. Timberland Owners Association. *Certified Loggers List*. http://www.nhtoa.org/ Accessed March 5, 2010.

RSA 227-J. *Timber Harvesting*. http://www.gencourt.state.nh.us/rsa/html/xix-a/227-j/227-j-mrg.htm Accessed May 27, 2010.

Simpson, W., and A. TenWolde. 1999. *Wood handbook—wood as an engineering material*. USDA For. Serv. Gen. Tech. Rep. FLP-GTR-113.

Edmonds, R.L., G.D. Wells, F.E. Gilman, S.W. Knowles, and N. Engalichev. 1988. *Lumber From Local Woodlots*. Natural Resource, Agriculture, and Engineering Service. NRAES-27. NRAES Cooperative Extension, Ithaca, N.Y. 42 p.

Smith, S. 1991. *N.H. Best Log Scaling Practices Guide*. UNH Cooperative Extension, Durham, N.H. 13 p.

8.2 NONTIMBER FOREST PRODUCTS

BACKGROUND

Nontimber forest products (NTFPs) are part of a functioning ecosystem and may be vulnerable to overharvesting.

NTFPs are products from the forest that don't involve harvesting trees. They include nuts and seeds, berries, mushrooms, oils, foliage, and medicinal plants. People collect them for a variety of reasons. These activities connect people to the land, increase understanding of woodland ecology, and provide products for home use or for sale.

A complete list of all NTFPs is too lengthy for this chapter. About 2,000 plants grow in the state that have value as NTFPs, if not for home use or market potential, then for education and study. Table 1 lists examples of NTFPs found in New Hampshire.

OBJECTIVE

To increase knowledge and awareness of nontimber forest products and avoid overharvesting.

CONSIDERATIONS

- It is unlawful to collect plants protected under the Native Plant Protection Act of 1987 without landowner permission. However, "Nothing in this section shall limit the rights of private property owners to take protected species on their own lands" (RSA 217-A).
- A permit is required to remove plants or other types of forest products from the White Mountain National Forest.
- Rules relating to all state-owned parks and to N.H. Dept. of Resources and Economic Development (DRED) properties state that "No person shall remove or damage any structure, plant, marine life, or natural feature on DRED properties." (N.H. Administrative Rules Res 7301.05).
- More research is needed to determine strategies for sustainable management of NTFPs.
- Accurate identification is essential to prevent poisoning from wild plants and mushrooms and to prevent picking of threatened and endangered species or plants of special concern. Any harvesting of these species, such as American ginseng, is unsustainable.
- Removing whole plants without consideration for regeneration isn't sustainable.
- Different habitats support different NTFPs. Riparian areas and other forest wetlands typically provide habitat for a large number of plants. Fields, meadows, and other open spaces within or adjacent to woodlands are also important for sun-loving NTFPs, e.g., edible wild greens.
- Many children don't spend enough time outdoors to appreciate the abundant values offered in nature. The hands-on, mostly outdoors study of NTFPs would benefit our children.
- For business enterprises:
  - Adding value beyond collecting to some NTFPs increases income. Examples include balsam fir branches made into wreaths, mushrooms dried to concentrate their flavor, and wildflowers pressed and applied to lampshades.
  - Locating markets, no matter how small, increases income. Direct marketing, where products are sold directly to the consumer (e.g., farmers markets), is usually the most profitable for NTFP entrepreneurs and is often the most appropriate option for small-scale NTFP businesses. Wholesale marketing involves a broker, who then sells to the customer. Niche markets are small specialty markets. Drying mushrooms to enhance flavor is an example of a niche market.

Table 1. Examples of Nontimber Forest Products

NTFP	Uses	Examples of Species in NH Forests
bark	• medicinal extractions • baskets	• slippery elm (*Ulmus rubra*) • birch (*Betula spp.*) • black ash (wood strips)
berries and wild fruit	• wine • jams and preserves • sauces • cider	• apples (*Malus spp.*) • wild blackberry (*Rubus spp.*) • blueberry (*Vaccinium spp.*) • red and black raspberry (*Rubus spp.*) • currants and gooseberries (*Ribes spp.*)
cones and seeds	• floral and wreath arrangements • fire starters • wildflower seed mixes	• white pine (*Pinus strobus*) • red spruce (*Picea rubens*) • balsam fir (*Abies balsamea*) • eastern hemlock (*Tsuga canadensis*) • switchgrass (*Panicum virgatum*) • creeping red fescue (*Festuca rubra*)
forest botanicals	• herbs and spices • edible greens, roots or tubers • medicinal plants	• red raspberry leaves • rose hips (*Rosa spp.*) • dandelion (*Taraxacum officinale*)
greenery, transplants, and floral products	• decoration • crafts • landscaping	• balsam fir (*Abies balsamea*) • winterberry holly (*Ilex verticillata*) • grape (*Vitis spp.*) • dogwoods (*Cornus spp.*) • cinnamon fern (*Osmunda cinnamomea*) • various wildflowers
honey	• food	• blackberries and raspberries (*Rubus spp.*) • blueberries (*Vaccinium spp.*) • American basswood (*Tilia americana*) • black locust (*Robinia pseudoacacia*) • asters (*Aster spp.*) • goldenrod (*Solidago spp.*) • clover (*Melilotus spp.*) • red maple (*Acer rubrum*)
mushrooms	• food • medicine	• black trumpet (*Craterellus fallax*) • chantarelle (*Cantharellus cibarius*) • hen of the woods (*Grifolia frondosa*) • oyster mushroom (*Pleurotus ostreatus*) • shiitakes (*Lentinus edodes*) • birch conk (*Piptoporus betulinus*) • chaga (*Inonotus obliquus*) • tinder conk (*Fomes fomentarius*)
nuts	• food	• shagbark hickory (*Carya ovata*) • hazelnuts (*Corylus americana* and *C. cornuta*) • beechnut (*Fagus grandiflora*) • butternut (*Juglans cinerea*) • black walnuts (*Juglans nigra*)
spruce gum	• medicine • gum • patching birch bark canoes	• red, white and black spruce (*Picea rubens, P. glauca, P. mariana*)

RECOMMENDED PRACTICES

- ✓ Don't harvest threatened or endangered species or species of concern.
- ✓ To maintain sustainable populations of NTFPs:
  - Collect only moderate quantities.
  - Gather from a large group, rather than a small group with a few individuals.
  - Understand the growth and regeneration habits of the specific plants and use collection techniques that maintain healthy populations. Taking just leaves, tender tips, and stems may encourage growth.
  - Learn plant parts at all stages of development during different seasons to be sure you know what you are harvesting.
- ✓ Consult authoritative field guides and experts before harvesting plants for food or medicine, as some edible plants closely resemble their highly toxic relatives.
- ✓ Coordinate with timber harvesting and tending activities to help the sustainable flow of all forest products including NTFPs. Mapping locations of NTFPs prior to harvesting and then taking care of those sites will help provide high-quality NTFPs. For example, white birch trees could be located, and their birch bark removed prior to timber harvesting.
- ✓ Whether you are interested in casual collecting or starting a small business, inventory the natural resources on your land, including NTFPs. This will help determine whether an NTFP enterprise is viable, given the availability and sustainability of the resource. Understanding what you have is the best way to make sustainable choices about collection.

CROSS REFERENCES

1.2 Setting Objectives; 2.1 New Hampshire Forest Types; 2.2 Forest Structure; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 6.5 Permanent Openings; 6.6 Temporary Openings Created by Forest Management.

ADDITIONAL INFORMATION

Cercone, M., and W. D. Lilley. *Balsam Fir Tip Gathering. Bulletin #7011*. University of Maine Cooperative Extension. http://www.umext.maine.edu/onlinepubs/htmpubs/7011.htm Accessed March 9, 2010.

Kays, J., and J. Drohan. 2004. *Forest Landowner's Guide to Evaluating and Choosing a Natural Resource-Based Enterprise*. NRAES-151. NRAES Cooperative Extension.102 p.

Lilley W. D., and V. J. Holmes. *Growing a Continuous Supply of Balsam Fir Wreath Brush. Bulletin # 7089*. University of Maine Cooperative Extension. http://www.umext.maine.edu/onlinepubs/htmpubs/7089.htm Accessed March 9, 2010.

Louv, R. 2005. *Last Child in the Woods: Saving Our Children From Nature-Deficit Disorder*. Algonquin Books of Chapel Hill, Chapel Hill, N.C. 336 p.

Monthey, R., and E. and A. Angevine. *Integrating Production of Non-timber Forest Products with Timber Management*. USDA For. Serv. NA—State & Private Forestry. http://www.na.fs.fed.us/stewardship/pubs/docs/080915_non%20timber%20article.pdf Accessed March 9, 2010.

RSA 217-A. 1987. *New Hampshire Native Plant Protection Act*. http://www.gencourt.state.nh.us/rsa/html/XIX/217-A/217-A-mrg.htm Accessed May 27, 2010.

Seymour, T. 2002. *Foraging New England: Finding, Identifying, and Preparing Edible Wild Foods and Medicinal Plants from Maine to Connecticut*. The Globe Pequot Press, Guilford, Conn. 208 p.

Reichenbach, M., J. Krantz, and K. Preece. *Non-timber Forest Products and Implications for Forest Managers*. http://www.extension.umn.edu/specializations/environment/ntfp.html# Accessed June 9, 2010.

8.3 MAPLE SUGARING

BACKGROUND

Sap production in a sugarbush relies on developing and maintaining large, spreading crowns in maple trees.

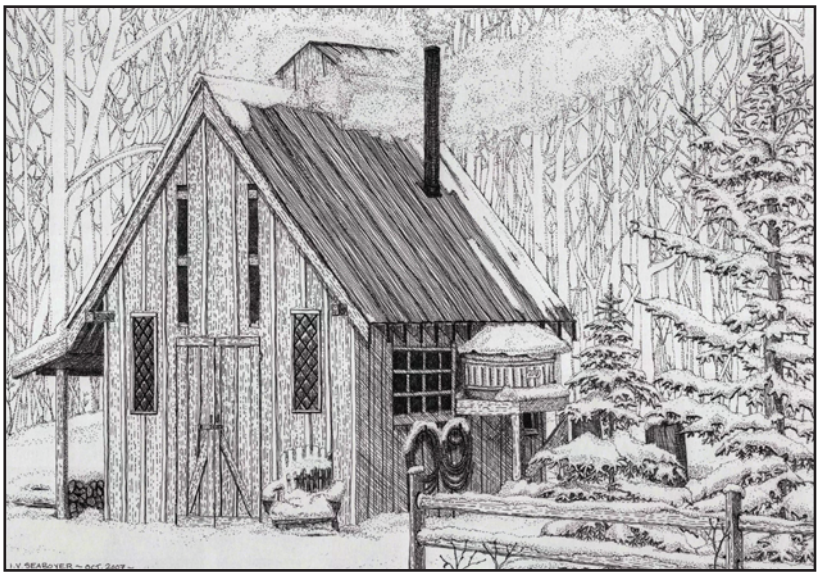
A sugarbush, or sugar orchard, is a stand of maple trees tapped for maple syrup. Sugarbushes can become overcrowded and tree vigor and sap production can decline. Maple trees rarely develop large, spreading crowns naturally in the competitive forest setting. To achieve such crowns, the tops of maples must be released through thinnings and improvement cuts—preferably throughout all stages of development. Often sap-producing maples growing in a mixed forest compete with other maples and with other kinds of trees. Overcrowding and competition for light and other resources negatively affect sugar content and sap volume and reduce stand vigor.

OBJECTIVE

Manage existing maples in sugarbushes to have large, spreading crowns. Regenerate maples to replace declining or overmature maples. Tap maple trees so tree health and vigor won't be adversely affected, and so the market value of the upper logs won't be compromised.

CONSIDERATIONS

- Sugar maples produce the sweetest and the most sap, but red maples can be tapped.
- Red maple "buds out" earlier than sugar maple. Sap from "budded out" trees produces an off-flavor. Bucket-collection systems are better adapted to mixed red and sugar maple bushes than tubing-collection systems. When red maple buds swell, operators can stop collecting from those buckets.
- Maples often occur in mixed stands with other trees suitable for timber production, wildlife habitat, or aesthetics (but not maple sap production).



Old Pound Road Sugarhouse, Antrim, New Hampshire

- Silvicultural actions taken to develop large, full crowns in maples will most likely result in an open park-like appearance to the stand.
- Tree vigor and production will decline in older maples. Establishing a new crop of trees through regeneration harvests and release of advanced regeneration sustains sap production.

