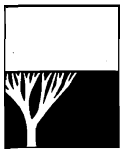
Good Forestry in the Granite State:

Recommended Voluntary* Forest Management Practices for New Hampshire

Presented by: The New Hampshire Forest Sustainability Standards Work Team

*Not all practices recommended in this manual are strictly voluntary; some are required by state law.

Published by:



The Society for the Protection of New Hampshire Forests
54 Portsmouth Street
Concord, New Hampshire 03301
(603) 224-9945

Printed at the Sant Bani Press, Tilton, New Hampshire

TABLE OF CONTENTS

Introduction

The purpose of this guide is to provide New Hampshire landowners, and the professionals that work with them, practical recommendations on sustainable management practices for individual forest ownerships.

Throughout New England, across the United States, and around the globe, the issue of how we sustain our forest resources is the subject of intense scientific inquiry and policy debate.

This complex subject is best defined by the single question: How can we produce the goods we desire today from the forest, without compromising the productive capability and biological integrity of the forest upon which future generations of people and wildlife depend?

Our society has long recognized trees as a renewable resource. Today, however, society increasingly understands the importance of sustaining forests — in all their complexity — but there exists little guidance for landowners as to what is, or is not, a sustainable practice.

Forest sustainability involves all resources and amenities provided by the forest: timber, water and scenery; trees, shrubs and herbaceous plants; soil bacteria, fungi and nutrients; wildlife and insects. It requires trade-offs and compromises among competing uses and the balancing of individual and societal needs, rights and responsibilities.

While this set of recommendations is new, commitment on the part of private landowners to a healthy forest is not. Landowners, both private and public, committed to stewardship have helped conserve and maintain a forest that covers over 80% of the state and provides benefits for all citizens. Public and private agencies have contributed to this forest resource by providing a wide array of technical assistance and expertise. This guide builds upon New Hampshire's long tradition of good forest management. It provides landowners, and the professionals that work with them, specific recommendations to help meet ownership objectives while conserving all values that the forest provides.

Forest sustainability is affected by "landscape" issues such as: population growth, conversion of forest land to urban uses, tax policy, acid rain, and other large-scale environmental threats. In order for landowners to implement the recommendations contained in this guide, they need to be able to afford to own and responsibly manage forest land. The state's Current Use program, which taxes land at its traditional use, must be maintained. Tax policy at both the state and national level needs to recognize the long-term investment that forest landowners enter into, and make it less costly for landowners to pass on forest land to their heirs. Markets for all forest products, especially low-grade wood, must be strengthened so that landowners can continue managing the forest in a responsible manner. While these issues cannot be ignored, this guide deals only with "operational" issues such as the prevention of soil erosion and protection of important habitats during timber harvesting.

Background

This guide was produced by 24 natural resource professionals (*the Forest Sustainability Standards Work Team, or FSSWT*), and hundreds of others who provided invaluable input through written comments or at public meetings. This effort came about because of a widely recognized need to develop a comprehensive guide to sustainable forest management in New Hampshire.

This work reinforces previous recommendations of the Forest Law Recodification and Revision Roundtable (1993 – 1995), which recommended that the Division of Forests & Lands coordinate an effort to produce a set of "recommended voluntary forest management practices"; and the Northern Forest Lands Council (1990 – 1994), which recommended that each state create a process to define credible benchmarks of sustainability.

The Forest Sustainability Standards Work Team continues to work on the difficult process of defining state-wide benchmarks of forest sustainability and setting landscape-level goals.

Two important principles guided the FSSWT in its development of this guide:

- These recommendations are intended for *voluntary use* and not as compulsory regulations. With the exception of a few recommendations that mirror state law, they represent options for landowners to consider in the management of their forests.
- These recommendations are based on the best available science, and the consensus professional judgment of the FSSWT. In certain areas, there remains both differences of opinion and scientific uncertainty.

Knowledge of sustainable forest management is evolving. For this reason, the guide is structured to allow the user to easily remove sections to use in the field and replace as new information becomes available. This format also allows landowners to select sections that are most relevant to their ownership. Future updates will be coordinated by the New Hampshire Division of Forests & Lands.

ACKNOWLEDGMENTS

Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire was created as a cooperative effort by the 24 members of the New Hampshire Forest Sustainability Standards Work Team, called together by then State Forester, Jack Sargent. Team members are listed below. Members with an (*) after their name were principal authors of the manual:

Phil Auger, University of New Hampshire Cooperative Extension

Philip Bryce, (Crown Vantage) New Hampshire Division of Forests & Lands

Chip Chapman, Consulting Forester*

J.B. Cullen, New Hampshire Division of Forests & Lands

Gary Donovan, Champion International Corporation*

Bob Eckert, University of New Hampshire Department of Natural Resources

Steve Fay, U.S. Forest Service*

Carol Foss, Audubon Society of New Hampshire*

Susan Francher, New Hampshire Division of Forests & Lands

Geoff Jones, Society for the Protection of New Hampshire Forests*

Eric Kingsley, New Hampshire Timberland Owners Association

John Lanier, New Hampshire Fish & Game Department

Bill Leak, U.S. Forest Service*

Don Merski, Mead Paper*

Tom Miner, New Hampshire Division of Forests & Lands

Frank Mitchell, University of New Hampshire Cooperative Extension*

Steve Morton, New Hampshire Timber Harvesting Council

Dave Publicover, Appalachian Mountain Club*

Mike Seeger, U.S. Forest Service*

Jamie Sayen, Northern Forest Forum

Tammara Van Ryn, Society for the Protection of New Hampshire Forests*

Scot Williamson, Wildlife Management Institute

Mariko Yamasaki, U.S. Forest Service*

Additional review was provided by Steve Weber, New Hampshire Fish & Game Department; Ken Desmarais, New Hampshire Division of Forests & Lands; and Bethlehem Tree Farmer David Tellman.

Project direction and coordination, senior editors:

- Susan Francher, New Hampshire Division of Forests & Lands
- Tammara Van Ryn, Society for the Protection of New Hampshire Forests

Preliminary editing and layout:

- Charles Niebling, Innovative Natural Resource Solutions
- Scot Williamson, Wildlife Management Institute

Production manager and designer:

- Rosemary Conroy, Society for the Protection of New Hampshire Forests

Illustrations:

- Inge Seaboyer

Project administration:

- Society for the Protection of New Hampshire Forests — Tammara Van Ryn
- New Hampshire Timberland Owners Association — Eric Kingsley
- New Hampshire Division of Forests & Lands — Susan Francher
- New Hampshire Fish & Game Department — John Lanier

This project made possible by the generous financial support from:

- The New Hampshire Charitable Foundation
- The Northern Forest Dialogue Project
- The American Forest & Paper Association
- The U.S. Environmental Protection Agency, Region 1
- The Granite State Division of the Society of American Foresters
- The William P. Wharton Trust

and by the contributions of hundreds of hours of time and materials from members of the work team, and the many individuals who commented on drafts of the manual. The work team is indebted to all those who contributed toward the publication of this manual.

PRINCIPLES OF SUSTAINABILITY

The following principles are adapted from the Northern Forest Lands Council Principles of Sustainability and the Society of American Foresters Task Force *Report on Sustaining Long-Term Forest Health and Productivity*. The headings are used for organizational purposes only, both sets of principles are interrelated and equally important.

Maintain the structural, functional, and compositional integrity of the forest as an ecosystem, through:

- Maintenance of soil productivity
- Conservation of water quality, wetlands, and riparian zones
- Maintenance or creation of a healthy balance of forest size classes
- Conservation and enhancement of habitats that support a full range of native flora and fauna
- Protection of unique or fragile natural areas

Meet the diverse needs of the human community, through:

- Continuous flow of timber, pulpwood, and other forest products
- Improvement of the overall quality of the timber resource as a foundation for more value added opportunities
- Addressing aesthetic impacts of forest harvesting
- Continuation of opportunities for traditional recreation

ABOUT THE MANUAL

Within each of the tabbed sections are chapters which correspond to specific aspects of forest management that are relevant to the principle(s) highlighted within that section. Each chapter contains an issue statement, objective, considerations, recommended practices, cross references to other chapters, and literature citations. At the beginning of each tabbed section, the reader will find a brief list of general information sources and references for further reading.

ISSUE

Each chapter begins with an *issue* description that provides background information on the topic of the chapter. Each description explains why a certain activity or natural feature is an item of concern, and why the topic is important to forest sustainability.

OBJECTIVE

The *objective* describes the desired outcome of sustainable forest management activities.

CONSIDERATIONS

Considerations are factors that can affect implementation of recommended practices. Considerations may describe legal issues that influence how practices are applied, or highlight areas where scientists have not come to complete agreement on an issue.

RECOMMENDED PRACTICES

These are on-the-ground steps that landowners, and the professionals that work with them, can take during forest management activities to achieve the principles of sustainability. These *recommended practices* are designed to meet the objective while factoring in the considerations. When site conditions make it difficult or impractical to implement the practices, managers should make sure the actions they take are consistent with the objective.

CROSS REFERENCE

Many aspects of sustainability are interrelated. *Cross references* lead the reader to additional information relevant to the issue.

LITERATURE CITED

A list of *literature cited* is given at the end of each section. These are the sources from which information for the chapter is drawn and which provide the scientific justification for the actions that are recommended.

GLOSSARY

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

APPENDICES

Several *appendices* provide additional detailed information.

FIRST STEPS IN FOREST MANAGEMENT

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

Owning forest land can be a financial investment as well as a way to leave a legacy of forest stewardship for the future. The key to protecting your investment and legacy is working with a team of professionals: foresters, loggers, other natural resource professionals; plus financial and legal advisors.

GETTING STARTED

New Hampshire has a well established network of public and private organizations to help guide private forest landowners. The most sensible first step for landowners is to learn as much as possible about their forest and to establish appropriate goals for managing it. County based foresters employed by the UNH Cooperative Extension (*see Appendix A*) can get landowners started by providing objective educational forest management assistance.

Private consulting foresters provide detailed planning, inventory, and timber sale assistance to private landowners for a fee. These foresters are licensed by the State of New Hampshire. Cooperative Extension Offices can provide a list of licensed foresters. Other natural resource professionals (wetland scientists, wildlife biologists) can help identify special habitats and design management options to protect these resources.

The public and private agencies and organizations listed in Appendix A provide printed materials and educational courses on a wide variety of forest management and related issues.

PLANNING PAYS DIVIDENDS

Goals and Objectives

An important component of planning is setting clear short- and long-term goals and objectives. These must be realistic and based on the forest's current condition and its potential capability. Goals and objectives can include:

- protection of water resources
- protection and/or enhancement of wildlife habitat
- protection of native plants and animals
- periodic income
- timber production
- recreational development
- maintenance or enhancement of scenery and aesthetics

Information and Inventory

Good management requires an understanding of what resources are on your property. Knowing as much as possible about the property and its history can save time and money in developing and implementing a management plan. It is also important to consider a piece of land in relation to its surroundings *(see page 13)*.

Start with a property map. Work with a professional to develop a forest type map of the property *(see forest type descriptions on page 15)*. Identify and mark property boundaries. Also, inventory or map:

- soil types
- riparian corridors and wetlands
- wildlife habitat features
- unique or fragile areas

  timber volume and species
- forest roads and transportation systems
- scenic, recreational, and cultural features

Management Plans

A management plan outlines how and when to reach goals and objectives for a specific piece of property. 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 forest management plan prepared by a licensed forester. The more care and preparation taken before timber harvesting begins, the better the results will be.

TIMBER HARVESTING

Timber harvests have more impact, positive or negative, on the current and future condition of New Hampshire's forests than most other actions taken by landowners during their ownership. Experience and research here and in other states clearly demonstrates that professional forestry advice and supervision during timber harvests makes a difference. Carefully prepared and supervised timber harvests often return greater income and meet goals more satisfactorily.

Professional foresters can plan roads and trails, identify wildlife features and protection mechanisms, plan for regeneration, and restore the site when the harvest is over. A written contract is an important tool to make sure the harvest goes as planned. The contract should clearly identify which parties have responsibility for the cost and implementation of any of the recommended practices in this guide. In addition, be cautious of the potential liability that can result from the unintentional development of employer–employee relationships.

Licensed foresters are available to plan and supervise timber harvests. Their services typically involve designing the timber sale, marking trees to be cut, estimating harvest volumes in advance, contracting with logging professionals, supervising harvesting, and marketing wood products.

Certified professional loggers are available to implement management plans. These individuals have participated in the four-course voluntary certification program offered by the New Hampshire Professional Loggers Program. Certified loggers are required to take courses in first aid, safe and productive felling, fundamentals of forestry, and timber-harvesting law.

Lists of licensed foresters and certified professional loggers, and information on logging contracts, can be obtained from county extension foresters (Appendix A).

ADDITIONAL STEPS: ESTATE PLANNING AND CONSERVATION EASEMENTS

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. Contact your legal advisors and a local land trust to find out more about estate planning and land protection options.

YOUR LAND AND THE LARGER LANDSCAPE

Forest ownerships do not exist in isolation, but are part of the larger landscape. The goals of a forest landowner, and the opportunity to achieve those goals, may be significantly affected by the nature of the surrounding lands. (Consider, for example, the difference between two similar tracts, one adjacent to the White Mountain National Forest and the other surrounded by subdivisions on the outskirts of Manchester.) Conversely, a landowner's actions can affect values throughout the surrounding landscape. When setting management goals, landowners should keep in mind not only the nature of their own tract but also the condition and management of surrounding ownerships. The possibilities and constraints imposed by the larger landscape are particularly significant for small ownerships.

This "landscape perspective" is especially important when considering options for wildlife-habitat management. A wide range of forest types and age classes is necessary to meet the habitat needs of different species. Most wildlife species require different habitats during different parts of the year or during different stages of their life cycle. Many large landowners (such as the National Forest and some industrial owners) manage wildlife habitat in units of 5,000 – 10,000 acres. However, few non-industrial forest landowners own sufficient acreage to fully meet all the habitat needs of many species of wildlife. Owners should examine their land within the larger context to identify what habitats are important to the larger surrounding area, and to determine the habitat management opportunities that may be effective and reasonable to pursue within their ownership. The benefits of managing for wildlife on smaller tracts may only be realized if this management complements conditions and management on neighboring lands (*DeGraaf et al. 1992*).

Among the things landowners should consider when examining the landscape on and around their property are:

- In what ways is my land similar to the surrounding landscape and in what ways is it different?
- What is the mix of land uses around my property (forest, residential, agriculture, recreation, developed)?
- Who owns the land around my property and how large are the parcels?
- What uncommon or important habitats (such as ponds, wetlands, meadows, fields, or other features described in this publication) are present on my land that may be used by species from the surrounding area?
- Are there important habitats (such as deer yards or riparian areas) that extend onto adjacent ownerships?
- Are there any uncommon or rare species or natural communities on my property?

Landscape management can range from the simple (examining maps or photos to see what lies around your property) to the complex (multi-owner management cooperatives). One way to get a better understanding of the larger landscape is to talk to neighboring landowners. A joint woods tour (perhaps in the company of a county extension forester) can give all parties a sense of the array of conditions in the neighborhood, as well as promoting discussion of the goals of different owners and opportunities for coordinated management.

Management that encompasses a larger landscape can have economic benefits as well, such as the design of more efficient transportation systems. The cost and impact of roads may be lessened if they are designed for a larger area rather than individual ownerships. Other benefits may be possible by coordinating management and operations. Planning costs (such as mapping and inventory) may be reduced if spread across a larger land base. Receipts from timber sales may be increased if management costs are shared and timber products are combined for greater marketability. Fully realizing these benefits requires formal cooperation between neighboring landowners. Legal aspects need to be considered when setting up this type of arrangement. Such multi-owner cooperatives are not yet common in New Hampshire, but have been formed in the southeastern United States (*Johnson et al. 1996*). However, even without such formal arrangements, a sense of the "big picture" can greatly help landowners determine realistic management goals for their properties.

LITERATURE CITED

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and J.W. Lanier. 1992. *New England Wildlife: Management of Forested Habitats*. USDA Forest Service General Technical Report 144, Radnor, PA. 271 pp.

Johnson, J.E., G.E. Scheerer, G.M. Hopper, J.A. Parkhurst, M. King, J.C. Bliss, and K.M. Flynn. 1996. *Managed Forests for Healthy Ecosystems*. Agricultural Extension Service, University of Tennessee, Bulletin PB 1574, Knoxville, TN. 39 pp.