- Sugarbushes can either be even-aged or uneven-aged. Each stand structure requires its own silvicultural prescription to maintain vigor and health and to regenerate a new cohort of maple trees.
- Some sugarbushes are declining because they (1) have been tapped for many years, (2) aren't on soils ideal for optimal maple development, and (3) have root and stem damage from logging, or yearly sap collecting and sugarbush maintenance. Stand age and the effects of tapping, combined with off-site development, all can lead to stand decline.
- While coniferous cover around the sugarbush edge may help minimize wind damage, conifers may create habitat for unwanted wildlife such as porcupines and squirrels that are apt to gnaw on tubing.
- Sugarbush health can be affected by several factors out of landowner control. Ice storms, insect outbreaks, drought, acid deposition, and other stressors affect sap production and sugar content. Sugarbushes in good health and on better sites will better tolerate these uncontrollable forces.
- Tapping injures the tree. The tree's ability to recover from this injury, and the overall health and productivity of the sugarbush, are closely related to tree health and environmental stresses.
- When tapped correctly, healthy, vigorous trees will respond to tapping by compartmentalizing the wound and closing the tap hole within one to three years. Trees in poor health and those under stress during the growing season won't respond as quickly as healthier individuals. This slow response to injuries may result in a greater area of decay and potentially a decline in health, production and quality.
- Traditional tapping guidelines allowed for tapping smaller trees and using more taps. Newer, more conservative tapping guidelines minimize the impact of tapping while maintaining or in some cases even increasing sap production.
- Trees harvested for firewood for maple syrup production are exempt from the yield (timber) tax (RSA 79).

RECOMMENDED PRACTICES

- ✓ Manage for a diversity of species, but select for healthy maples. An abundance of species and age classes will meet other forest stewardship objectives and create a resilient, diverse forest.
- ✓ Select maple crop trees for large crowns, sugar content, vigor, and form. Timber quality may not be a priority, but a maple with good form will tolerate the stresses of wind, snow and ice better than one with decay, cavities and poor branching patterns. To promote large, full crowns, release the crowns of the crop trees by removing undesirable trees whose tops are touching the tops of the maple crop trees.
- ✓ Make improvement cuts and thinnings gradually to promote crown development. Excessively releasing maples too quickly may overexpose them and cause dieback or mortality. Thinnings should follow silvicultural guidelines based on stand density and tree and crown size.
- ✓ Time thinnings to coincide with tubing-system replacements.
- ✓ Especially in long-established sugarbushes, regenerate when appropriate. Encourage new trees to grow to production size through releasing and thinning.
- ✓ Follow best management practices (BMPs) to maintain water and soil quality, nutrients, wildlife habitat, and forest health.
- ✓ Follow these tapping guidelines for tree health:
  - Tap only trees 12 inches diameter at breast height (DBH) and larger.

- Place one tap hole in trees 12 to 18 inches DBH.
- Place two tap holes in trees greater than 18 inches DBH.
- Place no more than two tap holes per tree.
- Drill tap holes at a slight upward angle to prevent sap pooling.
- Use the smaller-diameter "health spouts" (5/16- or 19/64-inch spouts). Health spouts are preferred, but the 7/16 inch spouts are still acceptable and common when using buckets to collect sap.
- Avoid tapping when the wood is frozen.
- Drive spouts with care to avoid splitting the bark and wood.
- For 7/16 inch spouts, place the tap hole no more than 2½ inches deep and for the smaller-diameter spouts, no more than 1½ inches deep.
- Tap only white, clean wood. To avoid areas of discoloration and decay, don't place new tap holes within 6 inches horizontally and at least 2 feet directly above or below old tap holes.
- Make sure "drops" (tubing attached directly to the spout) are long enough so tap holes can be placed on all sides of the tree. This avoids clustering of tap holes.
- Don't retap existing holes in any given year to expose new wood, or drill new holes to prolong the sap run.
- Don't use a tap-hole sanitizing agent.
- Remove spouts from tap holes immediately after the season.

✓ Attach tubing systems including mainlines to trees with protectors such as wooden blocks to protect the tree from stem injury or girdling. Avoid driving nails, lags, screw eyes, or other hardware into the trees.

✓ Prevent damage to tree trunks and roots, as well as to roads and trails, from sap-gathering or maintenance vehicles, such as tractors, trucks, sleds or trailers. Set collection containers so they are easily accessible.

✓ Avoid tapping trees that may yield high quality logs, if growing sugar maple sawlogs is an objective.

✓ Allow other native tree species to grow, especially if they aren't competing with maples and don't attract nuisance wildlife that cause damage to tap lines. Other species can serve as good anchors for tubing mainlines.

CROSS REFERENCES

2.2 Forest Structure; 2.3 Regeneration Methods; 2.4 Managing for High-Value Trees; 5.1 Insects and Diseases; 5.3 Ice and Wind Damage; 5.4 Logging Damage.

ADDITIONAL INFORMATION

Heiligmann, R.B., M.R. Koelling, T.D. Perkins. 2006. *North American Maple Syrup Producers Manual: Second Edition*. Ohio State University Extension, Columbus, Ohio. 329 p.

Houston, D. R., D. Allen, and D. Lachance. 1990. *Sugarbush management: a guide to maintaining tree health*. USDA For. Serv. Gen. Tech. Rep. NE-129. 55 p.

RSA 79. *Forest Conservation and Taxation*. http://www.gencourt.state.nh.us/rsa/html/v/79/79-mrg.htm Accessed May 27, 2010.

8.4 ECOSYSTEM SERVICES AS AN EMERGING MARKET

BACKGROUND

Compensation for ecosystem services provided by the forest may some day provide income and thus an incentive to participate in ecosystem-services markets.

Forests provide a myriad of public benefits to human welfare and the overall health and sustainability of the biosphere. Known as "ecosystem services" these benefits include wildlife and pollinator habitat, improved water quality, groundwater recharge, storage and regulation of storm flows, decomposition of organic debris, soil creation and maintenance, erosion control, sediment retention, carbon storage, recreation, and aesthetics. These public benefits are provided by the thousands of private landowners who keep their forest as forest. Once forests get converted to other land uses many of these natural services diminish or disappear.

Historically, economists and policy makers haven't assigned a dollar value to ecosystem services, but this is changing. Scientists and policy makers have begun proposing and implementing programs to compensate landowners for the services their lands provide. The intention of these programs is to provide landowners with incentives to keep their land in forest. Though current use assessment (RSA 79-A) doesn't explicitly talk about ecosystem services, it is an example of the State Legislature recognizing private landowners for preserving open space, "...thus providing a healthful and attractive outdoor environment for work and recreation of the state's citizens, maintaining the character of the state's landscape, and conserving the land, water, forest, agricultural and wildlife resources."

Carbon storage is one of the most developed ecosystem services markets. Although the existence of a market for carbon doesn't mean it is the most important ecosystem service. Work and research continues on the valuation of other services. New markets for ecosystem services may emerge as the public becomes more aware of their importance. Wetlands banking, conservation banking, and other large-scale efforts to protect the values and services provided by natural landscapes are already established in regions around the nation. Private landowners stand to benefit from growing markets for ecosystem services.

Carbon Sequestration Markets (Carbon Offset Markets)

All forests store carbon. The rate and quantity of carbon stored varies by forest type, age, and structure. Carbon markets, which provide credible standards by which carbon storage is measured and verified, are developing and give forest landowners an opportunity to measure and monitor the carbon stored in their forests and sell credits on an open market. Carbon emitters seeking to offset their carbon emissions purchase carbon credits. Currently these markets within the United States are entirely voluntary, though the development of a mandatory national carbon "cap-and-trade" system would change this situation.

Carbon-credit transactions may be private transactions between parties or coordinated through centralized registries or exchanges. There are several registries for forest carbon-offset credits. The Climate Action Reserve (CAR) is one example.

Developing a carbon-offset project is complex and expensive, involving inventory, monitoring, and verification costs above and beyond what is necessary for a normal forest management plan. Currently, participation in these markets is only feasible for large landowners, though some carbon-offset project-development companies are developing programs to aggregate multiple smaller landowners. Participation in these markets imposes long-term commitments and expenses.

Other Markets

Other models exist for compensating landowners for their good stewardship to ensure their forests provide ecosystem services. Wetland-mitigation banking and conservation banking for endangered species mitigate unavoidable impacts on aquatic resources and endangered species from development or other activity. The "bank" is a restored, enhanced or conserved area maintained to specific contractual standards by the bank owners. The banks are subject to regulatory review. Mitigation or conservation credits, which provide a specific ecosystem function, are sold to companies whose projects have an unavoidable impact on a similar resource. For example, if a project impacts a specific endangered species habitat, the purchased credit must support that same species habitat in the bank. New Hampshire has no mitigation banks, but states such as California and Florida have used them for decades.

OBJECTIVE

Be aware of new and emerging markets.

CONSIDERATIONS

- Protecting forest land in perpetuity with a conservation easement is one way to ensure that forests continue to provide ecosystem services.
- Selling carbon credits comes with encumbrances. If you sell carbon credits, you may not be able to sell other services, or sell or harvest forest products in the future.
- Voluntary carbon markets and standards by which carbon is measured and traded continue to develop and change. It has yet to be proven whether participation in carbon-exchange programs will be successful at providing an income stream and an incentive for landowners to participate in this market.
- As with any new economic activity, existing contract and tax law applies. The *National Timber Tax* website provides guidance for treating the costs and income associated with carbon contracts for federal income tax purposes.
- Landowners interested in participating in carbon markets will need to establish a baseline inventory of their woodlot using required protocols for carbon inventories.
- Managing for a diversity of species, structure and size classes, keeps options open in the event you wish to participate in an ecosystem-services market.
- Federal farm bill programs may provide financial assistance to landowners to participate in emerging environmental services market.
- Human-engineered systems that replace ecosystem services lost through forest conversion generally are expensive, require technology not yet developed or perfected, and aren't as efficient or cost-effective as what a natural ecosystem provide.

RECOMMENDED PRACTICES

- ✓ Discuss your interest in ecosystem services with your forester. Consider emerging ecosystem services markets when developing your forest management plan. Establish a baseline inventory of your woodlot using required protocols.
- ✓ Participate in a forest certification system, such as the American Tree Farm System, Forest Stewardship Council, or the Sustainable Forestry Initiative. This may be required to participate in carbon markets and is likely to be required as markets for other ecosystem services are created.

- ✓ Identify aggregators (organizations that put together the carbon stocks from several landowners in their state or region). Private forest landowners will need to work with aggregators to participate in carbon trading.

CROSS REFERENCES

1.2 Setting Objectives; 1.3 Forest Management Planning.

ADDITIONAL INFORMATION

Chicago Climate Exchange. 2009. http://www.chicagoclimateexchange.com/ Accessed March 11, 2010.

National Timber Tax website. http://www.timbertax.org/ Accessed March 12, 2010.

RGGI. 2008. *Regional Greenhouse Gas Initiative*.
http://www.rggi.org/home Accessed March 11, 2010.

RSA 79-A. *Current Use Taxation*.
http://www.gencourt.state.nh.us/rsa/html/v/79-a/79-a-mrg.htm Accessed May 27, 2010.

USDA Forest Service. *Ecosystem Services*.
http://www.fs.fed.us/ecosystemservices/index.shtml Accessed March 11, 2010.

USDA Forest Service—Northern Research Station. *Carbon Tools*.
http://nrs.fs.fed.us/carbon/tools/ Accessed March 11, 2010.

US Environmental Protection Agency. *Mitigation Banking Fact Sheet*.
http://www.epa.gov/owow/wetlands/facts/fact16.html Accessed March 11, 2010.

GLOSSARY

GLOSSARY

Access road: A temporary or permanent route into forest land for over-the-road vehicles.

Advanced regeneration: Young age classes that have become established naturally without the influence of harvesting.

Aestivate: Also known as "summer sleep" and somewhat similar to hibernation, a state of animal dormancy which some animals (e.g., turtles) use to avoid periods of excessive heat or dryness.

Age class: Intervals of tree age used to describe stand characteristics, e.g., 10- or 20-year age class.

Aquatic organism: For animals, vertebrate or invertebrate species that spend all or a portion of their lives in the water. These include fish, certain species of amphibians and reptiles, aquatic insects in both adult and larval form, crustaceans, freshwater mussels, and other animals. For plants, this includes floating, submerged or emergent plants and algae.

Basal area: A measure of tree density determined by estimating the total cross-sectional area of all trees measured at breast height (4.5 feet) and expressed in square feet per acre.

Beaver flowage: Flat water behind a beaver dam.

Best management practices (BMPs): As used in this book—A practice or combination of practices determined by the State to be the most effective and practicable means of controlling point and non-point pollution at acceptable levels. These guidelines, some of which are incorporated into law, are found in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*, published by the N.H. Dept. of Resources and Economic Development, Division of Forests and Lands.

Biodiversity: The variety and variability of all living organisms.

Biomass: The living or dead weight of organic matter in a tree, stand, or forest. Or as it relates to harvesting: The wood products obtained (usually) from in-woods chipping of all or some of portion of trees including limbs, tops, and unmerchantable stems, usually for energy production.

Boreal: Pertaining to northern latitudes. A climate zone with short, warm summers and snowy winters.

Borrow pit: The area from which gravel is removed to build up a roadbed.

Browse: Leaves, buds and woody stems used as food by woodland mammals such as deer and moose.

Bucking: Cutting a felled tree into segments.

Butt: The base of a tree, the large end of a log. A butt log is the first log cut above the stump.

Cambium: Layer of living cells between the bark and the wood.

Canopy: The more or less continuous cover of branches and foliage formed by the crowns of adjacent trees and other woody growth.

Calcareous: Soil or rock containing calcite (calcium carbonate). Calcareous soils generally have pHs around 6.0 or 7.0.

Cavity trees: Trees, either alive or dead, which contain hollowed out areas. Used as shelter for a variety of animal species.

Cellulose: A principle chemical constituent of wood cells.

Glossary

Chain: A unit of length equal to 66 feet.

Clearcutting: See even-aged management.

Circumneutral: Water or soil with pHs between 6.0 and 7.0.

Codominant (crown class): A tree whose crown helps form the general level of the main canopy and whose crown receives full light from above and little from the sides.

Coppice: The production of new stems from stump or roots. A plant derived by coppicing.

Corduroy: Poles, logs or brush laid perpendicular to the direction of travel and used as a roadbed to cross a wet area, where there isn't a defined stream channel.

Crop tree: A tree retained for maximum longevity due to desired characteristics such as commercial quality or biotic contribution.

Crop tree release or crop tree management: A thinning technique where (usually) high-quality trees with vigorous crowns are identified as crop trees and competing trees are cut to release the crown of the crop trees.

Crown: The part of the tree or woody plant bearing live branches.

Crown closure: The percent of the stand canopy overlying the forest floor.

Cutting cycle: The interval between harvesting operations when uneven-aged methods are employed using group or single-tree selection. Sometimes called "entry period."

DBH: (diameter at breast height) The average diameter of a standing tree, measured outside the bark at a point 4.5 feet above the ground.

Diameter class: Intervals of tree size (often 1 or 2 inches) used to describe stand characteristics, e.g., 10" or 12" diameter class.

Diameter-limit cutting: Harvesting practice in which only trees above a designated diameter are cut.

Disturbance: Any relatively discrete event that changes the make-up of a stand, community, or ecosystem. Natural disturbances include windstorms, insect outbreaks, or fire. Human disturbances include harvesting.

Dominant (crown class): A tree whose crown extends above the general level of the main canopy and whose crown receives full light from above and partial light from the sides.

Ecosystem: A community of species (or group of communities) and its physical environment, including atmosphere, soil, sunlight and water.

Ecosystem integrity: The ability of an ecosystem to continue to function over the long term without the loss of biological diversity or productive capacity. The ecological integrity of an area is maintained when the following conditions are met:

1. All community types and successional stages are represented across their natural range of variation.
2. Viable populations of all native species are maintained.
3. Ecological and evolutionary processes such as disturbance, nutrient cycling, and predation, are maintained.
4. The biological diversity in the area can respond naturally to change.

Early successional habitat: Young, regenerating forest and shrubby areas used by animals requiring the thick cover the vegetation provides. The seedling-sapling stage of the early successional type of aspen-birch differs vegetatively and structurally from the "young forest" seedling-sapling stage of other types, and these differences result in different benefits to wildlife.

Edge: A transition between two (or more) relatively distinct habitat types, stands, or vegetation types. Edges are often described as being either "hard" or "soft." Hard edge describes a very abrupt transition between one habitat with short vegetation (e.g., field or recent clearcut) and another with a tall, vertical wall of live trees that grow right up to the edge of the short vegetation. Soft edge describes a more gradual transition between habitats with different vegetation heights, such as occurs where a field with short grass, transitions into a slightly taller shrub border, which transitions into a stand of taller trees.

Endemic: A population of potentially injurious plants or animals that persist at low levels. Also can mean native to a particular area.

Entry period: The interval between harvesting operations. When uneven-aged methods are employed using group or single-tree selection, also called "cutting cycle."

Ephemeral: Existing for a short time; short-lived.

Epicormic sprouting: Small branches occurring on the stem and branches of some tree species in response to increased light, often from thinning or removal of substantial portions of the tree crown.

Even-aged management: A management system that results in the creation of stands in which trees of essentially the same age grow together. Regeneration in a particular stand is obtained during a short period of time at or near the time that a stand has reached the desired age or size for regeneration and is harvested. Cutting methods producing even-aged stands include (1) clearcutting; (2) patch clearing; (3) strip clearcutting; (4) shelterwood; and (5) seed tree.

1. Clearcutting: an even-aged cutting method whereby most or all trees within a given area are removed in one cutting, which leads to the establishment of an even-aged forest or stand. Reproduction of the new stand, either artificial or natural, occurs after cutting. Modifications of the clearcutting method include patch clearcutting and strip clearcutting.
2. Patch clearcutting: a modification of the clearcutting method where the area being treated is removed in a series of clearcuts made in patches. Often employed to regenerate even-aged stands which can't be reproduced by natural seeding if all trees are removed in a single cutting.
3. Strip clearcutting: a modification of the clearcutting method where the area being treated is removed in a series of clearcuts made in strips. Trees on the uncut strips furnish all or part of the seed for stocking the cut strips and protect the cutover area and the new crop. The width of the cut strips depends on the distance of effective seed dispersal, usually not exceeding 5 times the height of surrounding trees.
4. Shelterwood: a series of two or three harvests that gradually open the stand and stimulate natural reproduction of a new even-aged stand.
5. Seed tree method: an even-aged cutting method that removes most of the trees in one cutting except for a small number of trees left singly or in small groups to serve as a seed source for establishing regeneration.

Even-aged stand: All trees are the same age or at least of the same age class. A stand is considered even-aged if the difference in age between the oldest and the youngest trees doesn't exceed 20 percent of the length of the rotation. From an ecological viewpoint, the minimum size of an even-aged stand could be considered as the size of the largest opening entirely under the influence of adjacent mature timber. The opening of critical size might be that which, at the very center, exhibited the same temperature regime as any larger opening. Such an opening is probably about twice as wide as the height of mature trees.

Exemplary natural communities: Include (1) all viable occurrences of rare natural community types, and (2) higher-quality examples of more common communities.

Financial maturity: The rotation at which the current value growth rate of the stand equals the alternative rate of return. One indication of whether or not to harvest.

Fir waves: Linear patches of blowdown or standing dead trees oriented perpendicular to the prevailing wind and arranged in a progression of waves of different ages of resulting regeneration adjacent to one another.

Fledge: The stage in a young bird's life when it has acquired its adult feathers and and is able to fly.

Forb: An herbaceous plant other than grass.

Ford: A structure built for crossing a stream.

Forester: A person trained in the science of developing, caring for, and cultivating forests.

Forest management: The application of business methods and technical forestry principles to a forest property to produce desired values, resource uses, products, or services (see forest sustainability).

Forest type: A natural group or association of different species of trees which commonly occur together over a large area. Forest types are defined and named after one or more dominant species of trees in the type.

Forest sustainability: The capacity of a forest to produce the goods we desire today without compromising the productive capability and biological integrity on which future generations will depend.

Free-to-grow: A tree, often a seedling or small tree, free from direct competition for light, water or nutrients from other plants

Girdling: More or less continuous incisions around a living stem, through both the bark and the cambium with the intent to kill the tree.

Group selection: See uneven-aged management.

High grading: An exploitive logging practice that removes only the best, most accessible and marketable trees in the stand.

Hydrology: The properties, distribution, and circulation of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere.

Integrated resource management: The simultaneous consideration of various disciplines to balance competing demands on a natural system to maintain or enhance its health, diversity, and cultural and aesthetic value.

Intermediate (crown class): A tree whose crown extends into the lower portion of the main canopy and whose crown receives little direct sunlight from above and none from the sides.

Invasive: A non-native plant capable of moving aggressively into an area, monopolizing light, nutrients, water, and space to the detriment of native species. Variously referred to as exotic, nonnative, alien, noxious, or non-indigenous weeds. Non-native insects are usually referred to as "exotic."

Landing: A place where trees and logs are gathered in or near a harvest site for further processing and transport. Also called log yard.

Legacy tree: Usually mature, older tree left on-site after harvesting for biological, wildlife, spiritual, or aesthetic purposes.

Lignin: A complex polymer associated with cellulose and imparts rigidity to the cell.

Lopping: Cutting off branches, tops, and small trees after felling, into lengths that allow the resulting slash to lie close to the ground.

Merchantable: Trees or stands having the size, quality, and condition suitable for marketing. That portion of a tree suitable for sale.

Montane: Relating to mountains.

Natural resource professional: Person by training, education or experience who has expertise in managing natural resources. May include foresters, wildlife biologists, loggers, wetland scientists, etc.

Natural community: Recurring assemblages (groups) of species found in particular physical environments.

Outwash: Soil mixed and deposited by glacial meltwater; sands and gravels.

Overmature: Also called biological maturity. A tree or even-aged stand declining in vigor and health and reaching its natural life span. A tree or even-aged stand that has begun to lessen in commercial value because of size, age, decay, or other factors.

Overtop: When one tree (or shrub) is growing over another.

Overtopped (crown class): Also called suppressed. A tree whose crown is completely overtopped by the crown of its neighbors.

Overstocked: Too many trees in a stand (as compared to the optimum number) to achieve some management objective, usually improved growth rates or timber values.

Overstory: The upper-crown canopy of a forest, usually referring to the largest trees.

Patch clearcutting: See even-aged management.

Patch retention: Keeping an area of relatively homogeneous vegetation that differs from the surrounding vegetation for an ecological or wildlife habitat purpose.

Perched culvert: A culvert with its downstream end above the water.

Pioneer: An early occupier of disturbed sites.

Plantation: A stand of trees that has been planted or direct-seeded.

Poletimber: A DBH size-class representing trees that are usually more than 4.0 inches DBH and less than 10.0 inches DBH.

Predation: The act of capturing and killing other animals for food.

Prune: To remove living or dead branches for improved timber value, aesthetics, or vigor.

Regeneration: The renewal of a stand of trees by either natural or artificial (planting or seeding) means.

Regeneration cut: A harvest intended to assist regeneration already present or establish new regeneration by manipulating light levels, seed source, and seedbed.

Release: Freeing the tops of young trees from undesirable, usually overtopping, competing vegetation. Also used to describe removing competing vegetation from the sides of crowns as when releasing a crop tree during a thinning.

Residual trees: Trees left to grow in the stand following a silvicultural treatment.

Residual stand: A stand composed of trees remaining after a harvest.

Residual stocking: The numbers of trees left after a harvest.

Revegetation: The re-establishment of vegetation on bare soil by natural or artificial (planting or seeding) means.

Rotation: The period between regeneration establishment and final harvest. The age at which a stand is considered ready for harvest. Used in even-aged systems.

RSA: Revised Statutes Annotated, the compilation of the laws of the State of New Hampshire.

Sapling: Trees more than 4.5 feet tall but less than 5.0 inches DBH.

Sawlog: A log considered suitable in size and quality for producing lumber.

Scarification: Loosening topsoil, or breaking up the soil, in preparation for regeneration by planting, direct seeding or natural seed-fall.

Seedlings: Trees that are less than 4.5 feet tall.

Seed tree method: See even-aged management.

Seep: A spot where groundwater oozes to the surface, forming a small pool.

Selection harvesting: Removing single, scattered individuals or small groups of trees at relatively short intervals, repeating indefinitely to encourage continuous regeneration and maintenance of an uneven-aged stand.

Shelterwood: See even-aged management.

Silviculture: The art and science of establishing and tending trees and forests.

Single tree selection: See uneven-aged management.

Site index: A measure of the relative productive capacity of an area based on tree height growth.

Site preparation: Removal of unwanted vegetation and other material as preparation for the planting or seeding of trees. Site preparation may include removal of slash and other debris, removal or control of competing vegetation, or exposure of bare soil.