NEW HAMPSHIRE FOREST TYPES

Forest types are distinctive associations or communities of trees, shrubs, and herbaceous plants. They are named for the predominant tree species occurring in the type. Common forest types in New Hampshire include 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 will grow on a particular area. Forest type, in turn, influences the variety of wildlife that will inhabit an area and the silvicultural options available to the landowner.

A forest type may be dominated by a single tree species or it may be dominated by several species growing together. White Pine often occurs as a pure (single species) type. Northern Hardwood, which is composed of sugar maple, beech, yellow birch and smaller amounts of other species, is an example of a multiple species type.

In some areas two types blend together to form a Mixed-wood type. Mixed-wood types often occur in transition zones between major types. Two common mixed types are the Pine–Oak and Spruce–Fir–Northern Hardwood combinations.

Brief descriptions of the common forest types follow. Information on other less common forest types may be found in Chapter 4.1, Rare Plants and Natural Communities.

White Pine

This type is most common in southern New Hampshire. White pine may occur in pure stands or be mixed with red pine, hemlock, red oak and/or other hardwoods.

White pine often colonizes abandoned agricultural land. On fertile sites the type is gradually replaced by hardwood or hemlock through a process known as ecological 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 on the forest floor. Wildlife species associated with the type include the red squirrel, deer mouse, pine warbler, and red-breasted nuthatch. Owls often use the type for winter roost sites.

Timber products derived from white pine include lumber for furniture, toys, millwork and crates, and pulpwood.

Perhaps the most important sustainability issue facing this type is the conversion of forest land to urban uses. Because white pine occurs primarily in southern New Hampshire at the urban-rural interface, it is under intense development pressure. 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.

Northern Hardwood

This type is most common in central and northern New Hampshire. It is usually composed of a mix of trees, including: sugar maple, beech, and yellow birch, red maple, and white ash. Sugar maple is typically the most abundant species on rich sites. Beech increases in abundance on drier sites and yellow birch becomes more prominent on moist sites. Northern hardwoods typically grow on the slopes of hills and mountains where the soils are fertile and well-drained.

Northern hardwood tends to be a relatively stable and permanent type. Sugar maple and beech are shade-tolerant trees which can reproduce and grow in the shade of a forest canopy. Yellow birch and white ash are somewhat less tolerant of shade and require more sunlight to reproduce and grow.

Common understory shrubs include striped maple, witch hazel, and hobblebush. Wildlife species associated with the type include the gray fox, flying squirrel, red-eyed vireo, white-breasted nuthatch, and ovenbird.

Products derived from the this type include lumber and veneer for furniture, paneling and doors, pulpwood, firewood, and maple syrup.

An important sustainability issue is the extent to which high-grading has occurred within the type. High-grading is a type of logging in which the best trees are cut and poor quality trees are left to grow. Over time, a forest that is repeatedly high-graded will become dominated by low quality, low value trees.

Spruce–Fir

This type is most common in northern New Hampshire. Red spruce and balsam fir are the dominant species. The type grows on poorly drained flats and the shallow, rocky soils of mountain tops.

Because the spruce–fir type grows on wet or shallow soils, the trees are susceptible to windthrow. Additional disturbances in spruce–fir include the spruce budworm, a native insect which can impact vast areas during its periodic outbreaks, and heart rot fungi which affect overmature balsam fir.

Bunchberry, goldthread, and trilliums are common wildflowers in this type. Wildlife species associated with the type include the pine marten, snowshoe hare, spruce grouse, gray jay, black-backed woodpecker, and ruby-crowned kinglet.

Timber products include framing lumber and wood pulp for newsprint and high-quality printing and writing papers.

An important sustainability issue concerns the forest-age class structure within the spruce–fir type. Due to the cyclical nature of spruce budworm outbreaks and historic cutting patterns, the type tends to grow in a boom-bust cycle. The budworm epidemic of the 1970s and the heavy salvage cutting that followed have resulted in a relative shortage of mature and middle-aged stands. This boom and bust cycle has important implications for both regional timber supply and wildlife habitat management.

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 often 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 is a valuable tree for both timber and wildlife. Red oak lumber and veneer are used to manufacture high-quality furniture. Acorns provide a valuable food source for deer, turkey, gray squirrel, and many other species of wildlife. Blue jays, tufted titmice, scarlet tanagers, and rufous-sided towhees are some of the birds that commonly nest in red oak and pine–oak stands.

As with white pine, land use conversion may be the most important sustainability issue facing this type.

Hemlock

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

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

Timber products include pulpwood, construction lumber, and bark for landscaping mulch.

The hemlock woolly adelgid, a recently introduced insect, poses a serious threat to the hemlock type. While this insect has not yet reached New Hampshire, it is of grave concern to natural resource managers. Insects and diseases brought into our region from other parts of the world can be particularly devastating to native plants and animals. To help prevent the spread of the hemlock adelgid, there are restrictions on the importation of hemlock logs from infested areas such as southern New England.

Aspen–Birch

Aspen–birch is a pioneer type which is relatively uncommon in New Hampshire. The type is composed primarily of quaking and bigtooth aspen and white birch. It occurs on a wide variety of soils.

Aspen and white birch require full sunlight to grow, and rely on disturbances such as fire, windstorms, or clearcutting to create the conditions necessary for their reproduction.

Common associates in young aspen-birch stands are raspberries and blackberries. Aspen–birch provides valuable habitat for several species of wildlife including ruffed grouse, woodcock, Nashville warbler, mourning warbler, and beaver.

Timber products include veneer used in the interior of doors, dowels, toothpicks, chip board, and pulpwood.

An important sustainability issue is that this type is becoming less common as abandoned agricultural land and large-scale burned areas develop into mature forest communities. Additional information about this topic may be found in Chapter 3.4, Aspen Management.

Section One

Soil Productivity

Additional Reading:

Introduction to Forest Ecology and Silviculture
Thom J. McEvoy
University of Vermont
School of Natural Resources and Extension System
1995

Best Management Practices for Erosion Control
on Timber Harvesting Operations in New Hampshire
New Hampshire Department of Resources & Economic Development
1996 (Provided in Appendix C)

1.1 EROSION AND SOIL DAMAGE

ISSUE

Erosion and soil damage may diminish soil productivity.

Soil erosion may result from roads, skid trails and landings; and includes not only soil loss from these areas but also slumping and landslides adjacent to poorly designed roads on steeper slopes. Application of *Best Management Practices for Erosion Control (Appendix C)* can greatly reduce these impacts.

Soil damage can occur from timber harvesting by disrupting topsoil, mixing soil layers, creating deep ruts, and compacting soil layers. Half the feeder roots in a forest are found in the top six inches of soil. Roots need both air and water to supply the rest of the tree. Activities that compact the soil, eliminating space for air and water, will lower the productivity of the site. Much of this damage comes from heavy equipment. Machinery used outside the permanent transportation system (roads, landings, and skid trails) may excessively disturb the soil and reduce site productivity (*Turcotte et al. 1991, Mou et al. 1993*).

Repeated passes of heavy equipment over certain types of soil, especially during wet conditions, can compact soil air spaces, impeding root growth and allowing the entry of root diseases such as Armillaria root rot fungus (*Turcotte et al. 1991, Martin 1988*). To some extent, natural soil processes (such as freeze/thaw cycles and activities of soil organisms) help restore compacted soils to near pre-harvest conditions. The rate of recovery is dependent upon soil type, soil depth, and degree of compaction (*Reisinger et al. 1992*).

Of particular concern are soils that have low fertility; have a high silt, clay, or organic matter content; or are shallow to bedrock. These soils may either be more subject to excessive disturbance or have most of the fine roots very near the surface where they may be easily damaged.

OBJECTIVE

Maintain the long-term productivity of the forest by minimizing erosion and soil damage.

CONSIDERATIONS

- Roads, skid trails, and landings are a necessary part of timber management. Some localized soil erosion and short-term compaction is unavoidable.
- Leaving roads open for recreational use may make it more difficult to install permanent erosion-control measures.
- Exposure of mineral soil is sometimes important to promote regeneration of certain species (such as white pine).

RECOMMENDED PRACTICES

- ✓ Apply *Best Management Practices for Erosion Control* in all harvesting operations *(Appendix C)*.
- ✓ Contact the local Natural Resources Conservation Service (NRCS) office for soil maps and advice on which soils in the harvest area may be susceptible to erosion or compaction *(see Appendix A)*.
- ✓ Work with professionals to design roads, skid trails, and landings for the entire ownership (or a logical portion of it) in advance of the harvest. Build only what you need and can maintain properly.
- ✓ Minimize damage to areas that NRCS describes as susceptible to erosion or compaction by:

  - harvesting during dry, snow-covered, or frozen ground conditions.
  - restricting equipment use to permanently designated skid trails.
  - using equipment that is suited to the site and the size of material being harvested.
  - using low-impact equipment such as mechanical harvesters with long booms or low ground pressure skidders.
  - spreading limbs and tops on skid trails to cushion the impact of harvesting equipment *(see illustration)*.

- ✓ Promote rapid revegetation of heavily impacted areas by grading already exposed areas and seeding with a recommended conservation mix *(see Appendix C, Best Management Practices for Erosion Control)*.

CROSS REFERENCE

Soil Nutrients 1.2; Wetlands and Riparian Areas 2.1; Water Quality 2.2; High Elevation Forests 4.9; Truck Roads and Skid Trails 6.2; Landings 6.3.

LITERATURE CITED

Martin, C. 1988. "Soil Disturbance by Logging in New England — Review and Management Recommendations." *Northern Journal of Applied Forestry* 5:30-34.

Mou, P., T. Fahey, and J. Hughes. 1993. "Effects of Soil Disturbance on Vegetation Recovery and Nutrient Accumulation Following Whole-Tree Harvest of Northern Hardwood Ecosystem." *Northern Journal of Applied Ecology* 30: 661-675.

Reisinger, T., P. Pope, and S. Hammond. 1992. "Natural Recovery of Compacted Soils in an Upland Hardwood Forest in Indiana." *Northern Journal of Applied Forestry* 9:138-141.

Turcotte, D., S. Smith, and C. Federer. 1991. "Soils Disturbance Following Whole-Tree Harvesting in North-Central Maine." *Northern Journal of Applied Forestry* 8: 68-72.

1.2 SOIL NUTRIENTS

ISSUE **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 four main ingredients — mineral particles, organic matter, water, and air. Soil productivity is influenced by levels of nutrients. Of the 20 elements that are required for plant growth, five are taken up from the soil in relatively large quantities — nitrogen, phosphorus, potassium, magnesium, and calcium. Levels of these and other soil nutrients are determined mostly by the type of minerals from which the soil is derived. For example, limestone-derived soils tend to be more fertile, while soils derived from granite tend to be less fertile. Because there are few practical, economically feasible means of increasing soil productivity (*Beattie et al. 1993*), maintaining existing soil nutrients is important.

Acid deposition, including acid rain and other forms of air pollution, has caused leaching of certain soil nutrients, especially calcium (*Likens 1996*). These losses may equal or exceed losses from timber harvesting over the length of the rotation (*Hornbeck et al. 1990, Pierce et al. 1993*). Because of the potential for this loss, it is important that forest managers avoid exacerbating the nutrient depletion problem during timber harvesting.

Nutrient loss from timber harvesting is affected by what portion of a tree is taken, the harvest method, and the regularity with which a stand is treated. The more frequently a stand is harvested and the more fiber removed over a rotation, the greater the amount of nutrients taken. Whole-tree harvesting removes more nutrients than conventional bole-only harvests because the tops and limbs are a significant reservoir for many nutrients. In general, whole-tree harvests by the clearcut method on short rotations (e.g. 40 years) will have the greatest nutrient impacts on the soil.

Leaching of nutrients from the soil contributes to nutrient loss. Exposing soil can result in small amounts of harvest-induced leaching. Soil type and the percentage of the watershed that is harvested can influence the amount of leaching. Prompt re-vegetation of the site can minimize losses.

The greatest concern arises when the more intense practices are routinely applied over time on sites already low in nutrients. Sites that are low in nutrients include: coarse-textured sands, soils shallow to ledge, and soils with high seasonal water tables.

OBJECTIVE **Maintain the long-term soil productivity of the forest by minimizing loss of soil nutrients.**

CONSIDERATIONS

- The impacts of changes in soil nutrients over time are not well-known in New Hampshire. For instance:
  - There is little firm evidence to indicate changes in forest growth or species composition from past changes in soil nutrients. However, this issue is the subject of considerable ongoing research.
  - It is also unclear what role weathering of rock plays in replacing nutrients.
- Spreading of sludge (bio-solids derived from municipal solid-waste treatment), and commercial land application of wood ash are becoming more common sources of soil nutrient additives. At this time, there are no best management practices developed for the application of sludge. However, application of sludge is governed by state and federal law and may be limited by local regulation.

RECOMMENDED PRACTICES

- ✓ Identify low fertility soils from maps and descriptions available from the local Natural Resources Conservation Service office or the state geologist's office (*see Appendix A*).
- ✓ Use bole-only harvesting (taking out the main portion of tree only, leaving branches and limbs in the woods) on low-fertility soils, or where fertility is unknown, as a precaution against nutrient loss.
- ✓ If whole-tree harvesting hardwoods, try to plan harvests during leaf-off periods to retain leaves and nutrients on site.
- ✓ 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).

CROSS REFERENCE

Erosion and Soil Damage 1.1.

LITERATURE CITED

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

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." *Forest Ecology & Management* 30: 55-64.

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: 244-246.

Pierce, R.S. et al. 1993. *Whole-tree Clearcutting in New England: Manager's Guide to Impacts on Soils, Streams, and Regeneration.* U.S.D.A. Forest Service General Technical Report NE-172, Radnor, PA. 271 pp.

McEvoy, Thom. 1995. *Introduction to Forest Ecology and Silviculture.* University of Vermont. 75 pp.

Section Two

Water Quality, Wetlands and Riparian Areas

Additional Reading:

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

New England Wildlife: Management of Forested Habitats
Richard DeGraaf, Mariko Yamasaki, William Leak, and John Lanier
General Technical Report 144
USDA Forest Service Northeastern Forest Experiment Station
1992

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 Hunter
Prentice-Hall
1990

Best Management Practices for Erosion Control
on Timber Harvesting Operations in New Hampshire
New Hampshire Department of Resources & Economic Development
1996 (Provided in Appendix C)

2.1 WETLANDS AND RIPARIAN AREAS

ISSUE **Wetlands and riparian areas are ecologically important and should receive special management consideration in order to protect water quality, wildlife habitat, and scenic values.**

Wetlands and riparian areas (i.e., areas along the shores of streams and ponds) are among the most critical parts of any forest ecosystem (*Hunter 1990*). Forest management within these areas has the potential to affect more animal species than anywhere else in the landscape (*DeGraaf et al. 1992*). Wetlands and riparian areas have a long history of use and alteration by humans, including urbanization, road-building, agriculture, draining, dam-building, and timber harvesting. The combined pressures on these areas underscore the importance of properly managing those that are not yet heavily impacted and restoring those that are currently degraded.

The importance of wetlands and riparian areas is reflected in the fact that the State of New Hampshire regulates forest practices in these areas (for example, RSA 482-A, wetlands regulations and RSA 227-J, basal area and slash disposal laws.) Guidelines for conducting forest management operations around streams and wetlands (known as *Best Management Practices for Erosion Control* or BMPs) have been available since 1972 (*Cullen 1996, Appendix C*). These laws and guidelines are designed primarily to protect water quality and are generally adequate for that purpose. However, they were not designed to protect the full range of ecological values associated with wetlands and riparian areas. Management of these areas should take a comprehensive approach that gives a high priority to both protection of water quality and conservation of wildlife habitat.