Size class: Descriptive term defining the most common tree size in a stand, e.g., poletimber or sawtimber stand.

Slash: The residue left on the ground after felling, lopping, storm, fire, girdling or poisoning. It includes nonmarketable portions of trees such as stumps, broken branches, dead trees and other debris left on the ground.

Snag: A dead or dying standing tree, often left in place for wildlife.

Stand: A group of trees reasonably similar in age structure and species composition and growing on a site of sufficiently similar quality to be distinguishable from adjacent areas.

Stocking: An indication of the number of trees in a stand as compared to the optimum number of trees to achieve some management objective, usually improved growth rates or timber values.

Stream gradient: The grade (slope) of a stream. A measure of steepness.

Strip cut: See even-aged management.

Succession: The replacement of one plant community by another over time in the absence of disturbance.

Suppressed (crown class): Also called overtopped. A tree whose crown is completely overtopped by the crown of its neighbors.

Supracanopy trees: Super-dominant trees whose crowns protrude above the main crown canopy.

Sustainable forest management: See forest sustainability.

Sustained yield: An annual or periodic output of products from the forest that doesn't impair the productivity of the land, generally harvesting equal to growth.

Take (for animals): Capturing, killing, wounding, disturbing, harrying, and similar acts against wildlife. For threatened and endangered species, taking includes disturbances to active nests, dens or other shelter while it is being used for reproduction, raising of young, overwintering or other critical needs.

Take (for plants): To pick, collect, cut, transplant, uproot, dig, remove, damage, destroy, trample, kill, or otherwise disturb, or to attempt to engage in any such conduct.

Thin: To reduce the stand density primarily to improve growth, enhance tree health, or recover potential mortality.

Till: Unsorted and unstratified soil deposited by a glacier, consisting of clay, silt, sand, gravel, stones, and boulders in any proportion.

Timber: Wood, other than fuelwood, potentially usable for lumber. Forest stands containing timber.

Timber stand improvement (TSI): Silvicultural activities that improve the composition, constitution, condition, and growth of a timber stand.

Tolerance: The capacity of a tree to become established and grow in the shade.

Understocked: Too few trees in a stand (as compared to the optimum number) to achieve some management objective, usually improved growth rates or timber values.

Understory: All vegetation growing under an overstory.

Unmerchantable: Trees or stands lacking the size, quality, and condition suitable for marketing. That portion of a tree unsuitable for sale.

Two-aged stand: A stand of trees that contains two well-defined age classes intermingled on the same area.

Uneven-aged management: The application of actions needed to maintain a continuous high-forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a wide range of ages and sizes to provide a sustained yield of forest products. Cutting methods that develop and maintain uneven-aged stands include (1) single-tree selection; and (2) group selection.

1. Single-tree selection: removal of single, scattered individuals or exceedingly small groups of trees at relatively short intervals, repeated indefinitely, by encouraging continuous reproduction and maintaining an uneven-aged stand.
2. Group selection: periodic removal of trees in small groups, producing openings smaller than the minimum feasible acreage for a single stand under even-aged management. Aims to produce an uneven-aged stand with a mosaic of small and variable-sized age class groups. Differs from single-tree selection in that the predominant characteristics of the group rather than the individual stems, are evaluated for treatment.

Uneven-aged stand: A stand of trees that contains at least three well-defined age classes intermingled on the same area.

Vascular plants: Plants having tissues that conduct (transport) water, minerals, and food throughout the plant's roots, stems and leaves.

Vernal pool: A temporary body of water that forms in shallow depressions or basins, lacks a permanently flowing outlet, supports vernal-pool indicator wildlife species (e.g., spotted salamanders, wood frogs, fairy shrimp) and holds water for at least 2 months after spring ice-out.

Viewshed: The landscape that can be seen from a viewpoint or along a road or trail.

Water bar: An excavated, shallow channel or raised barrier of soil or other material laid diagonally across the surface of a road or skid trail to lead water off the road and prevent soil erosion.

Windfirm: The ability of a tree's root system to withstand wind pressure and keep the tree upright.

Windrow: Slash, residue and debris raked into piled rows.

Windthrow: Trees felled by wind. Also called blowdown or windfall.

APPENDICES

INFORMATION DIRECTORY

State and Federal Agencies

UNH Cooperative Extension, Forestry and Wildlife Program:
Extension Educators in Forestry and Wildlife are available statewide and in each county. Find your UNH Cooperative Extension county forester.
1-800-444-8978
http://www.nhwoods.org

New Hampshire Dept. of Resources and Economic Development:
Division of Forests and Lands
(603) 271-2214
http://www.nhdfl.org/

Natural Heritage Bureau
(603) 271-2214
http://www.nhdfl.org/about-forests-and-lands/bureaus/natural-heritage-bureau/

New Hampshire Fish and Game:
For the state office or to find your regional Fish and Game office.
(603) 271-3211
http://www.wildlife.state.nh.us/index.htm

New Hampshire Dept. of Environmental Services:
Water Division
(603) 271-3434
http://des.nh.gov/organization/divisions/water/index.htm

Drinking Water Source Protection Program
(603) 271-2513
http://des.nh.gov/organization/divisions/water/dwgb/dwspp/index.htm

Wetlands Bureau
(603) 271-2147
http://des.nh.gov/organization/divisions/water/wetlands/index.htm

Geological Survey
(603) 271-1976
http://des.nh.gov/organization/commissioner/gsu/index.htm

Waste Management Division
Spills/Complaints—Petroleum or Hazardous Waste
(603) 271-3899
http://des.nh.gov/organization/divisions/waste/index.htm

USDA Natural Resource Conservation Service — New Hampshire
For the state office or to find your local NRCS Service Center.
(603) 868-7581
http://www.nh.nrcs.usda.gov/

New Hampshire Division of Historical Resources:
(603) 271-3483
http://www.nh.gov/nhdhr/contact.html

New Hampshire Dept. of Agriculture, Markets and Food:
(603) 271-3551
http://agriculture.nh.gov/

Division of Pesticide Control
(603) 271-3550
http://agriculture.nh.gov/divisions/pesticide_control/index.htm

New Hampshire Joint Board of Licensure and Certification:
(603) 271-2219
http://www.nh.gov/jtboard/

Board of Foresters
http://www.nh.gov/jtboard/fr.htm

Board of Land Surveyors
http://www.nh.gov/jtboard/ls.htm

Board of Natural Scientists
http://www.nh.gov/jtboard/ns.htm

USDA Forest Service
Northern Research Station
(603) 868-7600
http://www.fs.fed.us/ne/

State and Private Forestry—Northeastern Area
(603) 868-7600
http://www.na.fs.fed.us/

White Mountain National Forest
(603) 536-6100
http://www.fs.fed.us/r9/forests/white_mountain/

Non-Governmental Organizations

Granite State Division — Society of American Foresters
http://www.nesaf.org/new-england-society-american-foresters-divisions-granite-state.asp

New Hampshire Association of Conservation Commissions
(603) 224-7867
http://www.nhacc.org/

New Hampshire Association of Natural Resource Scientists
(603) 224-0401
http://www.nhanrs.org/

New Hampshire Audubon
(603) 224-9909
http://www.nhaudubon.org/

New Hampshire Timber Harvesting Council and New Hampshire Professional Loggers Program
(603) 224-9699
http://www.nhtoa.org/

New Hampshire Timberland Owners Association
(603) 224-9699
http://www.nhtoa.org/

New Hampshire Tree Farm Program
http://www.nhtreefarm.org/

Society for the Protection of New Hampshire Forests
(603) 224-9945
http://www.spnhf.org/

The Nature Conservancy, New Hampshire Chapter
(603) 224-5853
http://www.nature.org/wherewework/northamerica/states/newhampshire/

Contact information current as of November 2010.

IMPORTANT FOREST SOIL GROUPS

New Hampshire soils are complex and highly variable due primarily to their glacial origins. The Natural Resource Conservation Service (NRCS) soil mapping recognizes and inventories these complex patterns and organized them into a useful and understandable planning tool, Important Forest Soil Groups. The objective—a simplified yet accurate tool that will be helpful to natural resource professionals and landowners.

These groupings allow managers to evaluate the relative productivity of soils and to better understand patterns of plant succession and how soil and site interactions influence management decisions. All soils have been grouped into one of six categories, as described below. For a complete list, contact your local NRCS field office or http://extension.unh.edu/resources/files/Resource001580_Rep2136.xls

Group IA consists of the deeper, loamy, moderately well-drained and well-drained soils. Generally, these soils are more fertile and have the most favorable soil-moisture conditions. Successional trends are toward climax stands of shade-tolerant hardwoods such as sugar maple and beech. Early successional stands frequently contain a variety of hardwoods such as sugar maple, beech, red maple, yellow, gray, and white birch, aspen, white ash, and northern red oak in varying combinations with red and white spruce, balsam fir, hemlock, and white pine. The soils in this group are well-suited for growing high-quality hardwood veneer and sawtimber, especially, sugar maple, white ash, yellow birch, and northern red oak. Softwoods are usually less abundant and are best managed as a minor component of predominantly hardwood stands. Hardwood competition is severe on these soils. Successful natural regeneration of softwoods and the establishment of softwood plantations requires intensive management.

Group IB generally consists of soils that are moderately well-drained and well-drained, sandy or loamy-over-sandy, and slightly less fertile than those in group 1A. Soil moisture is adequate for good tree growth but may not be quite as abundant as in group 1A. Successional trends and the trees common in early successional stands are similar to those in group IA. However, beech is usually more abundant on group IB and is the dominant species in climax stands. Group IB soils are well-suited for growing less-nutrient-and-moisture-demanding hardwoods such as white birch and northern red oak. Softwoods generally are scarce to moderately abundant and managed in groups or as part of a mixed stand. Hardwood competition is moderate to severe on these soils. Successful regeneration of softwoods and the establishment of softwood plantations are dependent upon intensive management. The deeper, coarser-textured, and better-drained soils in this group are generally suitable for conversion to intensive softwood production.

Group IC soils are derived from glacial outwash sand and gravel. The soils are coarse textured and are somewhat excessively drained to excessively drained and moderately well-drained. Soil moisture and fertility are adequate for good softwood growth but are limiting for hardwoods. Successional trends on these soils are toward stands of shade-tolerant softwoods, such as red spruce and hemlock. White pine, northern red oak, red maple, aspen, gray birch, and paper birch are common in early successional stands. These soils are well-suited for high quality softwood sawtimber, especially white pine, in nearly pure stands. Less site-demanding hardwoods such as northern red oak and white birch have fair to good growth on sites where soil moisture is more abundant. Hardwood competition is moderate to slight. With modest levels of management, white pine can be maintained and reproduced. Although chemical control of woody and herbaceous vegetation may be desirable in some situations, softwood production is possible without it.

Group IIA consists of diverse soils and includes many of the soils that are in groups IA and IB. The soils in IIA, however, have limitations such as steep slopes, bedrock outcrops, erodibility, surface boulders, and extreme stoniness. Productivity of these soils isn't greatly affected by those limitations, but management activities such as tree planting, thinning, and harvesting are more difficult and more costly.

Group IIB soils are poorly drained. The seasonal high water table is generally at a depth of 12 inches or less. Productivity is lower than in IA, IB, or IC. Fertility is adequate for softwoods but is a limitation for hardwoods. Successional trends are toward climax stands of shade-tolerant softwoods, such as red spruce and hemlock. Balsam fir is a persistent component in nearly all stands. Early successional stands frequently contain a variety of hardwoods such as red maple, yellow, gray, and paper birch, aspen, and white and black ash in varying mixtures with red spruce, hemlock, balsam fir, and white pine. These soils are well-suited for spruce and balsam fir pulpwood and sawtimber. Advanced regeneration is usually adequate to fully stock a stand. Hardwood competition isn't usually a major limitation, but intensive management by chemical control of competing woody and herbaceous vegetation may be desirable.

Not Rated Several mapping units in New Hampshire are either so variable or have such a limited potential for commercial production of forest products that they haven't been placed in a group. Examples are very poorly drained soils and soils at high elevations.

WILDLIFE SPECIES OF GREATEST CONSERVATION NEED

(excluding coastal non-forested habitats, extensive grasslands or high alpine)

Common Name	Scientific Name	**Status** E=Endangered T=Threatened SC=Special Concern	Habitat	**Recommendations in these chapters in GFGS will help these animals. "Special" means this animal needs some particular management technique.**
INVERTEBRATES				
Dwarf wedge mussel	*Alasmidonta heterodon*	E	Stream	Forest Management in Riparian Habitats
Brook floater mussel	*Alasmidonta varicosa*	E	Stream	Forest Management in Riparian Habitats
Eastern Pondmussel	*Ligumia nasuta*	SC	Pond	Forest Management in Riparian Habitats
Ringed boghaunter dragonfly	*Williamsonia lintneri*	E	Wetlands, Pond	Wetlands
Scarlet Bluet	*Enallagma pictum*	SC	Wetlands, Pond	Wetlands
Pine Barrens Bluet	*Enallagma recurvatum*	SC	Wetland, Pond	Wetlands
Rapids Clubtail	*Gomphus quadricolor*	SC	Stream	Wetlands
Skillet Clubtail	*Gomphus ventricosus*	SC	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Riverine Clubtail	*Stylurus amnicola*	SC	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Coppery Emerald	*Somatochlora georgiana*	SC	Wetlands	Wetlands
Ebony Boghaunter	*Williamsonia fletcheri*	SC	Wetlands	Wetlands
Cobblestone tiger beetle	*Cicindela marginipennis*	E	Connecticut River	Forest Management in Riparian Habitats
Puritan tiger beetle	*Cicindela puritana*	E	Connecticut River	Forest Management in Riparian Habitats
Frosted elfin butterfly	*Callophrys irus*	E	Forest	Pine Barrens
Karner blue butterfly	*Lycaeides melissa samuelis*	E	Forest	Pine Barrens, Special
Persius duskywing skipper	*Erynnis persius*	E	Forest	Pine Barrens
Pine pinion moth	*Lithophane lepida lepida*	T	Forest	Pine Barrens
Sleepy Duskywing	*Erynnis brizo brizo*	SC	Forest	Pine Barrens
Barrens itame	*Itame sp. 1*	SC	Forest	Pine Barrens
Barrens xylotype	*Xylotype capax*	SC	Forest	Pine Barrens
Broad-lined catopyrrha	*Erastria coloraria*	SC	Forest	Pine Barrens
Cora moth (bird dropping moth)	*Cerma cora*	SC	Forest	
Phyllira tiger moth	*Grammia phyllira*	SC	Forest	Pine Barrens
Pine barrens zanclognatha moth	*Zanclognatha martha*	SC	Forest	Pine Barrens

Common Name	Scientific Name	Status E=Endangered T=Threatened SC=Special Concern	Habitat	Recommendations in these chapters in GFGS will help these animals. "Special" means this animal needs some particular management technique.
FISH				
American brook lamprey	*Lampetra bifrenatus*	E	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Shortnose sturgeon	*Acipenser brevirostrum*	E	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Bridle shiner	*Notropis bifrenatus*	T	Stream, Pond	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Alewife (sea run only)	*Alosa psuedoharengus*	SC	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
American Eel	*Anguilla rostrata*	SC	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
American Shad	*Alosa sapidissima*	SC	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Blueback Herring	*Alosa aestivalis*	SC	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Rainbow Smelt (sea run only)	*Osmerus mordax*	SC	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Sea Lamprey	*Petromyzon marinus*	SC	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Banded Sunfish	*Enneacanthus obesus*	SC	Pond	Forest Management in Riparian Habitats
Finescale Dace	*Phoxinus neogaeus*	SC	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Lake Whitefish	*Coregonus clupeaformis*	SC	Pond	Forest Management in Riparian Habitats
Northern Redbelly Dace	*Phoxinus eos*	SC	Stream, Pond	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Redfin Pickerel	*Esox americanus americanus*	SC	Stream	Streams Crossings and Habitat; Forest Management in Riparian Habitats
Round Whitefish		SC	Pond	Forest Management in Riparian Habitats
Swamp Darter	*Etheostoma fusiforme*	SC	Pond	Forest Management in Riparian Habitats
AMPHIBIAN				
Marbled salamander	*Ambystoma opacum*	E	Vernal Pool	Vernal Pools, Dead and Down Woody Material
Jefferson Salamander	*Ambystoma jeffersonianum*	SC	Vernal Pool, Wetland	Vernal Pools; Dead and Down Woody Material
Blue-spotted Salamander	*Ambystoma laterale*	SC	Vernal Pool, Wetland	Vernal Pools; Dead and Down Woody Material

WILDLIFE SPECIES OF GREATEST CONSERVATION NEED

Common Name	Scientific Name	Status E=Endangered T=Threatened SC=Special Concern	Habitat	Recommendations in these chapters in GFGS will help these animals. "Special" means this animal needs some particular management technique.
Fowler's Toad	*Anaxyrus fowleri*	SC	Forest	
Northern Leopard Frog	*Lithobates pipiens*	SC	Grasslands, Grassy areas in Forests	Temporary Openings Created by Forest Management; Permanent Openings; Forest Management in Riparian Habitats
REPTILE				
Blanding's turtle	*Emydoidea blandingii*	E	Vernal Pool, Wetland	Vernal Pools; Wetlands
Spotted turtle	*Clemmys guttata*	T	Wetlands	Wetlands
Wood Turtle	*Glyptemys insculpta*	SC	Riparian Forest	Forest Management in Riparian Habitats
Eastern Box Turtle	*Terrapene carolina*	SC	Forest	
Eastern hognose snake	*Heterodon platirhinos*	E	Forest	Pine Barrens; Dead and Down Woody Material
Timber rattlesnake	*Crotalus horridus*	E	Forest	
Black racer	*Coluber constrictor*	T	Forest, openings	Temporary Openings Created by Forest Management; Permanent Openings; Dead and Down Woody Material
Smooth Green Snake	*Opheodrys vernalis*	SC	Grasslands, Forests	Permanent Openings
BIRD				
Northern Harrier	*Circus cyaneus*	E	Grasslands	
Golden eagle	*Aquila chrysaetos*	E	Forest	
Common nighthawk	*Chordeiles minor*	E	Forest	Pine Barrens
Sedge wren	*Cistothorus platensis*	E	Wetlands	Wetlands
Pied-billed grebe	*Podilymbus podiceps*	T	Wetlands	Wetlands
Common loon	*Gavia immer*	T	Pond	Forest Management in Riparian Habitats
Bald eagle	*Haliaetus leucocephalus*	T	Pond	Woodland Raptor Nest Sites; Forest Management in Riparian Habitats
Peregrine falcon	*Falco peregrinus*	T	Forest	High-Elevation Forests
American three-toed woodpecker	*Picoides dorsalis*	T	Forest	High-Elevation Forests; Cavity Trees, Dens and Snags
Spruce Grouse	*Falcipennis canadensis*	SC	Forest	
Least Bittern	*Ixobrychus exilis*	SC	Wetlands	Wetlands
Osprey	*Pandion haliaetus*	SC	Pond	Cavity Trees, Dens and Snags; Forest Management in Riparian Habitats
American Kestrel	*Falco sparverius*	SC	Forest	Cavity Trees, Dens and Snags
Sora	*Porzana carolina*	SC	Wetlands	Wetlands

Common Name	Scientific Name	Status E=Endangered T=Threatened SC=Special Concern	Habitat	Recommendations in these chapters in GFGS will help these animals. "Special" means this animal needs some particular management technique.
Common Moorhen	*Gallinula chloropus*	SC	Wetlands	Wetlands
Whip-poor-will	*Caprimulgus vociferus*	SC	Forest	Pine Barrens
Olive-sided Flycatcher	*Contopus cooperi*	SC	Forest	
Horned Lark	*Eremophila alpestris*	SC	Grasslands	
Purple Martin	*Progne subis*	SC	Forest	Special
Bank Swallow	*Riparia riparia*	SC	Riparian banks	Forest Management in Riparian Habitats
Cliff Swallow	*Petrochelidon pyrrhonota*	SC	Grasslands	Special
Bicknell's Thrush	*Catharus bicknelli*	SC	Forest	High-Elevation Forests
Golden-winged Warbler	*Vermivora chrysoptera*	SC	Forest	Temporary Openings Created by Forest Management; Permanent Openings
Cerulean Warbler	*Dendroica cerulea*	SC	Forest	
Eastern Meadowlark	*Sturnella magna*	SC	Grasslands	
Rusty Blackbird	*Euphagus carolinus*	SC	Wetlands	Wetlands
MAMMAL				
Small footed bat	*Myotis leibii*	E	Forest	
New England cottontail	*Sylvilagus transitionalis*	E	Shrublands	Temporary Openings Created by Forest Management; Permanent Openings; Pine Barrens
Canada lynx	*Lynx canadensis*	E	Forest	High-Elevation Forests
Gray wolf (federally listed, not yet in NH)	*Canis lupus*	E	Forest	
American marten	*Martes americana*	T	Forest	High-Elevation Forests
Eastern Red Bat	*Lasiurus borealis*	SC	Forest	Cavity Trees, Dens and Snags
Hoary Bat	*Lasiurus cinereus*	SC	Forest	Cavity Trees, Dens and Snags
Silver-haired Bat	*Lasionycteris noctivagans*	SC	Forest	Cavity Trees, Dens and Snags
Northern long-ear bat	*Myotis septentrionalis*	SC	Forest	Cavity Trees, Dens and Snags
Tricolored bat (fomerly Pipistrelle)	*Perimyotis subflavus*	SC	Forest	Cavity Trees, Dens and Snags
Northern Bog Lemming	*Synaptomys borealis sphagnicola*	SC	Forest	

SUMMARY OF GROWTH RATES AND YIELDS OF COMMON NEW HAMPSHIRE FOREST TYPES

Table 1. Very general growth and volume estimates for sawtimber stands in forest types of New Hampshire. Growth and volumes vary widely depending on site conditions, stand age, management intensity, species composition and stocking. Volume estimates also vary with product specifications, especially for softwood species. For additional information, use the references listed below the table.

Growth Measure	Northern Hardwood	Red Oak	White Pine	Hemlock	Spruce-fir
Annual Basal Area Growth/acre (sq.ft.)	1.0-2.2	1.0-2.5	1.5-3.5	2.0-2.7	2.0-3.0
Annual Board-foot growth/acre	100-275	150-400	300-1,200	150-250	150-250
Annual cubic-foot growth/acre	25-55	30-60	50-90	40-65	40-65
Annual diameter growth (inches)	0.05-0.20	0.10-0.25	0.10-0.40	0.10-0.30	0.10-0.20
Mature* gross standing volume (board feet)	10,000-15,000	5,000-15,000	10,000-50,000	15,000-20,000	15,000-30,000
Mature* gross standing volume (cubic feet)	2,500-4,000	3,000-5,000	6,000-9,000	4,500-5,500	4,000-6,000

*Mature: Refers to financial maturity (see 2.3 Regeneration Methods). Larger trees about 12-16 inches (spruce-fir) and 18-24 inches (other types).

ADDITIONAL INFORMATION

Dale, M.E. 1972. *Growth and Yield Predictions for Upland Oak Stands*. USDA For. Serv. Res. Pap. NE-241. 21 p.

Solomon, D.S. and R.M. Frank. 1983. *Growth Response of Managed Uneven-aged Northern Conifer Stands*. USDA For. Serv. Res. Pap. NE-517. 17 p.

Solomon, D.S. 1977. *The Influence of Stand Density and Structure on Growth of Northern Hardwoods in New England*. USDA For. Serv. Res. Pap. NE-362. 13 p.

Forbes, R.D. editor. 1955. *Forestry Handbook*. Ronald Press Co., New York, N.Y. 1202 p.

Barrett, J.P., R.J. Alimi, and K.T. McCarthy. 1976. Growth of White Pine in New Hampshire. *J. For.* 74(7):450-452.

Desmarais, K.M. and W.B. Leak. 2005. Ten-year Performance of Eastern White Pine Under a Crop Tree Release Regime on an Outwash Site. *North. J. Appl. For.* 22(2):139-142.

REFERENCES

REFERENCES

Getting Started

Setting Objectives

McGuinn, B. 2002. *Women and the Woods Curriculum*. Unpublished report. University of New Hampshire Cooperative Extension, Durham, N.H.

Forest Management Planning

N.H. Dept. of Revenue Administration. *Current Use Criteria Booklet*. http://extension.unh.edu/resources/resource/977/Current_Use_Criteria_Booklet Accessed May 27, 2010.

Estate Planning and Land Protection

Butler, B.J., and E.C. Leatherberry. 2004. America's family forest owners. *J. For.* 102(7): 4-14. http://familyforestresearchcenter.org/publications/04familyforestowners.pdf Accessed March 12, 2010.