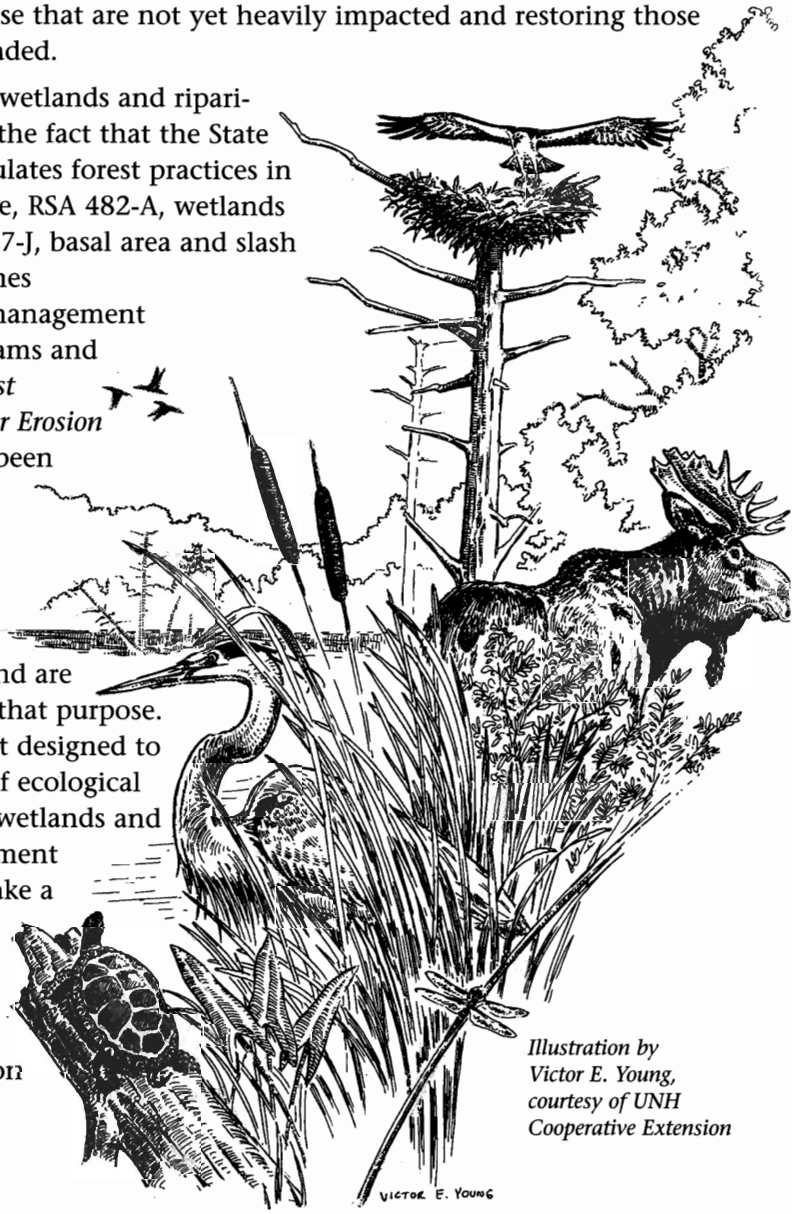


Illustration by Victor E. Young, courtesy of UNH Cooperative Extension

Designing Riparian Management Zones

Riparian management zones are designated linear zones along the shores of lakes, ponds, rivers, streams, and wetlands. They are intended to retain relatively continuous forest cover for the protection and maintenance of water quality, wildlife habitat, and scenic values.

It is difficult to arrive at any universal width to define these zones. Each riparian area has a unique combination of features that determine the appropriate size. A riparian area as used by wildlife might vary considerably in width at different points along a river. Water-body size, location, slope, elevation, soil, vegetation, and the nature of the activity outside the riparian area all affect how a riparian management zone should be designed.

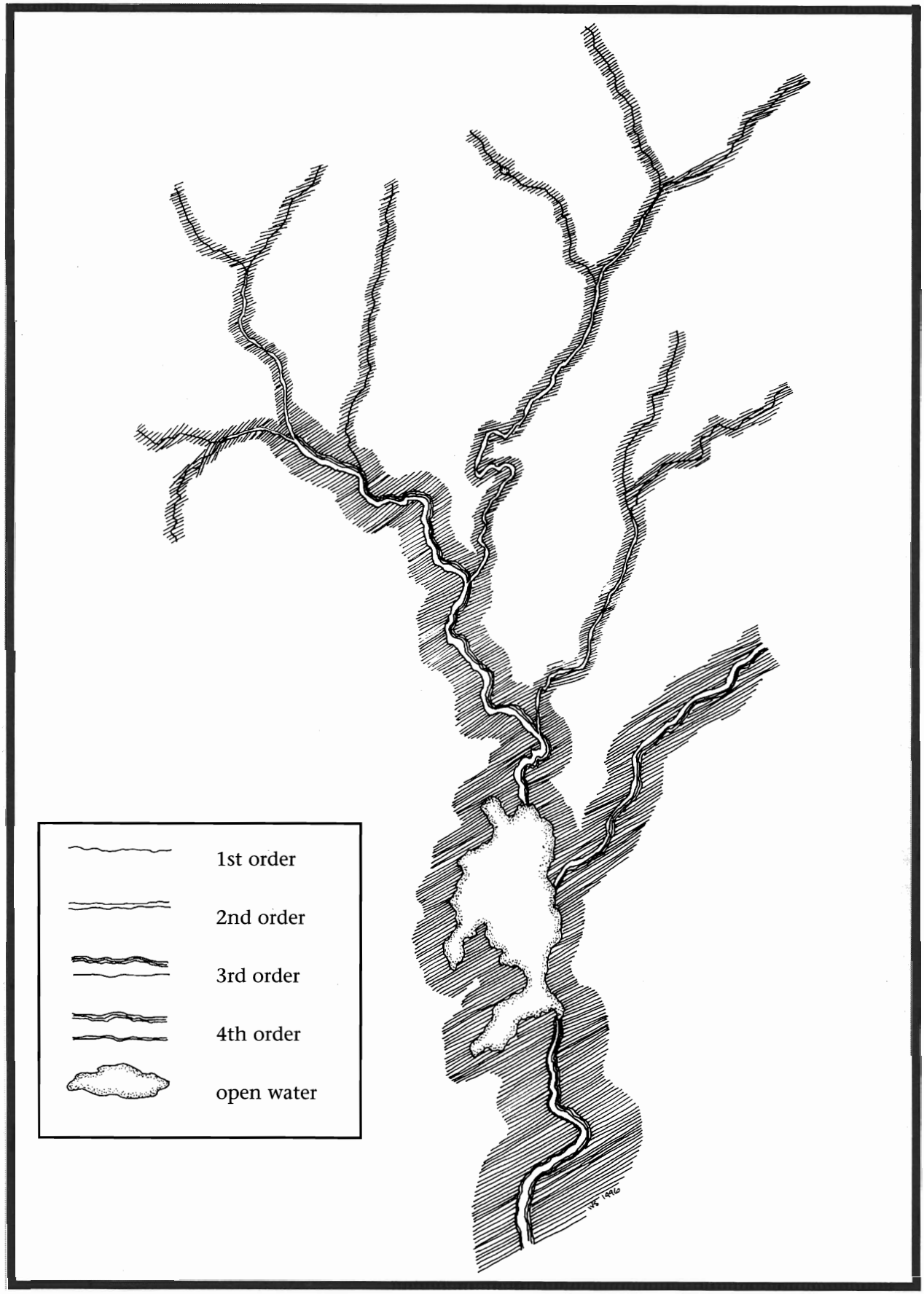
The following general guidelines should be considered when designing riparian management zones:

- The larger the water body, the larger the management zone should be.
- The more intense the land use outside of the management zone, the larger it should be.
- The management zone should be large enough to encompass all vegetative communities subject to flooding, ecologically or visually sensitive zones, and steep slopes or easily-erodible soils adjacent to the water body.

The following recommended widths are provided as general guidelines and should provide adequate protection for most water quality, habitat protection, and scenic objectives. The minimum recommended width for protection of water quality is 100 feet on both sides of a stream (*Chase et al. 1995*). Wider zones are designed primarily to address wildlife habitat or aesthetic concerns. Increasing the width of the no-harvest zone will provide greater protection to non-timber values within riparian areas.

	——Legally required[1]——		——Recommended[2]——	
	Management Zone	No-harvest Zone[3]	Management Zone	No-harvest Zone[3]
Feature (*see illustration, right*):				
Intermittent streams	none	none	100 ft.	none
1st and 2nd order streams	50 ft.	none	100 ft.	none
3rd order streams [4]	50 ft.	none	300 ft.	25 ft.
4th order and larger streams [4]	150 ft.	none	600 ft.	25 ft.
Pond <10 acres	50 ft.	none	100 ft.	none
Great pond (>10 acres)	150 ft.	none	300 ft.	25 ft.
Non-forested wetland <10 acres	none	none	100 ft.	none
Non-forested wetland >10 acres	none	none	300 ft.	25 ft.

[1] Width required under RSA 227-J:9 (basal area law). No more than 50% of the basal area may be removed in these areas.
[2] See Small and Johnson 1985, Jones et al. 1988, Elliott 1988, Elliott 1994, Meiklejohn 1994, Chase et al. 1995, CIC 1995, Peterson and Kimball 1995, Spackman and Hughes (in press).
[3] Portion of the management area directly adjacent to the water body in which no cutting should take place. It may be desirable to expand this in some areas, such as those with unstable soils or rare plant communities.
[4] A list of third-order and higher streams in New Hampshire is included as Appendix B.



The Values of Wetlands and Riparian Areas

Wetlands and riparian areas provide many benefits within a landscape *(Hunter 1990, BAG 1993, Peterson and Kimball 1995)*. These include:

- Protection of water quality through prevention of bank erosion and filtering of sediment and pollutants from upslope areas.
- Flood control and regulation of stream flow through the dispersal, absorption and slow release of floodwaters.
- Groundwater recharge.
- Protection and enhancement of aquatic habitat through shading of streams, creation of structure through input of fallen trees, and input of energy in the form of leaves, twigs, fruit and insects (This is especially important on headwater streams and small rivers).
- Wildlife travel corridors for both mammals and migratory birds, especially along larger rivers.
- Unique and diverse habitats.
- Riparian areas and wetlands are utilized by over 90% of the region's wildlife species and provide the preferred habitat for over 40% of these species (*DeGraaf et al. 1992*). Species such as loon or ducks use primarily open water, but may be affected by management in riparian forests.
- Large trees in these areas are the primary nesting sites for bald eagles, osprey, and some aquatic birds. Deer-wintering areas are often associated with riparian softwood forests. Many of the state's rare plants are associated with wetlands and streamside forests.
- Recreational and scenic opportunities, such as hiking, fishing, hunting, boating, bird-watching, and wildlife viewing.

Identifying Wetlands and Riparian Areas

There are many types of wetlands and many ways to define them ecologically based on vegetation, soils, or hydrology. They may be either forested (such as red maple swamps or cedar bogs) or non-forested (such as sedge meadows, alder thickets, or sphagnum bogs). They include small or ephemeral areas such as seeps and vernal pools (*see 4.2 and 4.3*). However, all are characterized by having saturated soil for at least part of the year, and all support vegetation adapted to wet conditions. *Best Management Practices for Erosion Control* includes a guide to wetland identification (*Appendix C*).

Riparian areas are generally defined as areas that influence, or are influenced by, aquatic ecosystems (such as lakes, rivers, streams, ponds, and tidal areas). Riparian areas may be defined on the basis of characteristic vegetation, which can vary from a narrow band of shrubs along small rivers or lake shores to floodplain forests hundreds of yards wide along large rivers.

They may also be defined by the function they serve, such as filtering erosion from upslope areas or providing shade to a stream. In these cases the size of the riparian area depends on what function is being considered, and may include upland forest as well as truly riparian communities.

The width needed to provide shade to a stream may be one tree height or less, whereas riparian wildlife habitat may extend several hundred feet into upland forests adjacent to a large river or lake (*Jones et al. 1988, Elliot 1988, 1994, Meiklejohn 1994, Chase et al. 1995, Spackman and Hughes in press*).

OBJECTIVE

Maintain the following important functions of aquatic ecosystems, wetlands and forested riparian areas:

- protection of water quality
- flood control
- groundwater recharge
- aquatic and terrestrial wildlife habitat
- recreational and scenic opportunities

CONSIDERATIONS

- Wetland permits or other legal requirements often apply to forestry operations in these areas.
- The integrity of aquatic, wetland, and riparian ecosystems may be affected by activities of other landowners throughout the watershed.
- Riparian forests may be highly productive; limiting harvesting will entail some economic loss to riparian landowners.
- Riparian zones may serve multiple habitat functions which can include the location of old-growth areas or extended rotation forest types.
- Identification of forested wetland boundaries may be difficult without specialized training.
- Identification and layout of larger riparian areas, or areas in complex landscapes with numerous streams and wetlands, may be difficult and time-consuming, but detailed boundary delineation may not be necessary for many management purposes.
- Riparian forests may be more prone to natural disturbance than upland areas, and natural events may override even the most careful management efforts.

RECOMMENDED PRACTICES

✓ Survey the immediate watershed in which the harvest will occur (ideally in early spring) and identify important hydrologic features such as streams, ponds, wetlands, seeps, and vernal pools. Consult a forester or other qualified professional for help with identification of wetlands, if necessary.

✓ Establish riparian-management zones along streams, rivers, ponds, tidal areas, lakes, and non-forested wetlands (*see page 28*). These are not necessarily intended to be no-harvest zones. In most areas the goal is to maintain a windfirm structurally stable forest that protects surface and groundwater quality, provides shade, coarse woody debris, and leaf litter to aquatic ecosystems, maintains wildlife habitat and travel corridors, and protects the scenic quality of river and lake shores.

- ✓ Locate new truck roads and log landings outside of riparian management zones wherever possible, except where doing so would result in greater overall impact. Design roads and skid trails within riparian management zones to minimize the total long-term impact on both water quality and wildlife habitat.
- ✓ Apply the following guidelines within riparian management zones and forested wetlands:
  - Manage using an uneven-aged system through single tree or small group selection cuts. The residual stand should be maintained with 70% crown closure or full stocking as recommended in silvicultural guides.
  - Within larger management zones (wider than 100 feet), the 25 feet closest to the stream, pond or wetland should be left unharvested. This will provide increased protection to aquatic habitats and allow a reliable long-term supply of cavity trees, snags, and downed woody material. Land owners and managers desiring greater protection of non-timber values should consider wider no-harvest zones, especially along larger rivers.
- ✓ Trees with cavities, standing dead trees, downed logs, and large supra-canopy trees (especially white pine) should be retained during harvest operations to the greatest extent possible.
- ✓ Avoid leaving isolated riparian management zones with long distances of abrupt edge. Riparian forests next to clearcuts may be subject to increased edge effect 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 the clearcut.

CROSS REFERENCE

Erosion and Soil Damage 1.1; Beaver-Created Openings 3.3; Deer Wintering Areas 3.5; Rare Plants and Natural Communities 4.1; Vernal Pools 4.2; Seeps 4.3; Heron Colonies 4.5; Bald Eagle and Osprey Nests 4.6; Bald Eagle Winter Roosts 4.7.

LITERATURE CITED

Ammann, A.P. and A. Lindley Stone. 1991. *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire.* NHDES-WRD-1991-3. New Hampshire Department of Environmental Services, Concord, NH.

Biologist's Advisory Group. 1993. *Draft Guidelines for the Management of Riparian Zones.* Unpublished report prepared for the New Hampshire Forest Law Recodification Roundtable.

Champion International Corporation. 1995. *Riparian Team Protection Recommendations (4th draft).*

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, NH. 80 pp.

Cullen, J.B. 1996. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire (2nd ed.).* New Hampshire Department of Resources & Economic Development, Division of Forests & Lands, Concord, NH.

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and J.W. Lanier. 1992. *New England Wildlife: Management of Forested Habitats.* USDA Forest Service General Technical Report 144, Radnor, PA. 271 pp.

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

Elliott, C.A. 1994. "Managing Riparian Habitat for Songbirds, Raptors and Small Mammals." Pages 71-82 in: *Proceeding of the Symposium on Riparian Zone Management.*, Canadian Forest Service R&D Report No. 9, Fredericton, New Brunswick.

Golet, F.C., A.J.K. Calhoun, W.R. DeRagon, D.J. Lowry, and A.J. Gold. 1993. *Ecology of Red Maple Swamps in the Glaciated Northeast: A Community Profile.* USDI Fish & Wildlife Service Biological Report 12, Washington, DC.

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

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 Department of Inland Fisheries & Wildlife, Augusta, ME.

Meiklejohn, B.A. 1994. *The Value of Buffer Strips as Riparian Habitat in Northern Forests.* M.S. Project, University of Vermont, Burlington, VT.

Miller, R., F. Mitchell, and L. Ryder. 1994. *A Study Guide to New England's Freshwater Wetlands (2nd ed.).* New Hampshire Department of Fish & Game and University of New Hampshire Cooperative Extension.

New Hampshire Department of Environmental Services. 1990. *Reporting and Remediation of Oil Discharges.* New Hampshire Code of Administrative Rules Env-Es *412*, NHDES, Concord, NH.

Peterson, S.C. and K.D. Kimball. 1995. *A Citizen's Guide to Conserving Riparian Forests.* River Network, Portland, OR. 82 pp.