Silviculture

New Hampshire Forest Types

Sperduto, D. D., and William Nichols. 2004. *Natural Communities of New Hampshire*. N.H. Natural Heritage Bureau, Concord, N.H. http://extension.unh.edu/resources/files/Resource000425_Rep447.pdf Accessed March 12, 2010.

Regeneration: The Right Tree on the Right Site

Frank, R.M., and J.C. Bjorkbom. 1973. *A Silvicultural Guide for Spruce-Fir in the Northeast*. USDA For. Serv. Gen. Tech. Rep. NE-6. 29 p.

Johnson, P.S. 1993. *Perspectives on the Ecology and Silviculture of Oak-Dominated Forests in the Central and Eastern States*. USDA For. Serv. Gen. Tech. Rep. NC-153. 28 p.

Lancaster, K.F., and W.B. Leak. 1978. A *Silvicultural Guide for White Pine in the Northeast*. USDA For. Serv. Gen. Tech. Rep. NE-41. 13 p.

Leak, W.B., D.S. Solomon, and P.S. DeBald. 1987. *Silvicultural Guide for Northern Hardwood Types in the Northeast (revised)*. USDA For. Serv. Res. Pap. NE-603. 36 p.

Leak, W.B. 1988. Effects of Weed Species on Northern Hardwood Regeneration in New Hampshire. *North. J. Appl. For.* 5(4):235-237.

Leak, W.B., and N.L. Lamson. 1999. *Revised white pine stocking guide for managed stands*. USDA For. Serv. NA—State and Private Forestry. NA-TP-01-99. 2 p.

Managing for High-Value Trees

Bennett, K. P. 2006. *Forest Land Enhancement Program (FLEP) Handbook*. UNH Cooperative Extension, Durham, N.H. 48 p.

Bennett, K.P., and K. Desmarais (eds.). 2003. *Managing white pine in a new millennium: 2003 workshop proceedings*. UNH Cooperative Extension, Durham, N.H. 78 p.

References

Frank, R.M., and J.C. Bjorkbom. 1973. *A Silvicultural Guide for Spruce-Fir in the Northeast*. USDA For. Serv. Gen. Tech. Rep. NE-6. 29 p.

Kittredge, D. B. 1988. The influence of species composition on the growth of individual red oaks in mixed stands in southern New England, U.S.A. *Can. J. For. Res.* 18(12): 1550-1555.

Leak, W.B., D.S. Solomon, and P.S. DeBald. 1987. *Silvicultural Guide for Northern Hardwood Types in the Northeast (revised)*. USDA For. Serv. Res. Pap. NE-603. 36 p.

Oliver, C., and B. Larson. 1996. *Forest Stand Dynamics*. Upd. Sub.edition. John Wiley and Sons, Inc. 544 p.

Sendak, P.E., and W.B. Leak. 2008. *Early Crop-Tree Release and Species Cleaning in Young Northern Hardwoods: A Financial Analysis*. USDA For. Serv. Res. Pap. NRS-6. 13 p.

Seymour, R.S. 2003. Low-density management of white pine crop trees: A primer and short-term research results. P. 41-48 in *Managing White Pine in a New Millennium: 2003 Workshop Proceedings*. UNH Cooperative Extension, Durham, N.H. 78 p.

Smith, D. 1986. *The Practice of Silviculture* (8th edition). John Wiley and Sons, Inc. 544 p.

Solomon, D.S., D.A. Herman, and W.B. Leak. 1995. *Fiber 3.0: An Ecological Growth Model for Northeastern Forest Types*. USDA For. Serv. Gen. Tech. Rep. NE-204. 24 p.

Trimble, G.R. Jr., J.J. Mendel, and R.A. Kennell. 1974. *A Procedure for Selection Marking in Hardwoods*. USDA For. Serv. Res. Pap. NE-292. 13 p.

Timber Harvesting

Soil Productivity

Hornbeck, J.W., C.T. Smith, Q. W. Martin, L.M Tritton, and R.S. Pierce. 1990. Effects of Intensive Harvesting on Nutrient Capital of Three Forest Types in New England. *For. Ecol. Manage*. 30(1-4): 55-64.

Hornbeck, J.W., R.B. Smith, and C.A. Federer. 1988. Growth Trends in 10 Species of Trees in New England, 1950-1980. *Can. J. For. Res.* 18(10): 1337-1340.

Johnson, C.E., R.B. Romanowicz, and T.G. Siccama. 1997. Conservation of Exchangeable Cations After Clear-cutting of a Northern Hardwood Forest. *Can. J. For. Res.* 27(6):859-868.

Leak, W.B. 2007. Thinning Northern Hardwoods in New England by Dominant-Tree Removal — Early Results. *North. J. Appl.* For. 24(4):312-313.

Likens, G.E., C.T. Driscoll, and D.C. Buso. 1996. Long-term Effects of Acid Rain: Response and Recovery of a Forest Ecosystem. *Science* 272(5259): 244-246.

Pierce, R.S., J. W. Hornbeck, C.W. Martin, L.M. Tritton, C.T. Smith, C.A. Federer, and H.W. Yawney. 1993. *Whole-tree Clearcutting in New England: Manager's Guide to Impacts on Soils, Streams, and Regeneration*. USDA For. Serv. Gen. Tech. Rep. NE-172. 271 p.

Water Resources

Water Quality

N.H. Dept. of Environmental Services. 2007 Discharges of Oil Requiring Immediate Notification. N.H. Code of Administrative Rules Env-Or 604. NHDES, Concord, N.H.

Wetlands

Ammann, A.P., and A. Lindley Stone. 1991. *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire*. NHDES-WRD-1991-3. N.H. Dept. of Environmental Services, Concord, N.H. 97 p.

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and J.W. Lanier. 1992. *New England Wildlife: Management of Forested Habitats*. USDA For. Serv. Gen. Tech. Rep. NE-144. 271 p.

Hunter, M.L., Jr. 1990. *Wildlife, Forests and Forestry: Principles of Managing Forests for Biological Diversity*. Prentice-Hall, New York, N.Y. 370 p.

Riparian Areas

Blinn, C.R., and M.A. Kilgore. 2001. Riparian Management Practices: A Summary of State Guidelines. *J. For.* 99(8)11-17.

DeGraaf, R.M., and M. Yamasaki. 2000. Bird and mammal habitat in riparian areas. P.139-156 in Verry, E.S., J.W. Hornbeck, and C.A. Dolloff (eds.). 2000. *Riparian Management in Forests of the Continental Eastern United States*. Lewis Publishers, Boca Raton, Fla.

DeGraaf, R.M., and M. Yamasaki. 2001. *New England Wildlife: Habitat, Natural History, and Distribution*. University Press of New England, Lebanon, N.H. 482 p.

Elliott, C.A. 1988. A *Forester's Guide to Managing Wildlife Habitats in Maine*. University of Maine Cooperative Extension Service, Orono, Maine. 46 p.

Elliott, C.A. 1994. Managing Riparian Habitat for Songbirds, Raptors and Small Mammals. P. 71-82 in proceedings of the *Symposium on Riparian Zone Management*. Canadian Forest Service. R&D Report No. 9, Fredericton, New Brunswick.

Gomi, T., R.C. Sidle, and J.S. Richardson. 2002. Understanding Processes and Downstream Linkages of Headwater Streams. *Bioscience* 52(10):905-916.

Hagan, J. and A. Whitman. 2000. Rate of Stream Water Warming in Buffered-Clearcut and Intact-Forest Streams in Western Maine in proceedings of *Forestry in the Riparian Zone*. Manomet Center for Conservation Sciences, Brunswick, Maine.

Hunter, M.L., Jr. 1990. *Wildlife, Forests and Forestry: Principles of Managing Forests for Biological Diversity*. Prentice-Hall, New York, N.Y. 370 p.

Jones, J.J., J.P. Lortie, and U.D. Pierce, Jr. 1988. *The Identification and Management of Significant Fish and Wildlife Resources in Southern Coastal Maine*. Maine Dept. of Inland Fisheries and Wildlife, Augusta, Maine.

Lee, P., C. Smyth, and S. Boutin. 2004. Quantitative review of riparian buffer width guidelines from Canada and the United States. *J. Environ. Manage*. 70(2): 165–180.

Loftin, C.S., M.S. Bank, J.M. Hagan, and D. Siegel. 2001. *Literature Synthesis of the Effects of Forest Management Activities on Riparian and In-Stream Biota of New England*. University of Maine Cooperative Forestry and Research Unit. RR 01-01. 78 p.

Meiklejohn, B.A. 1994. *The Value of Buffer Strips as Riparian Habitat in Northern Forests*. M.Sc. thesis, University of Vermont, Burlington, Vt. 41 p.

Naiman, R.J., and J.J. Latterell. 2005. Principles for linking fish habitat to fisheries management and conservation. *J. Fish Biol*. 67 (Supplement B): 166–185.

Trout Unlimited. 2005. *Riparian Buffer and Watershed Management Recommendations for Brook Trout Habitat Conservation. Focus: Mountainous Brook Trout Watersheds of Maine and Northern New Hampshire*. Prepared by Kleinschmidt Associates, Pittsfield, Maine.

Stream Crossings and Habitat

Fahrig L., and G. Merriam. 1985. Habitat patch connectivity and population survival. *Ecology* 66(6):1762-1768.

Jackson, S.D. 2003. Ecological considerations in the design of river and stream crossings. P. 20-29 in proceedings of the *International Conference on Ecology and Transportation*, C.L. Irwin, P. Garrett, and K.P. McDermott, (eds.). Center for Transportation and the Environment, North Carolina State University, Raleigh, N.C.

Stream and Wetland Restoration Institute. 2009. *New Hampshire Stream Crossings Guidelines*. University of New Hampshire, Durham, N.H. 48 p.

Maine Forest Service. 2008. *Maine Forestry Best Management Practices: Use and Effectiveness, 2006–2007*. Maine For. Serv. Dept. of Conservation, Augusta, Maine. 24 p.

Forest Health

Insects and Diseases

Houseweart, M.W., and F.B. Knight. 1986. Entomological Problems in Growing White Pine. P. 88-92 in proceedings of *Eastern White Pine: Today and Tomorrow*. USDA For. Serv. Gen. Tech. Rep. WO-51. 124 p.

Houston, D.R. 1983. American Beech Resistance to *Cryptococcus fagisuga*. In proceedings of *IUFRO Beech Bark Disease Working Party Conference*. USDA For. Serv. Gen.Tech. Rep. WO-37. 140 p.

Jennings, D.T., and H.S. Crawford, Jr. 1985. *Spruce Budworm Handbook — Predators of the Spruce Budworm*. USDA For. Serv. Coop. State Res. Serv. Agriculture Handbook 644. 77 p.

Invasive Plants

Frappier, B., R.T. Eckert, and T.D. Lee. 2003. Potential impacts of the invasive exotic shrub *Rhamnus frangula L.* (glossy buckthorn) on forests of southern New Hampshire. Northeast. Nat. 10(3):277-296.

National Invasive Species Council. 2001. *Management plan: meeting the invasive species challenge*. http://www.invasivespecies.gov/ Accessed January 21, 2010.

National Invasive Species Information Center. http://www.invasivespeciesinfo.gov/plants/main.shtml Accessed January 21, 2010.

New England Wild Flower Society. 1998. Invaders. *New England Wild Flower: Conservation Notes of the New England Wildflower Society*. Framingham, Mass. 30 p.

Logging Damage

Hesterberg, G.A. 1957. *Deterioration of Sugar Maple Following Logging Damage*. USDA Forest Service Lakes States Experiment Station. Station Paper 51. 58 p.

Cline, M.L., B.F. Hoffman, M. Cyr, and W. Bragg. 1991. Stand Damage Following Whole-Tree Partial Cutting in Northern Forests. *North. J. Appl. For.* 8(2): 72-76.

Nyland, R.D., and W.J. Gabriel. 1971. *Logging Damage to Partially Cut Hardwood Stands in New York State*. State University College of Forestry, Applied Forestry Research Institute. Res. Rep. 5. 78 p.

Ostrofsky, W. 1988. Health of Forests in Relation to Timber Management Practices. P. 49-56 in *New Perspectives on Silvicultural Management of Northern Hardwoods*, USDA For. Serv. Gen. Tech. Rep. NE-124.

Weinsauer, J., and J.P. Mattson. 1986. Harvesting Alternatives for Thinning Northern Hardwoods. P. 223-241 in *Managing Northern Hardwoods: Proceedings of a Silvicultural Symposium*. State University of New York, Syracuse, N.Y.

Wildlife Habitat

Mast

Burns, R.M., and B. H. Honkala. 1990. *Silvics of North America, Volume 2: Hardwoods*. USDA For. Serv. Agriculture Handbook 654, Washington, D.C. 877 p.

White, D. W. 1989. *North American bird-dispersed fruits: ecological and adaptive significance of nutritional and structural traits*. Ph.D. thesis, Rutgers University, New Brunswick, N.J.

White, D. W., and E. W. Stiles. 1992. Bird dispersal of fruits of species introduced into eastern North America. *Can. J. Botany*. 70:1689-1696.

Cavity Trees, Dens and Snags

Hardin, K.I., and K.E. Evans. 1977. *Cavity Nesting Bird Habitat in the Oak-Hickory Forest—A Review*. USDA For. Serv. Gen. Tech. Rep. NC-30.

Harrison, H.H. 1975. A *Field Guide to Birds' Nests in the United States East of the Mississippi*. Houghton Mifflin Co., Boston, Mass.

Healy, W.M., R.T. Brooks, and R.M. DeGraaf. 1989. Cavity trees in sawtimber size oak stands in central Massachusetts. *North. J. Appl.* For. 6(2): 61-65.

Tubbs, C.H., R.M. DeGraaf, M. Yamasaki, and W.M. Healy. 1987. *Guide to Wildlife Tree Management in New England Northern Hardwoods*. USDA For. Serv. Gen. Tech. Rep. NE-118. 30 p.

Yamasaki, M., and W.B. Leak. 2006. Snag longevity in managed northern hardwoods. *North. J. Appl. For.* 23(3): 215-217.

Dead and Down Woody Material

Hagan, J. M., and S.L. Grove. 1999. Coarse Woody Debris: Humans and Nature Competing for Trees. *J. For.* 97(1):6-1.

Harmon, M.E., J.F. Franklin, F.J. Swanson, P. Sollins, S.V. Gregory, J.D. Lattin, N.H. Anderson, S.P. Cline, N.G. Aumen, J.R. Sedell, G.W. Lienkaemper, K. Cromack, Jr., and K.W. Cummins. 1986. Ecology of Coarse Woody Debris in Temperate Ecosystems. *Adv. Ecol. Res.* 15: 133-302.

Permanent Openings

Chandler, R.B., D.I. King, and S. DeStefano. 2009. Scrub-shrub bird habitat associations at multiple spatial scales in beaver meadows in Massachusetts. *The Auk* 126(1): 186–197.

Costello, C.A., M. Yamasaki, P.J. Pekins, W.B. Leak, and C.D. Neefus. 2000. Songbird response to group selection harvests and clearcuts in a New Hampshire northern hardwood forest. *For. Ecol. Manage.* 127(1-3): 41–54.

DeGraaf, R.M., and M. Yamasaki. 2003. Options for managing early-successional forest and shrubland bird habitats in the northeastern United States. *For. Ecol. Manage.* 185(1-2): 179–191.

References

Schlossberg, S., and D.I. King. 2007. *Ecology and management of scrub-shrub birds in New England: a comprehensive review*. Report submitted to USDA Natural Resources Conservation Service, Resource Inventory and Assessment Division. 120 p.

Temporary Openings Created by Forest Management

Brooks, R.T., 2003. Abundance, distribution, trends, and ownership patterns of early successional forests in the northeastern United States. *For. Ecol. Manage*. 185(1-2): 65-74.

Chandler, R.B., D.I. King, and S. DeStefano. 2009. Scrub-shrub bird habitat associations at multiple spatial scales in beaver meadows in Massachusetts. *The Auk* 126(1): 186–197.

Costello, C.A., M. Yamasaki, P.J. Pekins, W.B. Leak, and C.D. Neefus. 2000. Songbird response to group selection harvests and clearcuts in a New Hampshire northern hardwood forest. *For. Ecol. Manage*. 127(1-3): 41–54.

DeGraaf, R.M. 1991. Breeding bird assemblages in managed northern hardwood forests in New England. P. 153-171 in *Wildlife and habitats in managed landscapes*, J.E. Rodiek and E.G. Bolen (eds.). Island Press, Washington, D.C. 238 p.

DeGraaf, R.M., and M. Yamasaki. 2003. Options for managing early-successional forest and shrubland bird habitats in the northeastern United States. *For. Ecol. Manage*. 185(1-2): 179–191.

King, D.I., R.B. Chandler, S. Schlossberg, and C.C. Chandler. 2009. Habitat use and nest success of scrub-shrub birds in wildlife and silvicultural openings in western Massachusetts, USA. *For. Ecol. Manage*. 257(2): 421–426.

Leak, W.B., D.S. Solomon, and P.S. DeBald. 1987. *Silvicultural guide for northern hardwood types in the Northeast (revised)*. USDA For. Serv. Res. Pap. NE-603. 36 p.

Schlossberg, S., and D.I. King. 2007. *Ecology and management of scrub-shrub birds in New England: A comprehensive review*. Report submitted to USDA Natural Resources Conservation Service, Resource Inventory and Assessment Division. 120 p.

Schlossberg, S., and D.I. King. 2008. Are shrubland birds edge specialists? *Ecol. Appl*. 18(6): 1325–1330.

Schlossberg, S., and D.I. King. 2009. Postlogging succession and habitat usage of shrubland birds. *J. Wildl. Manage*. 73(2): 226–231.

Thompson, F.R. III, and R.M. DeGraaf. 2001. Conservation approaches for woody, early successional communities in the eastern United States. *Wildl. Soc. Bull*. 29(2): 483-494.

Trani, M.K., R.T.Brooks, T.L. Schmidt, V.A. Rudis, and C.M. Gabbard. 2001. Patterns and trends of early successional forests in the eastern United States. *Wildl. Soc. Bull*. 29(2): 413-424.

Aspen Management

Bates, P. C., C. R. Blinn, and A. A. Alm. 1991. *Regenerating quaking aspen: management recommendations*. Minnesota Extension Service, University of Minnesota. 7 p.

Frieswyk, T., and R. Widmann. 2000. *Forest statistics for New Hampshire: 1983 and 1997*. USDA For. Serv. Res. Bull. NE-146. 130 p.

Perala, D.A. 1977. *Manager's Handbook for Aspen in the North-Central States*. USDA For. Serv. Gen. Tech. Rep. NC-36. 30 p.

Beaver-Created Openings

Buech, R.R. 1985. Beaver in Water Impoundments: Understanding a Problem of Water-level Management. P. 95-105 in *Water Impoundments for Wildlife: a Habitat Management Workshop*, D.M. Knighton (ed.). USDA For. Serv. Gen. Tech. Rep. NC-100.

Chandler, R. B., D. I. King, and S. DeStefano. 2009. Scrub-shrub bird habitat associations at multiple spatial scales in beaver meadows in Massachusetts. *The Auk* 126(1):186-197.

Diefenbach, D.R., S.J. Lovett, and R.B. Owens, Jr. 1988. Beavers and Wetlands. P. 38-40 in *A Forester's Guide to Managing Wildlife Habitats in Maine*, C.A. Elliott (ed.). University of Maine Cooperative Extension and Maine Chapter of The Wildlife Society, Orono, Maine.

Hill, E.P. 1982. Beaver: *Castor canadensis*. P. 256-281 in *Wild Mammals of North America—Biology, Management, and Economics*, J.A. Chapman, and G.A. Feldhamer (eds.). Johns Hopkins University Press, Baltimore, Md.

Deer Wintering Areas

Alexander, C.E., and L.E. Garland. 1985. Spruce Budworm/Deer Winter Range: A Situation Statement. P. 211-216 in *Conference on Spruce-Fir Management and Spruce Budworm*. USDA For. Serv. Gen. Tech. Rep. NE-99.

Beier, P., and D. R. McCullough. 1990. Factors influencing white-tailed deer activity patterns and habitat use. *Wildl. Monographs* 109:3-51.

Broadfoot, J. D., D. R. Voigt, and T. J. Bellhouse. 1996. White-tailed deer, *Odocoileus virginianus*, summer dispersion areas in Ontario. *Can. Field Nat*. 110(2): 298-302.

Frank, R. M., and J. C. Bjorkbom. 1973. *A silvicultural guide for spruce-fir in the northeast*. USDA For. Serv. Gen. Tech. Rep. NE-6. 29 p.

Maine Dept. of Inland Fisheries and Wildlife. 1993. *General guidelines for the management of P-FW and P-4 deer wintering areas in the jurisdiction of the land use regulation commission*. MDIFW. Augusta, Maine. 10 p.

Rongstad, O. J., and J. R. Tester. 1969. Movements and habitat use of white-tailed deer in Minnesota. *J. Wildl. Manage*. 33(2): 366-379.

Tierson, W. C., G. F. Mattfeld, R. W. Sage, Jr., and D. E. Behrend. 1985. Seasonal movements and home range of white-tailed deer in the Adirondacks. *J. Wildl. Manage*. 49(3): 760-769.

Woodland Raptors

Craighead, J.J., and F.C. Craighead, Jr. 1956. *Hawks, owls and wildlife*. Stackpole Co., Harrisburg, Pa. 443 p.

Farmer, C.J., L.J. Goodrich, E.R. Inzunza, and J.P. Smith. 2008. Conservation status of North America's birds of prey. P. 303-420 in *State of North America's Birds of Prey*, K.L. Bildstein, J.P. Smith, E.R. Inzunza, and R.R. Veit (eds.). American Ornithologists' Union/Nuttall Ornithological Club. 466 p.

Fyfe, R.W., and R.R. Olendorff. 1976. *Minimizing the dangers of nesting studies to raptors and other sensitive species*. Can. Wildl. Serv. Occas. Pap. No. 23. Information Canada, Catalogue No. CW69-1/23.

Houston, C. S., D.G. Smith, and C. Rohner. 1998. Great Horned Owl (*Bubo virginianus*). In *The Birds of North America Online*, A. Poole (ed.). Cornell Lab of Ornithology, Ithaca, N.Y. http://bna.birds.cornell.edu/bna/species/372 Accessed February 23, 2010.

Johnsgard, P.A. 1988. *North American Owls*. Smithsonian Institution Press, Washington, D.C.

References

Johnsgard, P.A. 1990. *Hawks, Eagles, and Falcons of North America*. Smithsonian Institution Press, Washington, D.C.

Lanier, J., and R.M. Bollengier. 1994. Peregrine falcon (*Falco peregrinus*). P. 60-61 in *Atlas of Breeding Birds in New Hampshire*, C.R. Foss (ed.). Arcadia Press, Dover, N.H.

N.H. Fish and Game Dept. 2005. *New Hampshire Wildlife Action Plan*. N.H. Fish and Game, Concord, N.H.

Rosenfield, R.N., J.W. Grier, and R.W. Fyfe. 2007. Reducing management and research disturbance. P. 351-364 in *Raptor Research and Management Techniques*, D.M. Bird, and K.L. Bildstein (eds.). Hancock House Publishers. Blaine, Wash.

Speiser, R. 1993. Use of landmarks in nest site selection by woodland raptors. *Records of New Jersey Birds* 19:2-5.

Trexel, D.R., R.N. Rosenfield, J. Bielefeldt, and E.A. Jacobs. 1999. Comparative nest site habitats in sharp-shinned and Cooper's hawks in Wisconsin. *Wilson Bulletin* 111: 7-14.

Bald Eagle Winter Roosts

Grier, J.W., F.J. Gramlich, J. Mattson, J.E. Mathison, J.V. Kussman, J.B. Elder, and N.F. Green. 1983. *Northern States Bald Eagle Recovery Plan*. USDI Fish and Wildl. Serv. Minneapolis, Minn. 121 p.

Snow, C. 1973. *Habitat Management Series for Endangered Species: Report No. 5. Southern Bald Eagle Haliaeetus leucocephalus leucocephalus and Northern Bald Eagle Haliaeetus leucocephalus alascanus*. USDI Bureau of Land Management Tech. Note TN-17.

Heron Colonies

Elkins, K.C., and E.F. Swift. 1994. Great blue heron (*Ardea herodias*). Page 8 in *Atlas of breeding birds in New Hampshire*, C.R. Foss (ed.). Arcadia. Dover, N.H.

Gibb, J.P., S. Woodward, M.L. Hunter, Jr., and A.E. Hutchinson. 1987. Determinants of great blue heron colony distribution in coastal Maine. *The Auk* 104(1): 38-47.

Simpson, K., J.N.M. Smith, and J.P. Kelsall. 1987. Correlates and consequences of coloniality in great blue herons. *Can. J. Zoolog*. 65(3): 572-577.