Small, M.F. and W.N. Johnson. 1985. "Wildlife Management in Riparian Forests." Pages 69-80 in: *Proceedings of the Symposium: Is Good Forestry Good Wildlife Management?* Maine Agricultural Experiment Station Miscellaneous Publication No. 689, Orono, ME.

Society for the Protection of New Hampshire Forests. 1995. *A Guide to the Forestry Laws of New Hampshire.* SPNHF, Concord, NH.

Spackman, S.C. and J.W. Hughes. "Assessment of Minimum Stream Corridor Width for Biological Richness." *Biological Conservation* (in press).

Terrell, C. and P. Bytnar Perfetti. 1989. *Water Quality Indicators Guide.* USDA Soil Conservation Service SCS-TP-161.

Welsch, D.J. 1992. *Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources.* USDA Forest Service Report NA-PR-07-91, Radnor, PA. 20 pp.

2.2 WATER QUALITY

ISSUE

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.

Forestry activities that can affect water quality include construction of roads, landings, and skid trails; stream and wetland crossings; handling of slash; removal of forest cover; spilling of petroleum products and the application of chemicals. The most important aspect of protecting water quality is maintaining the integrity of wetlands and riparian areas (*see Chapter 2.1*).

OBJECTIVE

Protect water quality from degradation during and following harvesting and road-building operations. Avoid the spilling or improper use of toxic chemicals, and prevent undesirable changes in sedimentation, temperature, nutrient content, or water levels in streams, lakes and wetlands.

CONSIDERATIONS

- Water quality may be affected by activities throughout a watershed, many of which may be beyond the control of the landowner or land manager.
- Removing a significant proportion of the forest cover of any watershed can increase stream flow and the chances for erosion and downstream impacts. However, changes in water flow are highly variable depending on local climate, topography, vegetation, soil characteristics, and harvesting procedures. Therefore, no simple guidelines for forest cover retention can be given. Impacts are likely to be greatest in:
  - north-facing watersheds
  - areas with steep slopes
  - areas with poorly-drained soil
  - areas with high pre-harvest stream flow
  - areas dominated by soft woods (*Lee 1980*).
- Using biodegradable oils and lubricants can minimize risks to water quality, but check your chainsaw or other equipment manufacturer warranties to ensure that use of biodegradable oils and lubricants will not damage equipment or invalidate the warranty.
- Be aware of aquifers, wells, and public water supply reservoirs that harvesting may influence.

RECOMMENDED PRACTICES

✓ Become familiar with and apply *Best Management Practices for Erosion Control* during all harvesting operations *(Appendix C)*, these are required by law in certain situations.

✓ Survey existing roads for indications of instability and erosion problems. Roads experiencing significant erosion should be stabilized according to guidelines in *Best Management Practices for Erosion Control (Appendix C)*.

✓ Monitor sites before, during and after harvesting operations for visible signs of erosion and sedimentation.

These 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 runoff channels or gullies

✓ Take action to identify and correct the source of these problems

✓ Exercise care when working with fuels, oils, hydraulic fluid, and similar materials. Conduct filling and maintenance of equipment well away from open water or wetlands. Keep sawdust or other absorbent material on the site to soak up accidental spills or leaks.

Spills must be reported to the New Hampshire Department of Environmental Services (NHDES) unless: the spill is less than 25 gallons; is immediately contained; does not threaten surface or groundwater; and all discharge and contamination is removed within 24 hours (*NHDES 1990).* If a spill occurs, the best course of action is to contact the NHDES for information.

✓ Encourage the use of vegetable-based bar and chain oil as an alternative to non-biodegradable petroleum-based bar and chain oil. These oils biodegrade rapidly and are virtually non-toxic to fish and algae. These oils are more expensive and your contractor may request that you share the cost.

✓ Avoid excessive removal of vegetation within any individual watershed, especially those with characteristics discussed under Considerations. When harvesting is conducted across an entire watershed, impacts may be reduced by using partial or multi-stage (strip or shelterwood) harvests as opposed to clearcuts.

CROSS REFERENCE Erosion and Soil Damage 1.1; Soil Nutrients 1.2; Wetlands and Riparian Areas 2.1; Beaver-Created Openings 3.3; Truck Roads and Skid Trails 6.2; Landings 6.3.

LITERATURE CITED

Cullen, J.B. 1996. *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire (2nd ed.)*. New Hampshire Department of Resources & Economic Development, Division of Forests and Lands, Concord, NH.

Lee, R. 1980. *Forest Hydrology*. Columbia University Press, New York. 349 pp.

New Hampshire Department of Environmental Services. 1990. *Reporting and Remediation of Oil Discharges*. New Hampshire Code of Administrative Rules Env-Es 412, NHDES, Concord, NH.

Terrell, C. and P. Bytnar Perfetti. 1989. *Water Quality Indicators Guide*. USDA Soil Conservation Service SCS-TP-161.

Section Three
Habitat

Additional Reading:

New England Wildlife: Management of Forested Habitats
Richard DeGraaf, Mariko Yamasaki, William Leak, and John Lanier
General Technical Report 144
USDA Forest Service Northeastern Forest Experiment Station
1992

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

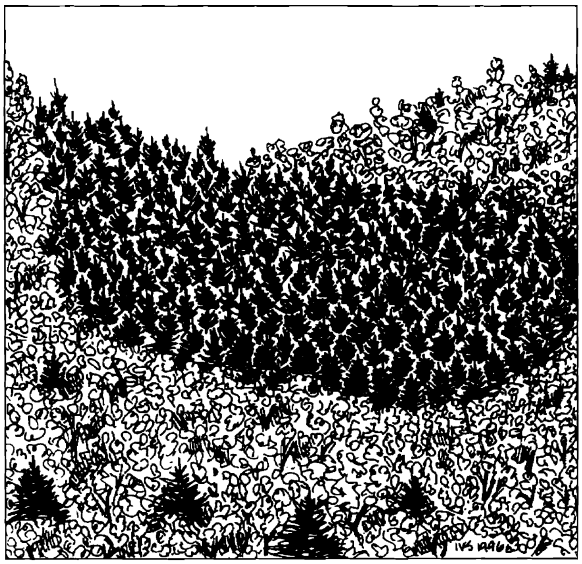
Wildlife Forests and Forestry:
Principles of Managing Forests for Biological Diversity
Malcolm Hunter
Prentice-Hall
1990

Forester's Guide to Wildlife Habitat Improvement
Scot Williamson
University of New Hampshire Cooperative Extension
1993 (Second Edition)

3.1 OVERSTORY INCLUSIONS

ISSUE

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 cover that are distinct from the surrounding forest but too small to be mapped or treated as a separate stand (*see illustration*). An example would be a patch of hemlock in a pure hardwood stand, or patches of oak in a primarily pine stand.

Inclusions increase the diversity of habitats available in an area, and provide feeding, nesting, and shelter opportunities that may not be present in continuous stands of a single type. They may result from either small-scale site differences or variations in the past disturbance history of a stand, and may range in size from a few stems to an acre or more. Over a quarter of New England's bird species and a lesser number of mammals use overstory inclusions in one way or another (*DeGraaf et al. 1992*).

The value of a minor inclusion increases in proportion to how different it is from the surrounding forest (*Hunter 1990*). Even a single softwood tree in a pure hardwood stand can greatly increase the variety of available habitats.

Management practices that do not consider overstory inclusions during harvest may not maintain these areas in future stands. Applying a single management practice designed for the dominant cover type may tend to make the stand more uniform, and may not adequately maintain or regenerate inclusions that differ in species composition, site, or regeneration requirements.

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 inclusion areas may be uneconomical if these treatments require different equipment or techniques.
- Small volumes of some species derived from treatment of inclusions may not be marketable.
- Inclusions may be prone to blowdown, sunscald, and other risks if surrounding cover is removed.

- Inclusions may be the result of small-scale irregularities in past disturbance history, and natural successional patterns may work against the maintenance of these areas, especially if advance regeneration of the surrounding dominant vegetation is in place. Maintenance and regeneration of inclusions will be more practical where inclusions result from relatively permanent site factors rather than past disturbance differences across a uniform site.

RECOMMENDED PRACTICES

✓ Develop specific prescriptions for stands containing inclusions to maintain or regenerate these areas in their current type. Inclusions should not necessarily receive the same prescription as the rest of the stand.

✓ Create inclusions in large uniform stands if site conditions allow.

✓ Leave inclusions unharvested if:

- the inclusion is relatively unique to the area
- the inclusion is small (1/4 acre or less) and the volume of timber generated from its treatment will be limited
- if the inclusion results from small-scale differences in site conditions and may be sensitive to disturbance (such as wet areas or shallow soils over ledge).

✓ Leave a buffer around softwood inclusions to provide protection from wind. The buffer should be at least 2-3 tree heights wide on the side exposed to prevailing winds. Do not remove more than 25% of the basal area within this buffer.

CROSS REFERENCE

Aspen Management 3.4; Deer Wintering Areas 3.5; Mast 3.6.

LITERATURE CITED

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and J.W. Lanier. 1992. *New England Wildlife: Management of Forested Habitats.* USDA Forest Service General Technical Report 144, Radnor, PA. 271 pp.

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

3.2 PERMANENT OPENINGS

ISSUE

Maintaining permanent openings of up to a few acres — dominated by grasses, forbs, brambles, or shrubs — within a forested landscape provides valuable habitat for many species.

Non-forested upland and wetland areas, though representing a small portion of New Hampshire's landscape, may contribute a disproportionately high share of wildlife habitat to the overall forest environment. These areas, dominated by grasses, forbs, brambles, or fruiting shrubs, provide necessary habitat for about 22% of New England's wildlife species, and seasonally important habitat to nearly 70% of species (*DeGraaf et al. 1992*), including species of concern such as the bluebird and eastern cottontail.

Prior to European settlement these habitats were found primarily in wet areas (such as along large rivers and in beaver-created meadows), and in areas cleared by Native Americans. Non-forested habitats increased greatly with the expansion of agriculture through the mid-1800s (*NHDRED 1995*). For the last 150 years, however, this habitat has been declining. Cropland and pasture now constitute only a small percentage of New Hampshire land.

Some guidelines suggest that 3-5% of forest land should be maintained in permanent openings to maintain this habitat (*USFS 1986, DeGraaf et al. 1992*). The value of these openings depends on the surrounding landscape; they will be more beneficial in large areas of continuous forest cover than in areas that already contain a mixture of forest and non-forest habitats. The two primary sources of permanent openings in a managed forest are remnant meadows, pastures, or orchards on abandoned agricultural land; and log landings created during harvesting operations and maintained afterward.

OBJECTIVE

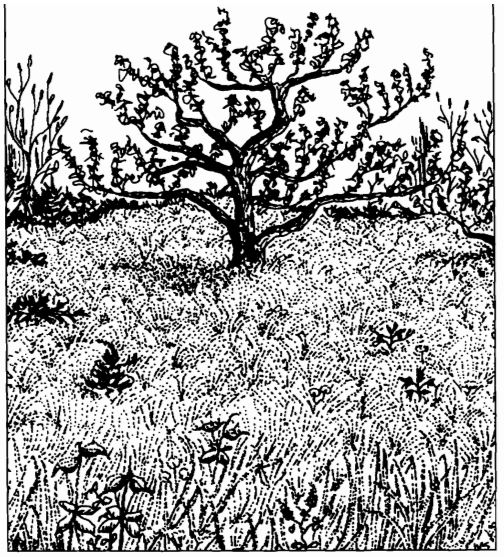
Create or permanently maintain openings dominated by grasses, forbs, or shrubs within forest-dominated upland landscapes.

CONSIDERATIONS

- Maintaining these habitats involves periodic treatments the cost of which is generally borne by the landowner. Landowners should check with their county extension forester on the availability of cost-share programs designed to reimburse some of these costs.
- Seeding with conservation mix and the application of lime and fertilization will result in more persistent establishment of grasses, potentially reducing maintenance costs in the long run.
- Maintaining permanent openings removes some land from the timber base. However, landings maintained as openings will be available for future harvest operations with little additional clearing.

RECOMMENDED PRACTICES

✓ Clear abandoned meadows, pastures, or orchards that remain at least partially open of invading woody vegetation, and retain some larger trees or snags for perches and nest sites.



✓ Retain old apple trees which provide a valuable food source for many types of animals. Pruning and releasing these trees can maintain their vigor *(Olson and Langer 1990)*.

✓ When the harvest is complete: clear landings of debris; level and smooth the ground. Plant with a recommended seed mix only if necessary to stabilize the soil, for wildlife, and for appearance. Otherwise let natural vegetation establish itself. Contact the Natural Resources Conservation Service for information on site-specific seeding practices.

✓ Consider establishing new permanent openings in large expanses of continuous closed-canopy forest *(Tubbs and Verme 1972)*. Foresters or wildlife biologists can provide advice regarding the need for openings as well as their size, location, and configuration.

✓ Treat permanent openings at approximately 5-year intervals to prevent succession to woody vegetation and to retain the dominant herbceous ground cover. More frequent treatments will maintain grass cover in openings; less frequent treatments will allow succession to brambles and shrubs. Treatment can be either by mowing, brush-cutting or prescribed burning. Burning should be done only with expert supervision; contact the county extension forester in your area for more information on this practice.

CROSS REFERENCE

Landings 6.3; Aesthetics of Clearcutting 6.5.

LITERATURE CITED

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and J.W. Lanier. 1992. *New England Wildlife: Management of Forested Habitats.* USDA Forest Service General Technical Report 144, Radnor, PA. 271 pp.

New Hampshire Department of Resources & Economic Development. 1995. *New Hampshire Forest Resources Plan Assessment Report.* NHDRED, Division of Forests & Lands, Concord, NH.

Olson, D. and C. Langer. 1990. *Care of Wild Apple Trees.* Cooperative Extension Service, University of New Hampshire, Durham, NH. 8 pp.

Tubbs, C.H. and L. J. Verme. 1972. *How to Create Wildlife Openings in Northern Hardwoods.* USDA Forest Service, State and Private Forestry, Upper Darby, PA. 6 pp.

United States Forest Service. 1986. *White Mountain National Forest Land and Resource Management Plan.* USDA Forest Service Eastern Region, Milwaukee, WI.

3.3 BEAVER-CREATED OPENINGS

ISSUE

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

Openings created by beaver in forested landscapes progress from newly flooded areas, through stagnant ponds, to open meadows *(Diefenbach et al. 1988)*. Nutrients enter beaver flowages (the flat water behind the dam) in the open water stage and accumulate in bottom organic matter as flowages stagnate.

When beaver 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 and the cycle begins again.

Each of these successional stages provides habitat for a variety of wildlife, from frogs, turtles, waterfowl, great blue herons, swallows, otter, mink, and moose in the open water stage; to geese, grouse, woodcock, woodpeckers, yellow-throats, yellow warblers, bog lemmings, bear, deer, and moose in the open meadow stage *(Hill 1982; Diefenbach et al. 1988; Williamson 1993)*. Beaver flowages also influence water quality as dams trap sediments and open meadows slow seasonal run-off *(Hill 1982; Olson and Hubert 1994)*.

OBJECTIVE

Include beaver and their habitat as essential components of the forest management plan. Maintain hardwoods, especially aspen, along drainways in places where beaver dam-building activity and subsequent wetland openings are desired; and where water levels can be controlled so that transportation corridor and personal property damage is minimal.

CONSIDERATIONS

- Surrounding forest composition influences potential beaver occupation. Hardwoods (especially aspen) in the first 100 feet from aquatic edges are important beaver food sources in uplands *(Buech 1985; Olson and Hubert 1994)*. Important aquatic foods include: water lily, duck potato, waterweed, pondweed, and duckweed.
- Channel gradients of quality beaver habitat are optimally less than 3% *(Olson and Hubert 1994)* and always less than 12% *(summarized in Buech 1985)*.
- Valley (drainage) widths in quality beaver habitat are greater than 150 feet wide *(Buech 1985; Olson and Hubert 1994)*.
- Controlling water levels can be accomplished with an array of drainage devices that can maintain water at a desired level *(Buech 1985; Laramie & Knowles 1985; Diefenbach et al. 1988; Olson & Hubert 1994)*.
- Road layout and construction in wide and flat drainages can enhance beaver dam-building activities but will require additional road design features *(Jones 1992)*.

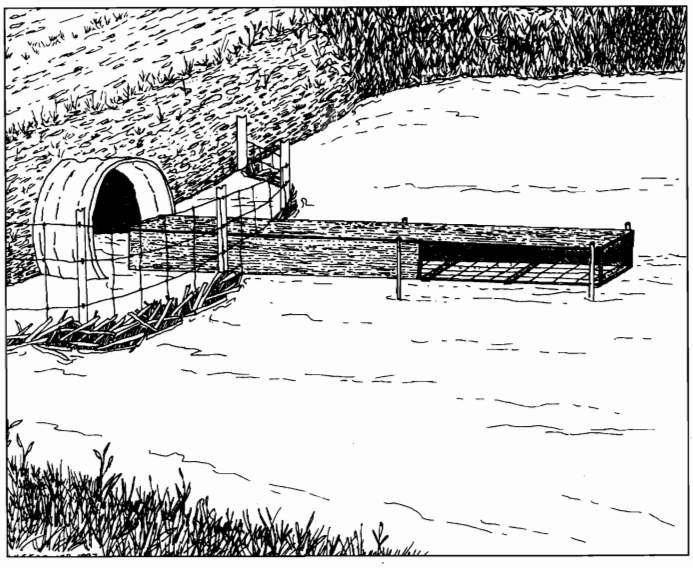
- Excess animals can become a nuisance to property owners when their tree-cutting and dam-building activities exceed an acceptable level. Control of beaver or beaver dams may be subject to regulation under RSA 210:9; consult with the New Hampshire Fish & Game Department (NHF&G). Property owners can give written permission and access to licensed trappers during the regular trapping season. Outside of the legal season, property owners can contact the NHF&G for the name of a local trapper who can remove nuisance animals under state supervision. Gradual removal of beaver dams can be accomplished in ways that slowly release impounded water without causing erosion and siltation if needed. Also consult with New Hampshire Department of Environmental Services for guidance on removing beaver dams.
- Harvesting more than 50% of the basal area within a riparian zone may require a variance from the basal area law (RSA 227-J:9). Contact the New Hampshire Division of Forests & Lands for more information.

RECOMMENDED PRACTICES

✓ Determine the maximum acreage of acceptable flooding in a drainage and set an appropriate water control device (solid or wood pipe, beaver box) at that level to minimize excessive flooding damage.

✓ Where safety factors allow, leave dead trees resulting from flooding for habitat value.

✓ Consider regenerating aspen and other hardwoods in small patches or strips in flat and wide riparian corridors (where stream channel gradients are less than 3% and in drainages wider than 150 feet).



✓ Locate new roads where they are unlikely to be flooded by new dam sites whenever possible.

✓ Be prepared to install water-control devices in road culverts that do cross wide and flat drainages. Consult with the New Hampshire Fish & Game Department or UNH Cooperative Extension for plans and drawings of water-control devices.

✓ Consider using stone fords for stream crossings when a solid maintenance-free base is required. Consult with the Natural Resource Conservation Service or the New Hampshire Department of Environmental Services for permitting requirements.

✓ Provide written permission and access to persons legally trapping excess beaver on private lands.

CROSS REFERENCE

Wetlands and Riparian Areas 2.1; Water Quality 2.2; Aspen Management 3.4.

LITERATURE CITED

Buech, R.R. 1985. "Beaver in Water Impoundments: Understanding a Problem of Water-level Management." Pages 95-105. In: Knighton, D.M. (compiler). *Water Impoundments for Wildlife: a Habitat Management Workshop.* USDA Forest Service General Technical Report NC-100, St. Paul, MN.

Diefenbach, D.R., S.J. Lovett, and R.B. Owens, Jr. 1988. "Beavers and Wetlands." Pages 38 – 40. In: Elliott, C.A. (editor). *A Forester's Guide to Managing Wildlife Habitats in Maine.* University of Maine Cooperative Extension and Maine Chapter of The Wildlife Society, Orono, ME.

Jones, G.T. 1992. *A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners.* NRAES-60. Northeast Regional Agricultural Engineering Service. Cooperative Extension. Ithaca, NY. 28pp.

Hill, E.P. 1982. "Beaver: *Castor canadensis.*" Pages 256 – 281. In: Chapman, J.A. Feldhamer, G.A. (editors). *Wild Mammals of North America — Biology, Management, and Economics.* Johns Hopkins University Press, Baltimore, MD.

Laramie, H.A., Jr. and S.W. Knowles. 1985. *Beaver and Their Control.* Wildlife Fact Sheet 10. University of New Hampshire Cooperative Extension Service, Durham, NH. 4pp.

Olson, R. and W.A. Hubert. 1994. *Beaver: Water Resources and Riparian Habitat Manager.* University of Wyoming unnumbered publication. Laramie, WY. 48pp.

Williamson, S.J. 1993. *Forester's Guide to Wildlife Habitat Improvement* (2nd ed). University of New Hampshire Cooperative Extension Service, Durham, NH

3.4 ASPEN MANAGEMENT

ISSUE

Aspen (also known as poplar or popple) stands are the preferred habitat for several wildlife species including ruffed grouse, woodcock, Nashville warbler, and beaver. Landowners may wish to expand aspen cover in their forest to enhance wildlife habitat diversity. Aspen is uncommon in New Hampshire.

Although aspen is one of the most widely-distributed forest types in North America, it is relatively uncommon in New Hampshire. According to the latest forest survey (1983), the aspen type occupies 117,000 acres (approximately 2% of the state's forest area).

Aspen, which often grows in close association with white birch, occurs chiefly as a "pioneer" forest type. Pioneer types are the first to colonize disturbed areas such as burns. In the absence of disturbance, the aspen type is replaced by more shade-tolerant trees such as spruce, fir, white pine, or northern hardwoods. Given historical and current fire suppression policies, the use of clearcutting is needed to maintain or expand the aspen type in New Hampshire.

OBJECTIVE

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

CONSIDERATIONS

- Aspen is extremely intolerant of shade; it needs full sunlight to grow. Disturbances such as fire or clearcutting are needed to grow shade-intolerant species such as aspen and white birch.
- 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 tree's lateral roots sprout, often producing several thousand suckers per acre. Because they have an established root system, the suckers may grow four feet or more in height during the first year.
- In New England, aspen stands reach maturity and begin to deteriorate at approximately 40 years of age. 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 depending on the quality of the site.
- Growing aspen requires a commitment to relatively short-rotation management (40 +/- years). On poor sites such as infertile sands or shallow-to-bedrock soils, short-rotation management may lead to soil nutrient depletion, particularly if whole-tree harvesting is used.
- A number of insects and diseases attack aspen. The most serious threats are hypoxylon canker and the forest tent caterpillar. Currently, the only feasible method of dealing with these pests is to keep aspen stands vigorous by harvesting them at an appropriate rotation age.

- Clearcuts can be very unsightly, particularly the first few years after the cut. Landowners, foresters and loggers should pay close attention to aesthetic considerations when clearcutting. Visual impacts can be mitigated by limiting their size, shaping them to blend with natural landscape features, and screening them from highways or other high use areas.
- Wildlife species associated with aspen need large and small patches of this type. Large ownerships offer more flexibility in providing this variety.

RECOMMENDED PRACTICES

✓ Perpetuation or expansion of the aspen type requires disturbances such as fire or clearcutting. If aspen is already present in an area, aspen regeneration can usually be secured by clearcutting adjacent to the aspen trees. The clearcut must be large enough to allow sunlight to reach the ground throughout the day.

✓ Cut aspen when dormant (late fall through early spring) to maximize density of root-suckering (*Perala, 1977*).

✓ Establishment of aspen on an area where none exists is more difficult and may involve site preparation to enhance the germination and survival of aspen seedlings. Contact a professional forester for advice on methods to establish aspen.

CROSS REFERENCE

Overstory Inclusions 3.1; Regeneration: The Right Tree on the Right Site 5.1; Clearcutting 5.5; Aesthetics of Clearcutting 6.5.

LITERATURE CITED

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and J.W. Lanier. 1992. *New England Wildlife: Management of Forested Habitats.* USDA Forest Service General Technical Report 144, Radnor, PA. 271 pp.

Perala, D.A. 1977. *Manager's Guide for Aspen in the North-Central States.* NC-36. USDA Forest Service General Technical Report NC-36. 30 pp.

Society of American Foresters. 1980. *Forest Cover Types of the United States and Canada.*

USDA Forest Service. 1985. *Forest Statistics for New Hampshire 1973 and 1983.* Resource Bulletin NE-88.

USDA Forest Service. 1965. *Silvics of Forest Trees of the United States.* Agricultural Handbook No. 271.

USDA Forest Service. 1973. *Silvicultural Systems for the Major Forest Types of the United States.* Agricultural Handbook No. 445.

3.5 DEER WINTERING AREAS

ISSUE **White-tailed deer in New Hampshire live near the northern limit of their geographical range in the northeast. Because of the severe winter conditions experienced here, deer require special habitats to survive.**

These special areas are typically lowland softwood stands, often associated with water courses and riparian habitat. They provide shelter from harsh winter weather by reducing snow accumulation and wind speeds, while allowing access to food supplies and escape from predators. Deer-wintering areas comprise about 3% of the land base in New Hampshire.

The severity of winter weather often determines whether a particular area is used in a particular year. The easier the winter, the farther deer will move from a core of dense softwoods that may only be used during the most severe weather (which may only occur once in five to ten years). The New Hampshire Fish & Game Department staff are available to review areas to determine whether or not they are functional winter habitat.

Deer-wintering areas consist of two basic habitat elements: a core area identified by concentrations of dense softwoods; and mixed hardwood and softwoods adjacent to or within the core area which provide accessible forage. Management planning for deer-wintering areas needs to provide a minimum of at least 50% of the entire area in functional shelter at all times. Functional shelter is softwood cover at least 35 feet tall, with crown closures averaging 65 to 70%. This crown closure distribution means some of this conifer cover will be much greater than 70%. Uninterrupted deer mobility and access throughout wintering areas can be provided by managing unbroken, dense lanes of softwood cover at least 200 feet wide utilizing existing networks of softwood riparian habitat where possible (*Reay, 1990*).

Managing an existing wintering area for deer will ensure a continued yield of forest products and abundant regeneration. Diversifying age and size classes of softwoods will provide quality habitat for a large range of wildlife species.

OBJECTIVE

Manage existing and potential deer-wintering areas to provide shelter, travel lanes to access food, escape from predators, and access to preferred browse.

CONSIDERATIONS

- Management of deer-wintering areas may reduce or delay harvest of sawtimber-sized trees or increase administrative costs of harvesting.
- Deer-wintering areas are dynamic habitats, changing over time. Optimal habitat values and use require conscious planning and decision-making.
- Single softwood trees or clusters of trees can be important for cover, especially in winter logging jobs when deer often feed on the tops of recently harvested hardwood trees.
- The aggregation of small deer-wintering areas on smaller multiple ownerships provides a significant portion of the winter range.

RECOMMENDED PRACTICES

General:

✓ The New Hampshire Fish & Game Department (NHF&G) has mapped most active deer-wintering areas in New Hampshire. Contact NHF&G to find out whether known deer-wintering areas occur on your land.

✓ Manage timber stands within the deer-wintering area for a balanced age class distribution.

✓ Maintain closed-forest cover in strips at least 200 feet wide as travel corridors across the deer-wintering area. Integrate, where possible, with riparian buffers. Manage buffers with uneven-aged techniques.

✓ Maintain at least 50% of the deer-wintering area in shelter areas that contain trees 35+ feet tall with an average canopy closure of 65-70%.

✓ Manage a hardwood buffer strip around the perimeter of the deer-wintering area as an integral part of the management unit. Manage these 200 to 1,320-feet wide strips for browse production. Small cutting units (1–5 acres), and clearcutting is recommended, using a 40-year rotation and 10-year cutting interval.

✓ Harvest during late winter months to provide tops for food and skid trails for ease of travel. Hardwood cuts planned adjacent to deer-wintering areas will produce additional browse.

✓ Avoid building truck roads within the wintering area.

Forest-Type Specific:

✓ In spruce–fir stands, uneven-aged management using group selection is the preferred method for managing deer-wintering areas *(Alexander and Garland 1985)* and is especially important for stands smaller than 100 acres. Harvests should create openings 20 feet to 40 feet in diameter. Rotation ages should range from 70 years (fir) to 100 years (spruce).

- ✓ Options for spruce–fir stands managed under even-aged systems depend upon advanced regeneration. If advanced regeneration is present, overstory removal can be completed on the area scheduled for harvest. If regeneration is absent, either two-cut shelterwood systems or strip clearcutting will stimulate seedling growth.
- ✓ Hemlock is a superior cover species and is the basic cover component of many wintering areas in central and southern New Hampshire. Management of eastern hemlock stands may be difficult and professional advice should be sought. Refer to Tubbs (1978) and Reay (1985) for details on hemlock silviculture. The most beneficial management activity in these areas is the release of understory hemlock by removing competing hardwoods, and the establishment of browse plots throughout the area. Some general guidelines for management of hemlock deer-wintering areas are:
  - If advanced regeneration is present, a single removal of the overstory trees in areas to be regenerated is appropriate. If there is inadequate regeneration, a two or three stage harvest is recommended.
  - If harvesting in the summer, scarify soil before or during harvest, and remove advanced hardwood regeneration in the area prior to harvest.
  - Cutting units should be 10–20 acres.
- ✓ Northern white cedar can be extremely hard to regenerate (especially in deer-wintering areas) because it is slow growing and is also a highly-preferred browse species. If a cedar deer-wintering area is encountered, contact a NHF&G biologist for details on management options.

CROSS REFERENCE

Wetlands and Riparian Areas 2.1; Overstory Inclusions 3.1; Permanent Openings 3.2; Regeneration: The Right Tree on the Right Site 5.1 ; Forest Structure 5.2; Managing for High Quality Trees 5.3; Clearcutting 5.5.

LITERATURE CITED

Alexander, C.E. and L.E. Garland. 1985. "Spruce Budworm/Deer Winter Range: A Situation Statement." *Institute of Spruce-Fir Management and Spruce Budworm.* USDA Forest Service General Technical Report NE-99, Broomall, PA 19008.

Johnston, W.F. 1977. *Northern White Cedar in the North Central States.* USDA Forest Service General Technical Report NC-35. 19 pp.

Lancaster, K.F. and W.B. Leak. 1978. *A Silvicultural Guide for White Pine in the Northeast.* USDA Forest Service General Technical Report NE-41. 13 pp.

Reay, R.S. 1985. *Compatibility of Timber Management and Wintering Deer in Hemlock Stands.* Proceedings of joint TWS-SAF conference, 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 Department of Forests, Parks & Recreation and Department of Fish & Wildlife. 35pp.

Strong, K.F. 1977. *Evaluative Review of Deer Yard Management Work in New Hampshire and Maine.* New Hampshire Fish & Game Department, Concord, NH.

Telfer, E.S. 1978. "Silviculture in Eastern Deer Yards." *Forest Chronicles* 54: 203-208.

Tubbs, C.H. 1978. *How to Manage Eastern Hemlock in the Lakes States*. USDA Forest Service North Central Forest Experiment Station, St. Paul, MN. 2 pp.

Verme, L.J. 1968. "Swamp Conifer Deer Yards in Northern Michigan: Their Ecology and Management." *Journal of Wildlife Management* 6: 38-43.

Weber, S.J., W.W. Mautz, J.W. Lanier, and J.E. Wiley, III. 1983. Predictive Equations for Deeryards in Northern New Hampshire. *Wildlife Society Bulletin* 11(4): 331-338.

3.6 MAST

ISSUE **Sources of mast are critical to wildlife survival and need to be maintained in New Hampshire.**

"Mast" refers to nuts, seeds, and fruits of woody plants that provide food for wildlife *(Elliott 1988)*. "Hard mast" refers to nuts and seeds; "soft mast" refers to fruits and berries. High levels of fat and protein in mast contribute to fat stores critical for migration or hibernation and to survival of newly independent young. Some birds and mammals depend heavily on mast during peak production periods in late summer and early fall, and/or during winter when some sources remain available on trees and shrubs, on the ground under the snow, or stored in caches.

Sources of hard mast have changed in New Hampshire's forests during the last century. Chestnut blight eliminated American chestnut; Gypsy moth outbreaks have caused considerable mortality of oaks; and beech-bark disease now threatens availability of beechnuts. Over-harvesting of mature oak may impact mast availability.

Hard Mast

American beech, hickory, and red, white, and black oak are the primary sources of hard mast in New Hampshire forests. These are important dietary components for 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 of age or 8 inches DBH and produce good crops at 2- to 8-year intervals. Red oaks bear heavy acorn crops at 2- to 5-year intervals and are at peak production when trees are in 19-22 inch DBH. White oaks bear heavy crops at 4- to 10-year intervals, and peak in production at 24-30 inch DBH. There is considerable variation in production between trees, but individual trees tend to produce consistently good or poor acorn crops. Acorns of white oak are more palatable to wildlife than those of red and black oak because the former contain lower tannin levels. Ash, birches, maples, and conifer species are also important sources of hard mast for seed-eating wildlife.