Vennesland, R.G. 2010. Risk perception of nesting Great Blue Herons: experimental evidence of habituation. *Can. J. Zoolog*. 88(9): 81-89.

Watts, B.D., and D.S. Bradshaw. 1994. The influence of human disturbance on the location of great blue heron colonies in the lower Chesapeake region. *Colonial Waterbirds* 17(2): 184-186.

Sensitive Areas

Natural Communities and Protected Plants

U.S. Fish & Wildlife Service. 1995. *The Small Whorled Pogonia: A Recovering Endangered Species*. USDI Fish and Wildl. Serv. Bethesda, Md. 8 p.

Seeps

Meisner, J.D., J.S. Rosenfeld, and H.A. Regier. 1988. The Role of Groundwater in the Impact of Climate

Warming on Stream Salmonines. *Fisheries*. 13(3): 2-8.

Whitlock, A. L., N.M. Jarman, and J.S. Larson. 1994. *Habitat Assessment Procedures for Wetland-Dependent Amphibians, Reptiles, and Mammals*. The Environmental Institute, University of Massachusetts, Amherst, Mass. 595 p.

Vernal Pools

Babbitt, K.J., M. Baber, and T.L. Tarr. 2003. Patterns of larval amphibian distribution along a wetland hydroperiod gradient. *Can. J. Zoolog*. 81(9): 1539-1552.

Baldwin, R.F., A.J.K. Calhoun, and P.G. deMaynadier. 2006. The significance of hydroperiod and stand maturity for pool-breeding amphibians in forested landscapes. *Can. J. Zoolog*. 84(11): 1604-1615.

Baldwin, R.F., A.J.K. Calhoun, and P.G. deMaynadier. 2006. Conservation planning for amphibian species with complex habitat requirements: a case study using movements and habitat selection of the wood frog (*Rana sylvatica*). *J. Herpetol*. 40(4): 442-453.

Broadmeadow, S., and T.R. Nisbet. 2004. The effects of riparian forest management on the freshwater environment: a literature review of best management practice. *Hydrol. Earth Syst. Sc.* 8(3): 286-305.

deMaynadier, P.G., and M.L. Hunter, Jr. 2000. Road effects on amphibian movements in a forested landscape. *Nat. Area. J.* 20(1): 56-65.

deMaynadier, P.G., and J. Houlahan. 2008. Conserving Vernal Pool Amphibians in Managed Forests. In *Science and Conservation of Vernal Pools in Northeastern North America*, A.J.K. Calhoun and P.G. deMaynadier (eds.). CRC Press, Inc., Boca Raton, Fla.

Harper, E.B., T.A.G. Rittenhouse, and R.D. Semlitsch. 2008. Demographic consequences of terrestrial habitat loss for pool-breeding amphibians: predicting extinction risks associated with inadequate size of buffer zones. *Conserv. Biol.* 22(5): 1205-1215.

Herrmann, H.L., K.J. Babbitt, M.J. Baber, and R.G. Congalton. 2005. Effects of landscape characteristics on amphibian distribution in a forest-dominated landscape. *Biol. Conserv*. 123(2):139-149.

Innes, R.J., K.J. Babbitt, and J.J. Kanter. 2008. Home range and movement of Blanding's turtles (*Emydoidea blandingii*) in New Hampshire. *Northeast. Nat*. 15(3): 431-444.

Joyal, L.A., M. McCollough, and M.L. Hunter, Jr. 2001. Landscape ecology approaches to wetland species conservation: a case study of two turtle species in southern Maine. *Conserv. Biol.* 15(6):1755-1762.

Morris, K.M., and T.J. Maret. 2007. Effects of timber management on pond-breeding salamanders. *J. Wildl. Manage*. 71(4): 1034-1041.

Patrick, D.A., M.L. Hunter, Jr., and A.J.K Calhoun. 2006. Effects of experimental forestry treatments on a Maine amphibian community. *For. Ecol. Manage*. 234(1-3): 323-332.

Roble, S.M., and D.B. Kittredge, Jr. 1991. Protection of Vernal Pools During Timber Harvesting. *The Northern Logger and Timber Processor*. May: 6-7.

Rothermel, B.B., and T.M. Luhring. 2005. Burrow availability and desiccation risk of mole salamanders (*Ambystoma talpoideum*) in harvested versus unharvested forest stands. *J. Herpetol*. 39(4): 619-626.

Russell, K.R., H.G. Hanlin, T.B. Wigley, and D.C. Guynn. 2002. Responses of isolated wetland herpetofauna to upland forest management. *J. Wildl. Manage*. 66(3): 603-617.

Semlitsch, R.D., and J.R. Bodie. 2003. Biological criteria for buffer zones around wetlands and riparian

habitats for amphibians and reptiles. *Conserv. Biol*. 17(5): 1219-1228.

Smith, M.A., and D.M. Green. 2005. Dispersal and the metapopulation paradigm in amphibian ecology and conservation: are all amphibian populations metapopulations? *Ecography* 28(1):110-128.

Veysey, J.S., K.J. Babbitt, and A. Cooper. 2009. An experimental assessment of buffer width: implications for salamander migratory behavior. *Biol. Conserv*. 142(10):2227-2239.

Zamudio, K.R., and A.M. Wieczorek. 2007. Fine-scale genetic structure and dispersal among spotted salamander (*Ambystoma maculatum*) breeding populations. *Mol. Ecol*. 16: 257-274.

Pine Barrens

Dacey, C. 2003. *Vegetation of the Ossipee Pine Barrens Preserve: Description, Classification and Successional Trends*. M. Sc. thesis, University of Vermont, Burlington, Vt.

Finton, A.D. 1998. *Succession and plant community development in pitch pine-scrub oak barrens of the glaciated northeast United States*. M. Sc. thesis, University of Massachusetts, Amherst, Mass.

Howard, L. 2003. *Factors affecting plant community composition and dynamics in the Ossipee Pine Barrens, New Hampshire*. Ph.D. thesis, University of New Hampshire, Durham, N.H.

Hunt, P. 2008. *Northeast Nightjar Survey: 2008 Summary and 2007 Data Analysis*. NH Audubon, Concord, N.H.

Lougee, J. 2005. *Vegetation, Landcover, and Fuel Mapping of the Ossipee Pine Barrens, Carroll County, New Hampshire*. The Nature Conservancy Northern New Hampshire Program, North Conway, N.H.

Wagner, D.L., M.W. Nelson, and D.F. Schweitzer. 2003. Shrubland *Lepidoptera* of southern New England and southeastern New York: ecology, conservation and management. *For. Ecol. Manage*. 185(1-2): 95-112.

Old-Growth Forests

Davis, M.B. (ed.).1996. *Eastern Old-Growth Forests: Prospects for Rediscovery and Recovery*. Island Press, Washington, D.C. 400 p.

Luyssaert, S., E.Detlef Schulze, A. Borner, A. Knohl, D. Hessenmoller, B.E. Law, P. Ciais, and J. Grace. 2008. Old growth forests as global carbon sinks. *Nature* 455:213-215.

Massachusetts Dept. of Environmental Management. *Old Growth Policy*. Division of Forests and Parks, Bureau of Forestry. http://www.mass.gov/dcr/stewardship/forestry/docs/oldgrwpol.pdf Accessed March 8, 2010.

High-Elevation Forests

Coos County Unincorporated Places. 1991. Zoning Ordinances.

Foss, C.R. (ed.). 1994. *Atlas of Breeding Birds of New Hampshire*. Arcadia. Dover, N.H.

Freedman, B. 1995. *Environmental Ecology: the Ecological Effects of Pollution, Disturbance, and Other Stresses*. Academic Press, San Diego, Calif.

Lambert, J. D., K.P. McFarland, C.C. Rimmer, S.D. Faccio and J.L. Atwood. 2005. A practical model of Bicknell's thrush distribution in the northeastern United States. *The Wilson Bulletin* 117(1):1-11.

Kelly, J. R. 2005. *Recent distribution of American marten in New Hampshire, and potential factors impacting distribution and habitat*. Thesis, University of Massachusetts, Amherst, Mass.

N.H. Fish and Game Dept. 2006. *Fresh tracks indicate rare Canada lynx "just passing through" Jefferson, N.H.* http://www.wildlife.state.nh.us/Newsroom/News_2006/News_2006_Q1/Lynx_tracks_found_020106.htm. Accessed December 23, 2009.

USDI Fish and Wildlife Service. *The Canada Lynx*. http://library.fws.gov/Pubs/lynx.pdf. Accessed December 23, 2009.

Steep Slopes

Ochterski, J., 2004. *Best Management Practices During a Timber Harvest*. Cornell Cooperative Extension. http://www2.dnr.cornell.edu/ext/bmp/contents/during/dur_roads.htm. Accessed June 2, 2010.

Kittredge, D.B. Jr., and M. Parker. 1999. *Massachusetts Forestry Best Management Practices Manual*. Massachusetts Dept. of Environmental Protection and U.S. Environmental Protection Agency. 56 p.

New York State Dept. of Environmental Conservation. 2010. *Timber Harvesting Guidelines*. http://www.dec.ny.gov/lands/5240.html Accessed June 3, 2010.

Forest Products

Timber Products

N.H. Dept. of Revenue Administration Average Stumpage Prices. http://www.nh.gov/revenue/munc_prop/avgstumpval.htm Accessed June 3, 2010.

Davis, L.S., K. N. Johnson, and K.P. Davis. 1987. *Forest Management*. McGraw-Hill Book Company. 790 p.

Frank, R.M., and B.M. Blum. 1978. *The Selection System of Silviculture in Spruce-Fir Stands — Procedures, Early Results, and Comparisons with Unmanaged Stands*. USDA For. Serv. Res. Pap. NE-425. 20 p.

Hornbeck, J.W., and W.B. Leak. 1992. *Ecology and management of northern hardwood forests in New England*. USDA For. Serv. Gen. Tech. Rep. NE-159. 44 p.

Marquis, D.A. 1969. *Thinning in Young Northern Hardwoods: 5-Year Results*. USDA For. Serv. Res. Pap. NE-139. 22 p.

Moser, John W. Jr. 1989. Introduction to Forest Growth and Yield. In *Central Hardwood Notes*. USDA For. Serv. North Central Forest Experiment Station. Note 5.01.

Sampson, T.L. 1983. *A stocking guide for northern red oak in New England*. M. Sc. thesis, University of New Hampshire, Durham, N.H.

Solomon, D.S. 1977. *The Influence of Stand Density and Structure on Growth of Northern Hardwoods in New England*. USDA For. Serv. Res. Pap. NE-362. 13 p.

Solomon, D.S., D.A. Herman, and W.B. Leak. 1995. *Fiber 3.0: An Ecological Growth Model for Northeastern Forest Types*. USDA For. Serv. Gen. Tech. Rep. NE-204. 24 p.

Solomon, D. S., and W.B. Leak. Growth and stocking of eastern hemlock (*Tsuga canadensis*) in New England. P. 43-49 in proceedings of *Symposium on Sustainable Management of Hemlock Ecosystems in Eastern North America*, K.A. McManus, K.S.Shields, and D.R. Souto (eds.). USDA For. Serv. Gen. Tech. Rep. NE-267.

Steinman, J.R. 1992. *A comprehensive evaluation of spruce-fir growth and yield in Maine as related to physical and chemical soil properties*. Ph.D. thesis, University of Maine, Orono, Maine.

Ward, J.S. 2002. Crop Tree Release Increases Growth of Mature Red Oak Sawtimber. *North. J. Appl. For.* 19(4):149-154.

Glossary

Helms, John A. editor. 1998. *The Dictionary of Forestry*. The Society of American Foresters. Bethesda, Md. 210 p.

Matlack, G.R. and J.A. Litvaitis. 1999. Forest Edges. P. 210-233 in *Maintaining Biodiversity in Forest Ecosystems*, M.L.Hunter (ed.). Cambridge University Press, New York, N.Y.

Sperduto, D. D., and William Nichols. 2004. *Natural Communities of New Hampshire*. N.H. Natural Heritage Bureau, Concord, N.H. http://extension.unh.edu/resources/files/Resource000425_Rep447.pdf Accessed March 12, 2010.

References Used Throughout the Book

Helms, John A. editor. 1998. *The Dictionary of Forestry*. The Society of American Foresters. Bethesda, Md. 210 p.

N.H. Fish and Game Dept. *Species Occurring in New Hampshire (Residents and Visitors)*. http://www.wildlife.state.nh.us/Wildlife/Nongame/species_list.htm Accessed June 3, 2010.