Soft Mast

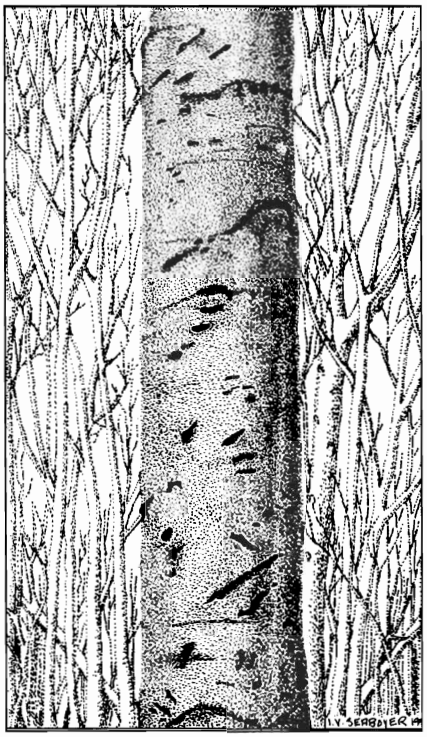
Black cherry is the primary soft-mast producer among New Hampshire's timber trees, and provides an important food source for bears, small mammals, and 28 bird species. While 10-year old saplings may produce fruit, peak production occurs between 30 and 100 years of age. Good crops occur at 1- to 5-year intervals, although black cherries usually produce some fruit annually. Black cherry trees may vary widely in fruit production, making the production history of individual trees an important consideration in selecting trees for harvest or retention. Other important native sources of soft mast in the state include pin and choke cherries, wild apples, mountain ash, shadbush, and brambles (blackberries and raspberries).

OBJECTIVE

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

CONSIDERATIONS

- Individual beech and black cherry trees may be poor-quality timber but invaluable mast sources. Such trees may have greater value if left for wildlife than if harvested for wood products.
- Beech-bark disease may affect management decisions in infected stands *(see Insects, Diseases and Wind Damage 5.6).*
- Early successional shrubs, such as brambles and pin cherry, are important mast sources despite their "weed" status.
- When planting mast-producing shrubs, favor native over exotic species. Avoid planting invasive exotics such as multiflora rose, winged euonymus, non-native honeysuckle species, and autumn olive.



RECOMMENDED PRACTICES

✓ When managing stands with multiple mast-producing species, maintain the diversity of mast sources.

✓ Manage oak stands on long rotations (100-125 years), growing trees to 20-26 inch diameters to maximize acorn production and timber value (*Burns and Honkala 1990, Elliott 1988*). Maintain oak in well-stocked stands by retaining vigorous trees with dominant crowns (*Elliott 1988*).

✓ Retain any beech tree with recent, fresh claw marks on the trunk (*see illustration*) or clumps of broken branches in the crown. Retain mature (greater than 40 years old) beech in stands supporting wild turkeys.

✓ When harvesting stands with a black cherry component, retain some trees with high fruit production or any tree that shows evidence of use by bear.

✓ Retain wild apple trees and gradually release from competition; prune cautiously (*Elliott 1988*). (*See Permanent Openings 3.2)*

CROSS REFERENCE

Overstory Inclusions 3.1; Permanent Openings 3.2; Deer Wintering Areas 3.5; Woodland Raptor Nest Trees 4.4; Regeneration: The Right Tree on the Right Site 5.1; Managing for High Quality Trees 5.3; Insects, Disease and Wind Damage 5.6.

LITERATURE CITED

Burns, R.M. and B. H. Honkala. 1990. *Silvics of North America, Volume 2, Hardwoods.* USDA Forest Service Agriculture Handbook 654, Washington, DC.

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

3.7 CAVITY TREES, DENS AND SNAGS

ISSUE **Retention of snags (dead or partially dead standing trees) and den trees (live trees with existing cavities) helps to maintain populations of cavity-nesting wildlife.**

Table 1.
Minimum tree diameters for cavity-using species *(From Tubbs et al 1987, Harrison 1975)*

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

Ten species of New Hampshire's forest birds excavate cavities for nesting and roosting (*Harrison 1975*); another 15 birds and 18 mammals use natural or excavated cavities in forested habitats for nesting, roosting, or denning (*Tubbs et al. 1987*). In addition, the brown creeper nests under loose flaps of bark, attached at the top, on standing dead trees. These species require a range of cavity-tree size classes to provide suitable shelter (Table 1). Larger trees accommodate more species.

OBJECTIVE

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

CONSIDERATIONS

- U.S. Occupational Safety and Health Administration (OSHA) regulations regarding dangerous tree removal should be consulted prior to timber harvesting. These regulations may be in conflict with the recommendations of this section. They require the removal of all snags by mechanical means. If the tree is to be left standing, it must be marked and no work conducted within two tree lengths of the tree, unless the employer demonstrates a shorter distance will not create a hazard for an employee.
- Providing for cavity trees in uncut patches and/or focusing on the following choices for retention trees will minimize safety issues: live trees with natural cavities or woodpecker holes, broken-topped live trees exceeding 12-inch DBH, secure standing dead trees, especially those with top-attached bark flaps, large aspens, longer-lived species (white pine, red spruce, eastern hemlock, sugar maple, beech, yellow birch), and/or saw-timber size individuals of species which persist for long periods as standing dead trees (yellow birch, sugar maple, elm, oaks, white pine).

- Riparian zones, roadside buffers, scenic areas, and small uncut patches contribute to snag retention goals for an ownership.
- Even distribution of snags on the landscape is desirable for some species, but there are many benefits to clumping snags as well (*Elliott 1988*). Uniformity is not always operationally practical or desirable.
- On smaller ownerships it may be necessary to manage snags on an acre by acre basis; on larger ownerships it is usually more practical to take a landscape-level approach — making sure that some areas of the ownership emphasize snag retention, while in other areas less priority may be placed on snag retention.

RECOMMENDED PRACTICES

✓ In areas under uneven aged management, retain a minimum of 6 secure cavity and/or snag trees per acre, with one exceeding 18 inches DBH and 3 exceeding 12 inches DBH *(NHDRED 1995)*. In areas lacking such cavity trees, retain 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% of the area *(USDA Forest Service 1986, Elliott 1988)*. Patch size may vary from a minimum of 0.25 acre. Use cavity trees exceeding 18 inches DBH or active den trees as nuclei for uncut patches. Remember, the larger the tree, the more species that can use it. Riparian and other buffers can help to satisfy this goal.

✓ Retain live trees with existing cavities.

CROSS REFERENCE

Wetlands and Riparian Areas 2.1; Overstory Inclusions 3.1; Mast 3.6; Dead and Down Woody Debris 3.8; Forest Structure 5.2.

LITERATURE CITED

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

Hardin, K.I. and K.E. Evans. 1977. *Cavity Nesting Bird Habitat in the Oak-Hickory Forest, A Review.* USDA Forest Service General Technical Report NC-30, St. Paul, MN.

Harrison, H.H. 1975. *A Field Guide to Birds' Nests in the United States East of the Mississippi.* Houghton Mifflin Co., Boston.

New Hampshire Department of Resources and Economic Development. 1995. *Nash Stream Forest Management Plan.* NHDRED, Division of Forests & Lands, Concord, NH.

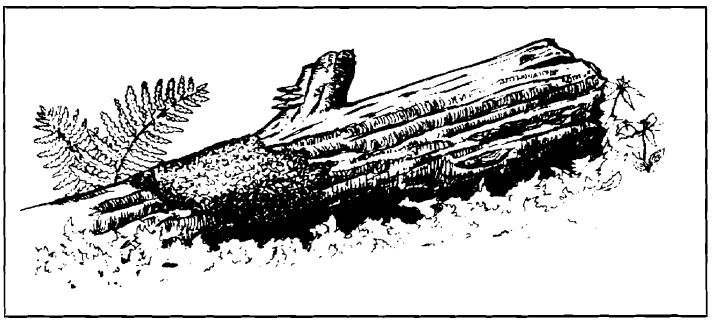
Tubbs, C.H., R.M. DeGraaf, M. Yamasaki, and W.M. Healy. 1987. *Guide to Wildlife Tree Management in New England Northern Hardwoods.* USDA Forest Service Genreal Technical Report NE–118, Broomall, PA 30pp.

USDA Forest Service. 1986. *Land and Resource Management: White Mountain National Forest.* USDA Forest Service, Eastern Region.

3.8 DEAD AND DOWN WOODY DEBRIS

ISSUE **Dead and down woody material in various stages of decay (logs, stumps, limbs and upturned tree roots) serves many critical functions in a forest and should be present in most if not all stands.**

Dead and down woody material, often referred to as coarse woody debris, is important for nutrient retention and cycling, as nurse logs for regeneration of trees and understory plants, and as wildlife habitat (*Harmon et al. 1986*). Large (18+ inches) hollow or rotten logs and stumps generally have the greatest value. Softwood stands usually contain more and longer-lasting woody debris than hardwood stands. Maintaining snags and cavity trees will also serve to maintain coarse woody debris, as these trees eventually fall over.



Coarse woody debris is utilized as habitat by over 30% of the region's mammal species (primarily rodents, shrews and carnivores), 45% of amphibians (primarily salamanders), and 50% of reptiles (primarily turtles and snakes) (*summarized from DeGraaf et al. 1992*). It is used as a feeding site by rodents, shrews, black bears, and woodpeckers and provides shelter for many species of small mammals. Seventeen species of New Hampshire mammals, from black bear to deer mouse, den in or under downed logs. Coarse woody debris creates moist micro-habitats that are used by amphibians. Downed logs create pools and riffles in streams that provide important fish habitat and basking and nesting locations for turtles, waterfowl, mink, and otter. Several ground-nesting birds (including juncos and winter wrens) nest within upturned tree roots. In addition, dead and down woody material provides habitat for many lower organisms such as insects and other invertebrates, mosses, fungi, and lichens.

The amount of coarse woody debris is low in many of New Hampshire's forests, especially those that have regrown from agricultural land. Dead and down materials have been viewed as potential wood products that should be salvaged, as fuels that create fire hazards, and as physical barriers to forest operations and regeneration. However, across much of the state, forests are maturing, and the supply of this material is naturally increasing as older trees die and fall over.

Several trends may reduce the supply of this material, including greater utilization of cull material through chipping or whole tree harvesting, increasing intensity of forest management, and shortening of rotation lengths.

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

CONSIDERATIONS

- Sound woody debris may have minimal economic value as biomass or chips.

RECOMMENDED PRACTICES

✓ Avoid damaging existing downed woody debris, especially large (18+ inches) hollow or rotten logs and rotten stumps during harvesting operations (including tree falling, skidding, and road and skid trail lay out).

✓ Leave cull material from harvested trees, especially sound hollow logs, in the woods. Some cull material should be left behind during whole-tree or biomass harvesting operations that may otherwise utilize this material. Large pieces of cull material bucked out on the landing should be returned to the woods.

✓ Avoid disrupting downed logs in and adjacent to streams, ponds, and wetlands.

✓ Avoid disrupting upturned tree roots from May-July to protect nesting birds.

✓ Maintain or create softwood inclusions in hardwood stands to provide a supply of longer-lasting down woody material.

CROSS REFERENCE

Overstory Inclusions 3.1; Cavity Trees, Dens and Snags 3.7; Forest Structure 5.2; Slash Disposal 6.4.

LITERATURE CITED

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and J.W. Lanier. 1992. *New England Wildlife: Management of Forested Habitats.* USDA Forest Service General Technical Report 144, Radnor, PA. 271 pp.

Harmon, M.E. et al. 1986. "Ecology of Coarse Woody Debris in Temperate Ecosystems." *Advances in Ecological Research* 15: 133-301.

Williamson, S.J. 1995. *Forester's Guide to Wildlife Habitat Improvement (2nd ed.).* University of New Hampshire Cooperative Extension Service, Durham, NH.

Section Four
Unique and Fragile Areas

Additional Reading:

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

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

Forester's Guide to Wildlife Habitat Improvement
Scot Williamson
University of New Hampshire Cooperative Extension
1993 (Second Edition)

4.1 RARE PLANTS AND NATURAL COMMUNITIES

ISSUE **Identifying and protecting rare plant populations and uncommon natural communities is a critical component of conserving New Hampshire's native biodiversity.**

Every species of native New Hampshire plant — whether a tree, a spring wildflower, or an inconspicuous grass — contributes to the quality of life in our state. The presence of unusual plants enriches our experience as we walk through the woods. This biological diversity provides a reservoir of materials for use in agriculture, medicine and industry, builds the soil, purifies water and air, and provides food and shelter for wildlife. Diversity allows the forest to adapt to changing conditions by providing many options for ecosystems to carry out the functions that maintain them (*Taylor et al. 1996*). Private landowners have a remarkable opportunity to help preserve New Hampshire's biological heritage by learning to recognize rare plants and natural communities and managing their land so as to maintain these important components of the forest.

New Hampshire has over 1500 native species of vascular plants. Of these, about 25% are considered uncommon enough to be of special concern to the New Hampshire Natural Heritage Inventory (NHNHI), and about 20% are legally listed as threatened or endangered by the state under the Native Plant Protection Act, RSA 217-A *(NHDRED 1995, Taylor et al. 1996)*. Only four plants are federally listed, and of those, only one — the small whorled pogonia — grows in forested areas.

Many of the state's uncommon plants occur in non-forested habitats such as marshes, riverbanks and alpine areas. Of those that occur in forested areas, the vast majority are restricted to a small portion of the landscape and are unlikely to affect harvesting operations. Although some rare plants may be sensitive to disturbance, many species can be maintained in harvested areas if appropriate silvicultural and harvesting procedures are followed. The NHNHI plant tracking list includes 6 relatively uncommon tree species that may reach harvestable size: black maple, river birch, hackberry, Atlantic white-cedar, butternut, and jack pine (*NHNHI 1994*).

Conserving the state's biodiversity requires consideration of natural communities as well as individual species. The NHNHI recognizes about 130 different natural communities in the state, of which about 40 are partially or completely forested. As with rare plants, rare natural communities occupy only a small part of the landscape. The Nature Conservancy has estimated that a small percentage (5%) of all natural communities make up the majority (about 75%) of the landscape; this includes the common forest types in which most management occurs. (However, because of the long history of intensive land use in the state, there are few examples of these communities that have been minimally disturbed by humans and which retain a relatively natural composition and structure.) Over half of the natural communities occupy in total only about 5% of the landscape; this includes most rare forest communities as well as bogs, cliffs, alpine areas, and similar communities that exist only in small areas.

Identifying Rare Plants and Natural Communities

Identifying these plants and communities can be daunting if one is not an experienced botanist. However, people with an interest in natural history and a good field guide to wildflowers can quickly learn to identify many rare plants. In addition, even people without formal training but with a keen eye in the woods can recognize certain areas as being different from the relatively common forest types that cover much of the landscape. A disproportionate number of rare elements are found in certain distinct communities that occupy a small part of the forested landscape. A guide to some important communities follows in this chapter.

Small whorled pogonia

Small whorled pogonia is one forest plant that every forester and forest landowner should know *(USFWS 1995)*. It is one of the rarest wild orchids in eastern North America, and its largest populations are found in the southeastern third of New Hampshire and adjacent areas of Maine. It grows in a variety of wooded habitats, primarily mid-successional mixed-woods dominated by maple, oak, beech, and white pine. The understory in areas where this plant is found is usually sparse. Understory plants that are often associated with small whorled pogonia include Indian cucumber-root (to which it is similar in appearance), New York fern, partridgeberry, rattlesnake plantain, and witch-hazel.

Small whorled pogonia can tolerate some level of disturbance, and the plant can be maintained in stands managed for timber. Though the effects of harvesting on this species are still being studied, partial cutting that retains a continuous forest cover is probably the best choice.

OBJECTIVE

Increase awareness of New Hampshire's rare plants and natural communities and manage forests to maintain these features where they are found.

CONSIDERATIONS

- Because of the many different rare plants and natural communities across the state, no general management guidelines can be stated, and there may be a wide range of silvicultural and harvesting techniques that are appropriate for different areas. Specific management guidelines have not been developed for most rare plants and natural communities. However, as a general principle forest management in these areas should consider managing for the communities.
- Accurately identifying some rare species and natural communities may require specialized training and knowledge.
- Conducting detailed surveys to identify rare plants and communities may be expensive and time-consuming if not done by the landowner, volunteers, or students. However, for many areas, especially those with a low diversity of habitats, such surveys may only be a small fraction of other forest management costs.

- Knowledge about the effect of various forestry practices on many rare species and communities is limited.
- Avoiding harvesting may be the best course of action for some species or communities but this entails an economic loss to the landowner. However, these areas generally occupy only a small part of the forested landscape.
- Some rare species and communities may depend on disturbance (such as fire) for their maintenance. Suppression of these disturbances, combined with natural successional processes, may alter or eliminate these elements. Harvesting operations may not adequately simulate the natural disturbance regime.
- Many landowners retain a fear of legal restrictions on property use due to the presence of rare plants or communities and may be reluctant to ask for assistance or conduct inventories. However, the state's Native Plant Protection Act (RSA 217-A) explicitly states that the presence of state-listed rare plants will not restrict landowner activities. State agencies are directed to consider these plants when issuing permits (such as wetlands permits), though any protection actions they propose are generally voluntary rather than mandatory. In the case of endangered or threatened plants, the Federal Endangered Species Act only establishes regulatory requirements where a federal permit, such as a wet lands permit from the Army Corps of Engineers, is being sought.

RECOMMENDED PRACTICES

✓ While surveying or working in the harvest area, be alert for any area that appears unique or different from the general forest landscape. These will often be areas with distinct vegetation or extreme site conditions (very dry, wet, nutrient-rich, etc.). Work with professionals trained in identifying species or communities of concern.

✓ Contact the NHNHI or the Nature Conservancy for information about any rare plant species or natural community that is known to (or could potentially) occur within the harvest area.

✓ If a harvest area is suspected of containing rare plants or communities, the NHNHI can provide information about the potential sensitivity of the site and appropriate silvicultural treatments for some communities.

✓ Conduct harvesting in areas suspected of containing rare plants or communities so as to avoid excessive changes in stand composition and structure, crown closure, forest floor characteristics, and other stand conditions.

CROSS REFERENCE

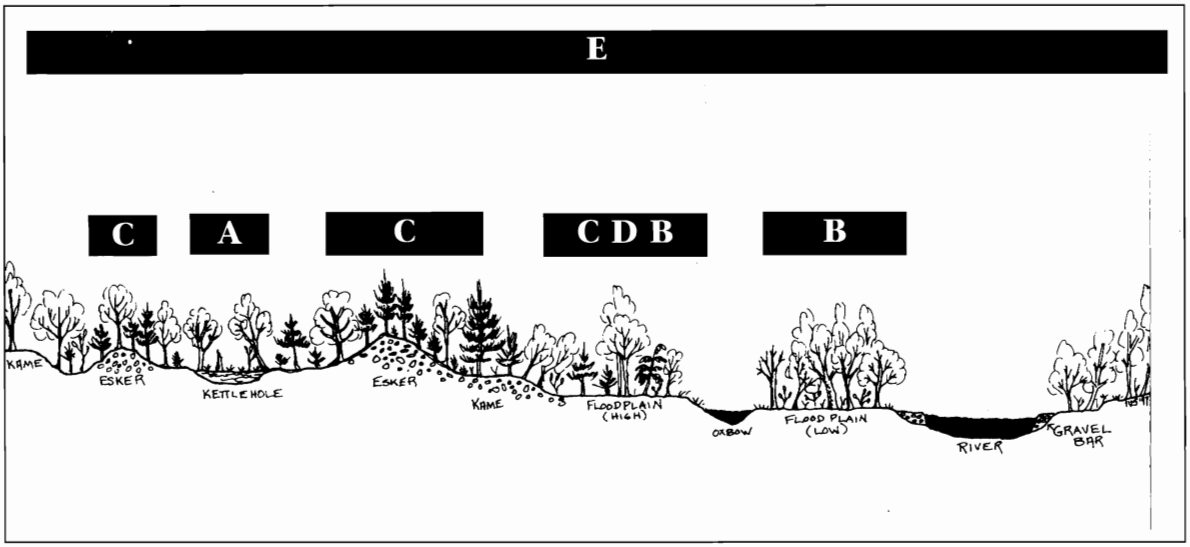
Wetlands and Riparian Areas 2.1; Old-Growth Forests 4.8.

Examples of Uncommon Natural Communities in New Hampshire

A ***Uncommon forested wetlands:***
These wetlands contain less common tree species like northern white cedar, black spruce, and black ash in the northern part of the state and Atlantic white cedar, black or green ash, elms, black gum, black willow, sycamore, or swamp white oak in the south. Understory species of interest in these areas include swamp azalea, yellow lady's-slipper and many other types of orchids, bulbous bittercress, sweet coltsfoot, and swamp valerian.

B ***Floodplain forests:***
These forests occupy frequently flooded terraces along river margins. They are usually dominated by silver maple forests along major rivers and by red maple–black ash–cherry–ironwood forests along smaller rivers. They may also contain other uncommon species such as hackberry, eastern cottonwood, boxelder, American elm, sycamore, swamp white oak, and river birch. Understory species of interest include green dragon and bladdernut.

C ***Uncommon dry (pine–oak–hickory) forest types:***
Most dry forest sites are dominated by relatively common forest types (red spruce in the north; white pine–red oak–hemlock in the south). However, less common types may be found on dry sites, especially in the southern part of the state. These communities may be distinguished by the dominance of less common species such as red, jack and pitch pine; black, white, chestnut, scarlet, and scrub oaks; hickories; and sassafras.

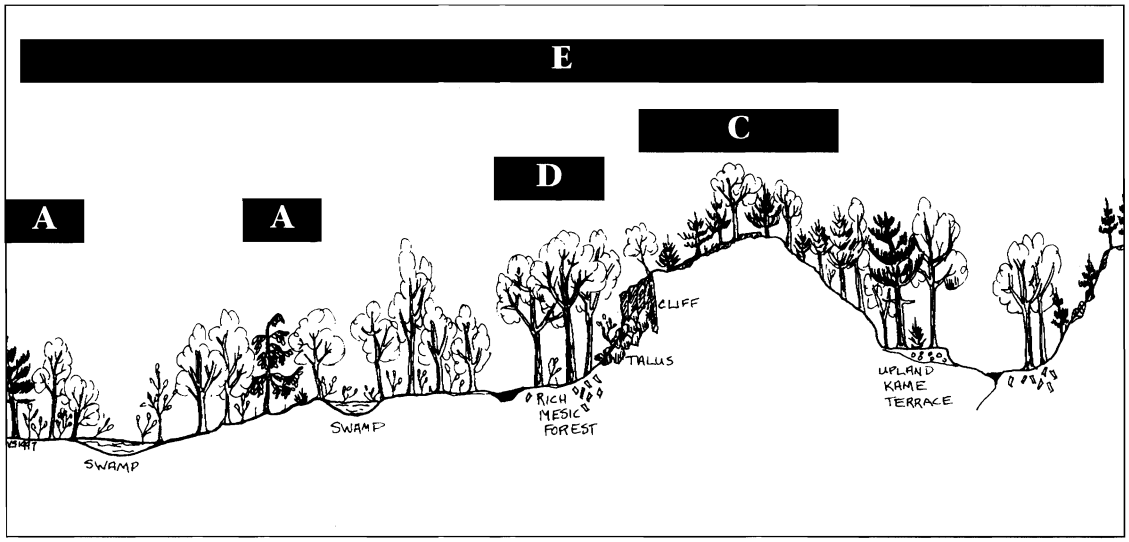


D ***Rich mesic forests (cove forests):***

These hardwood forests generally occur on lower concave slopes and are characterized by deep, fine-textured soils and relatively high nutrient status. They may also be found on areas with calcium-rich parent material. They are dominated by sugar maple with white ash or basswood also present. Understory plants indicative of these sites include white baneberry, red-berried elder, sweet cicely, silvery spleenwort, blue cohosh, rattlesnake fern, maidenhair fern, wild ginger, and Dutchman's breeches. A considerable number of New Hampshire's rare upland forest plants occur in this forest type, including butternut, flowering dogwood, squirrel corn, ginseng, Goldie's fern, large yellow lady's slipper, and mountain sweet cicely. These communities are very productive and well-suited for growing high-quality hardwood sawlogs. Careful management is required to assure that harvesting does not impact the ability of these sites to maintain populations of associated understory species.

E ***Areas with calcareous bedrock:***

Communities growing in soils derived from calcium-rich parent material are uncommon in New Hampshire. They run the full range from open wetlands to upland forests to cliffs and rocky ridge-tops. Among the plants that may help identify these sites are alder-leaved buckthorn, red-osier dogwood, and orchids in swamps; maidenhair fern, rattlesnake fern, and purple-flowering raspberry in upland seepage areas; and ebony spleenwort and blunt-lobed hepatica in dry oak forests. Many rare plants in New Hampshire are restricted to these sites.



LITERATURE CITED

Gawler S.C., J. J. Albright, P.D. Vickery, and F.C. Smith. 1996. *Biological Diversity in Maine: An Assessment of Status and Trends in the Terrestrial and Freshwater Landscape.* Report prepared for the Maine Forest Biodiversity Project. Maine Natural Areas Program, Department of Conservation, Augusta, ME. 80 pp. + Appendices.

New Hampshire Department of Resources & Economic Development. 1995. *New Hampshire Forest Resources Plan Assessment Report.* NHDRED, Division of Forests & Lands, Concord, NH.

Taylor, J., T.D. Lee, and L.F. McCarthy (eds.). 1996. *New Hampshire's Living Legacy: The Biodiversity of the Granite State.* New Hampshire Fish & Game Department Nongame and Endangered Wildlife Program, Concord, NH. 98 pp.

New Hampshire Natural Heritage Inventory. *Plant Tracking List, July 1994.* NHNHI, New Hampshire Department of Resources & Economic Development, Concord, NH.

Sperduto, D.D. 1994. *A Classification of the Natural Communities of New Hampshire, April 1994 Approximation.* New Hampshire Natural Heritage Inventory, Department of Resources & Economic Development. Concord, NH.

U.S. Fish & Wildlife Service. 1995. *The Small Whorled Pogonia: A Recovering Endangered Species.* USDI Fish & Wildlife Service, Bethesda, MD. 8 pp.

4.2 VERNAL POOLS

ISSUE

Vernal pools are inconspicuous, but provide critical habitat for several species.

Vernal pools are small depressions that fill when spring melt-water or autumn rains accumulate, or when the groundwater level rises above the level of the depression. They have no defined inlet or outlet. During dry periods, the presence of matted and discolored leaves in a small depression provides the most obvious clue to a vernal pool's existence.

These ponds cannot support fish either because they are temporary, too shallow, too warm, oxygen-poor, or because they freeze solid in winter *(Kenney 1995)*. Because they lack fish, vernal pools provide a unique habitat for aquatic organisms which fish would consume as prey. Wood frogs and mole salamanders breed only in vernal pools, and 10 other species of reptiles and amphibians also use these habitats for breeding and/or feeding *(Colburn 1991)*. Protection of vernal pools is very important in maintaining local amphibian populations. Many species of insects and other invertebrates, including tiny snails and clams, also live in vernal pools. While some spend part of their life cycle in other habitats, a number survive in the mud during periods when the pool is dry.

OBJECTIVE

Manage vernal pools as amphibian habitat by avoiding temperature increases from loss of shade and by preventing siltation.

CONSIDERATIONS

- *Best Management Practices for Erosion Control* (*Appendix C*) do not address siltation of vernal pools.

  Some vernal pools may meet the statutory definition of wetland and thus are subject to state wetlands regulations. Consult with the New Hampshire Department of Environmental Services or the Natural Resources Conservation Service for assistance.

- Deep ruts in skid roads that collect water may attract breeding amphibians but do not function as vernal pools. Productivity of such pools is often low because the water becomes too warm and oxygen-depleted for larvae to survive to adulthood.

- Amphibians breeding in vernal pools may attach their eggs to small twigs up to an inch in diameter. However, larger woody debris can obstruct amphibian movement through a pool.

- Vernal pools typically represent a very small proportion of a forest.

RECOMMENDED PRACTICES

✓ Identify and mark the perimeter of vernal pools during spring when they are filled with water. Vernal pool locations may not be obvious during the dry season or when the ground is snow-covered. Prior delineation will prevent damage during harvests conducted when they are difficult to detect.

✓ Avoid running machinery through vernal pool basins, even during dry periods, to avoid changing the pool's ability to hold water (*Roble and Kittredge 1991).*

✓ Maintain a shaded and minimally disturbed buffer zone extending 50 feet outward from the high water line to avoid siltation and temperature increases *(Roble and Kittredge 1991*).

✓ Avoid locating roads and skid trails through areas which will drain into vernal pool basins to avoid sedimentation from runoff.

✓ If necessary, conduct forestry operations on snow or frozen ground to avoid erosion and siltation.

✓ If operation on bare, unfrozen ground is unavoidable, avoid leaving ruts exceeding 6 inches in depth within 200 feet of a vernal pool, as such ruts can create barriers for amphibians migrating to and from the pool (*Roble and Kittredge 1991*), and maintain cover by avoiding exposure of mineral soil within 50 feet of a vernal pool.

✓ Avoid felling trees into or piling slash in vernal pool basins. Remove slash that falls into a pool during the dry season. If slash falls into a pool while it is holding water, leave it in place to avoid disturbing eggs already in the pool (*Roble and Kittredge 1991*).

CROSS REFERENCE

Wetlands and Riparian Areas 2.1.

LITERATURE CITED

Colburn, E.A., ed. 1991. *A Citizen's Step-by-Step Guide to Protecting Vernal Pools.* Massachusetts Audubon Society, Lincoln, MA.

Kenney, L.P. 1995. *Wicked Big Puddles: A Guide to the Study and Certification of Vernal Pools.* U.S. Government Printing Office.

Roble, S.M. and D.B. Kittredge, Jr. 1991. "Protection of Vernal Pools During Timber Harvesting." *The Northern Logger & Timber Processor.* May: 6-7

Taylor, J. 1993. *The Amphibians and Reptiles of New Hampshire.* New Hampshire Fish & Game Department, Concord, NH.

4.3 SEEPS

ISSUE **Seeps are easily overlooked areas of critical habitat.**

Seeps or seepage wetlands are generally small areas (less than 1/4 acre) that occur where groundwater comes to the surface. Soil at these sites remains saturated for some portion or all of the growing season, and often stays wet throughout the winter. These wetlands can occur as hillside forest seeps in sloping headwater areas, or as larger sloping seepage forests in till outwash and river terrace sediments *(Tiner 1994; Taylor et al. 1996)*.

Because these sites are the first to green-up in the spring, they are frequented by a variety of wildlife. Black bear, for example, show a strong preference for seeps as important sources of food in spring and summer. In a Massachusetts study, skunk cabbage, grass, and roots growing in seeps constituted a major portion of a bear's spring diet. Grasses, sedges, bulbous roots, and jewelweed next to seeps were shown to make up most of their early summer diet (*Elowe 1984*). Wild turkeys, deer and moose also seek seeps for food, water, and occasionally elements like calcium or sodium that may be present in the groundwater.

Salamanders, spring migrating birds, and cold-water fishes also depend upon seeps. Seeps are preferred habitats of the northern dusky and two-lined salamanders and are often visited by their predators: skunk, raccoon, and river otter (*Whitlock et al. 1994*). During the stress of spring migration, woodcock and robins depend on these sites for water, food (earthworms, insect larvae, etc.) and as a refuge after early spring snow storms.

Seeps located adjacent to streams or rivers maintain coldwater habitats for trout and salmon during summer months when cooler water temperatures prevent 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 has been related to seeps and groundwater upwelling in streams and rivers (*Meisner et al.1988*).

OBJECTIVE **Protect seeps and minimize disturbance to the forest floor (organic layer) adjacent to them during timber harvesting operations.**

CONSIDERATIONS

- Some seeps may meet the statutory definition of wetland and thus be subject to state wetlands regulations. Consult with the New Hampshire Department of Environmental Services or the Natural Resources Conservation Service for assistance.

RECOMMENDED PRACTICES

- ✓ Keep equipment a minimum distance of 50 feet from the seep.
- ✓ Locate roads and skid trails prior to the timber harvest (in seasons other than winter).
- ✓ Conduct selection harvesting or uneven-aged management in the vicinity of seeps on frozen ground where feasible. Avoid even-aged management around seeps.
- ✓ Keep tree tops and slash out of seeps and wildlife trails that access these areas.
- ✓ Avoid intercepting the flow of water downslope of seeps when constructing roads or other developments. If unavoidable, ensure that the interruption of groundwater flow is minimized by adherence to appropriate BMPs for water crossings, such as culverts, portable bridges and pole fords.

CROSS REFERENCE

Wetlands and Riparian Areas 2.1.

LITERATURE CITED

Elowe, K.D. 1984. *Home Range, Movements, and Habitat Preferences of Black Bear (*Ursus americanus*) in Western Massachusetts*. M.S. Thesis. University of Massachusetts, Amherst, MA. 112 pp.

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*. American Fisheries Society. 13(3): 2-8.

Taylor, J., T.D. Lee, and L.F. McCarthy (eds). 1996. *New Hampshire's Living Legacy: The Biodiversity of the Granite State*. New Hampshire Fish & Game Department Non-Game and Endangered Wildlife Program, Concord, NH. 98 pp.

Tiner, R. W. 1994. *Maine Wetlands and Their Boundaries: A Guide for Code Enforcement Officers*. Department of Economic and Community Development. Augusta, ME. 74 pp.

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, MA. 595 pp.

4.4 WOODLAND RAPTOR NEST TREES

ISSUE

Suitable nest sites for woodland-nesting raptors are limited. These birds can be sensitive to human disturbance and habitat changes in the vicinity of nests.

Red-tailed, red-shouldered, broad-winged, sharp-shinned, northern goshawk, and Cooper's hawks build large stick nests in major forks of mature hardwoods and on whorls of large branches of white pines in New Hampshire forests. Several of these species may reuse the same nest in successive years, or build a new nest nearby. These hawks also may remodel a nest originally constructed by a different species. Large owls (barred, great-horned, long-eared) may use old hawk nests. Suitable trees for supporting large stick nests are not common in present-day forests.

The red-shouldered hawk was listed as threatened from 1980 to 1986 — biologists still consider it a species of concern (*J. Kanter, pers. comm.*). This species selects nest sites in large contiguous stands of mature trees (*Johnsgard 1990*), typically in or near lowland forests (*Bent 1961*). Nest trees frequently exceed 17 inches DBH (*Nelson and Titus 1989*) and occur in stands with canopy closure in excess of 65% (*Campbell 1975, Bryant 1986*).

The northern goshawk is a species of concern because of recent declines in some parts of North America, particularly in the western United States (*Block et al. 1993*). This species has increased in New Hampshire as forests have matured (*E.C. Janeway in Foss 1994*). Goshawks nest in mature mixed hardwood and conifer forests (*E.C. Janeway in Foss 1994*) of trees exceeding 8 inches DBH. Most nest trees exceed 12 inches DBH *(Speiser and Bosakowski 1987*).

Cooper's hawk populations are gradually recovering from pesticide effects *(Johnsgard 1990)* and the species is listed as a threatened in New Hampshire (*J. Kanter, pers. comm.*). Nests are located in pine stands, mixed and deciduous woods (*Bent 1961*), near water and forest openings *(Johnsgard 1990*).

Excessive human activity near raptor nests during the early weeks of the breeding season may cause a pair to abandon the site, or may cause a female to flush from the nest, leaving eggs or nestlings vulnerable to fatal chilling or consumption by a predator (*Fyfe and Olendorff 1976).*

OBJECTIVE

Manage for suitable nest trees for woodland-nesting raptors and avoid disturbance of nesting pairs.

CONSIDERATIONS

- Some raptors like red-tailed and broad-winged hawk are more tolerant to disturbance and less stringent guidelines can be followed. Since the species using a particular nest usually is unknown, a conservative approach is best when planning forest management around raptor nests.

- Many woodland raptors nest near water or forest openings such as old woods roads (*Johnsgard 1990, Speiser, 1993*). Nesting hawks may tolerate vehicle traffic on regularly used roads. However, all-terrain vehicle traffic on otherwise unused roads can be a disturbance factor *(Speiser 1993)*.
- Extensive openings make forest habitat more inviting for great horned owls, which prey on both adult and nestling hawks, and may generally discourage hawk nesting attempts (*Craighead and Craighead 1969*).

RECOMMENDED PRACTICES

✓ Check mature white pine and large diameter hardwoods for stick nests; retain trees containing large stick nests, hardwoods with three-pronged forks, and cavity trees (*see Cavity Trees, Dens and Snags 3.7).*

✓ To avoid disturbance during the breeding season, discourage forest management activities within 1600 feet of active raptor nests *(Call 1979)* during February-June.

✓ Surround raptor nests with an uncut buffer of at least 66 feet *(Elliott 1988)* and retain 65-85% canopy closure within a 165 foot radius of large stick nests to maintain habitat conditions in vicinity of nest.

✓ In clearcuts, leave a group of several large trees for each 5-10 acres to ensure future availability of mature trees for nest sites *(Elliott 1988).* These clumps also can serve cavity needs (*see Cavity Trees, Dens and Snags 3.7).*

✓ Avoid recreational use of logging roads adjacent to active nests during the raptor nesting season (February-July). Trails may be temporarily re-routed around nesting areas.

CROSS REFERENCE Cavity Trees, Dens and Snags 3.7; Forest Structure 5.2.

LITERATURE CITED

Bent, A.C. 1961. *Life Histories of North American Birds of Prey. Part One.* Dover Publications, Inc., New York.

Block, W.H., M.L. Morrison, and M.H. Reiser, eds. 1993. "The Northern Goshawk: Ecology and Management." *Studies in Avian Biology No. 16,* Cooper Ornithological Society. 136 pp.

Bryant, A.A. 1986. "Influence of Selective Logging on Red-Shouldered Hawks, *Buteo lineatus,* in Waterloo Region, Ontario, 1953-1978". *Canadian Field-Naturalist* 100: 520-525.

Campbell, C.A. 1975. "Ecology and Reproduction of Red-Shouldered Hawks in the Waterloo Region, Southern Ontario." *Raptor Research* 9(1/2):12-17.

Call, M. 1979. *Habitat Management Guides for Birds of Prey.* USDI Bureau of Land Management Technical Note 338, Denver, Co.

Craighead, J.J. and F.C. Craighead. 1969. *Hawks, Owls and Wildlife.* Dover Publications, Inc., New York.

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

Foss, C.R., ed. 1994. *Atlas of Breeding Birds in New Hampshire.* Arcadia, Dover, NH, and Audubon Society of New Hampshire, Concord, NH.

Fyfe, R.W. and R.R. Olendorff. 1976. *Minimizing the Dangers of Nesting Studies to Raptors and Other Sensitive Species.* Canadian Wildlife Service Occasional Paper Number 23. Information Canada, Catalogue No. CW69-1/23, Ottawa.

Johnsgard, P.A. 1988. *North American Owls.* Smithsonian Institution Press, Washington, DC.

Johnsgard, P.A. 1990. *Hawks, Eagles, and Falcons of North America.* Smithsonian Institution Press, Washington, DC.

Nelson, B.B. and K. Titus. 1989. "Silviculture Practices and Raptor Habitat Associations in the Northeast." Pages 171-179 in Pendleton, B.G., ed. *Proceedings of the Northeast Raptor Management Symposium and Workshop.* Scientific and Technical Series No. 13, Institute for Wildlife Research, National Wildlife Federation, Washington, DC.

Speiser, R. 1993. "Use of Landmarks in Nest Site Selection by Woodland Raptors." *Records of New Jersey Birds* 19:2-5.

Speiser, R. and T. Bosakowski. 1987. "Nest Site Selection by Northern Goshawks in Northern New Jersey and Southeastern New York." *Condor* 89: 387-394.

4.5 HERON COLONIES

ISSUE

Herons nest in colonies in mature trees in or near wetlands and nesting birds are very sensitive to human disturbance.

Great blue herons are large wading birds that nest in colonies of several to many pairs. Nesting colonies may be located miles from wetland and shoreline feeding areas. Most southern New Hampshire nests are in dead trees in beaver ponds; North Country nests are usually in live white pines that tower above the rest of the treetops. Heron colonies also may occur in mature live hardwoods on upland sites.

New Hampshire heron colonies range up to more than 50 nests in size. While colonies of fewer than 8 nests may be relatively short-lived, larger colonies often persist for decades, and generate most of the annual production of young. New Hampshire currently supports about 30 colonies of at least 8 nests and numerous smaller ones (*ASNH data*). About 90% of known colonies, and all but one of the larger ones, are located south of the White Mountains.

Human activity in the vicinity of a nesting colony during the breeding season may lead to low productivity or abandonment (*Bjorkland 1975, Werschkul et al. 1976, Simpson et al. 1987*), and distance from human settlements appears to be a significant factor in colony site selection (*Gibbs et al. 1987, Watts and Bradshaw 1994*). Great blue herons will flush from nests in response to intrusions at distances of roughly 400-600 feet early in the breeding season (April-May) before incubation has begun, and at distances of roughly 100-300 feet during incubation and nestling periods (*Vos et al. 1985*).

OBJECTIVE

Prevent disturbance or loss of heron nesting colonies.

CONSIDERATIONS

- New 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 are more of a problem than traffic.

RECOMMENDED PRACTICES

Within 330 feet of a heron colony:

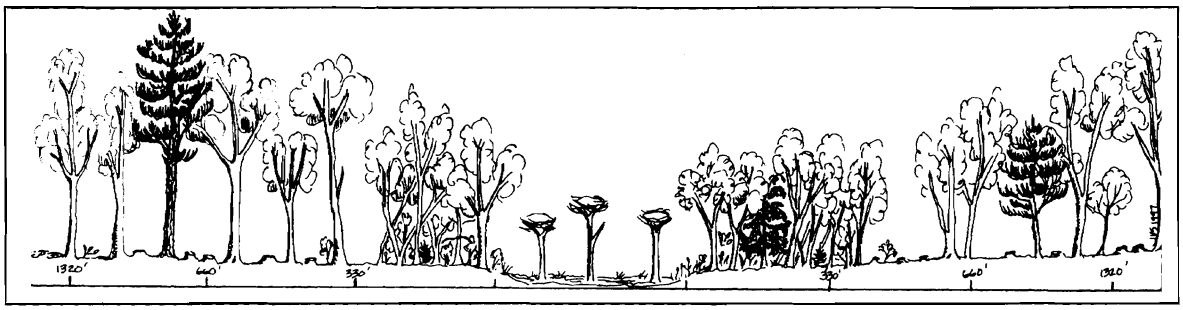
✓ Avoid harvesting and road construction;

✓ Avoid recreational activities during the nesting season (April-August) (*Elliott 1988).*

Between 330 and 660 feet from a heron colony:

✓ Limit harvests to single tree or small group selection;

✓ Avoid harvesting during the nesting season (April-August) (*Elliott 1988).*



Between 660 and 1320 feet from a heron colony:

- ✓ Avoid high disturbance activities such as road construction, site preparation, and loud recreational activities during the nesting season (April-August) (*Elliott 1988*).
- ✓ Avoid harvesting in ways that substantially increase wind exposure of nest trees.
- ✓ When planning operations in the vicinity of a heron colony exceeding eight nests, consult the New Hampshire Nongame and Endangered Wildlife Program biologist at the New Hampshire Fish & Game Department.

CROSS REFERENCE

Wetlands and Riparian Areas 2.1.

LITERATURE CITED

Bjorkland, R.G. 1975. "On the Death of a Midwestern Heronry." *Wilson Bulletin* 87: 284–287.

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

Gibb, J.P., S. Woodward, M.L. Hunter, and A.E. Hutchinson. 1987. "Determinants of Great Blue Heron Colony Distribution in Coastal Maine." *Auk* 104: 38–47.

Simpson, K., J.N.M. Smith, and J.P. Kelsall. 1987. "Correlates and Consequences of Coloniality in Great Blue Herons." *Canadian Journal of Zoology* 65: 572–577.

Vos, D., R. Ryder, and W. Graul. 1985. "Response of Breeding Great Blue Herons to Human Disturbance in North Central Colorado." *Colonial Waterbirds* 8: 13–22.

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.

Werschkul, D.F., E. MacMahon, and M. Leitschut. 1976. "Some Effects of Human Activities on the Great Blue Heron in Oregon." *Wilson Bulletin* 88:660–662.

4.6 BALD EAGLE AND OSPREY NESTS

ISSUE

The bald eagle is a state-endangered and federally-threatened species and the osprey is a state-threatened species. Continued existence of both birds in New Hampshire depends on the supply of adequate nest trees.

Both species require large water bodies for foraging; the osprey feeds almost exclusively on fish, while the bald eagle feeds largely on fish and waterfowl.

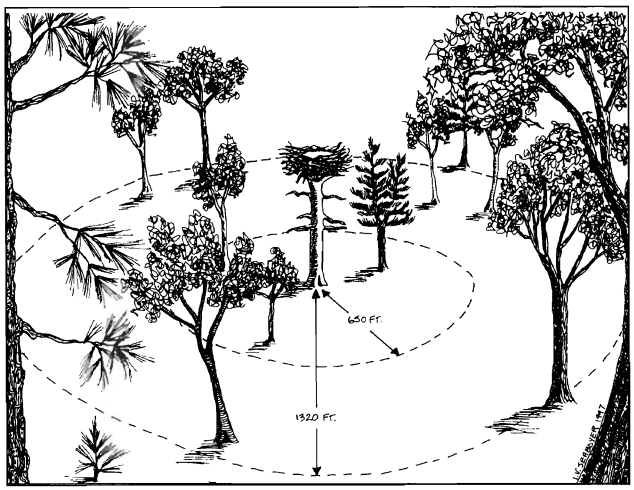
While there is only one nesting pair of bald eagles in New Hampshire (at Umbagog Lake) at the present time, this number is likely to increase in the coming decades (*M. Amaral, USFWS, pers. comm.*). This species typically nests in large live or dead trees, often white pines, usually within one half a mile of the shore of a large water body (*Snow 1973*). Ospreys nest in the upper Androscoggin drainage basin, the Connecticut Lakes region, and in the vicinity of Great Bay. After a period of serious decline due to the effects of DDT, New Hampshire's osprey population has expanded significantly during the past decade, and may colonize new areas in the future. Ospreys nest in dead or dead-topped trees, most often in white pines but occasionally in other tall softwoods. Osprey nests may be several miles from the nearest open water. Many are associated with a wetland or the riparian zone of a stream, but some are in upland settings. Both osprey and bald eagle nests are typically used for years or even decades, with pairs adding additional nesting material annually.

OBJECTIVE

Maintain existing eagle and osprey nest trees and potential replacement trees. Avoid disturbance in the vicinity of active nests during the breeding season.

CONSIDERATIONS

- The New Hampshire Fish & Game Department's Nongame and Endangered Species Program monitors nests of these species through efforts of the Audubon Society of New Hampshire, and maintains communication with landowners regarding the status of known nests. Provisions of voluntary management agreements in place with landowners since the mid-1980s are reflected in the recommended practices provided below.



RECOMMENDED PRACTICES

✓ Contact the Nongame and Endangered Species Program coordinator at the New Hampshire Fish & Game Department for assistance in planning a harvest within one quarter mile of an osprey or bald eagle nest (*Grier et al. 1984, Smith and Nevers 1985*).

✓ Avoid human activity within 650 feet of active nests from April 1–August 30 *(Call 1979)*. Schedule activities in the vicinity of osprey and bald eagle nests during September–March.

CROSS REFERENCE

Bald Eagle Winter Roosts 4.7.

LITERATURE CITED

Call, M. 1979. *Habitat Management Guides for Birds of Prey*. USDI Bureau of Land Management Technical Note TN-338.

Grier, J.W., F.J. Gramlich, J. Mattson, J.E. Mathison, J.V. Kussman, J.B. Elder, and N.F. Green. 1984. *Northern States Bald Eagle Recovery Plan*. USDI Fish & Wildlife Service, Denver, CO.

Smith, C.F. and H.P. Nevers. 1985. "Incorporating Osprey Nest Protection into Timber Management Practices: New Hampshire's Approach." Pages 292–300 in W. McComb, ed. *Proceedings of Workshop on Nongame Species and Ecological Communities*. Forestry Department, College of Agriculture, University of Kentucky, Lexington.

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 Technical Note TN-171.

4.7 BALD EAGLE WINTER ROOSTS

ISSUE

Wintering eagles need perch sites and sheltered roosting areas.

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, sometimes mixed with large hardwoods, provide sheltered roosting areas where eagles spend the night and periods of inclement weather. These roost areas may be some distance from the shore. Roosts must provide protection from the wind and from excessively cold temperatures, as well as open flyways to perch sites. Large trees with widely-spaced branches allow eagles, which stand more than 3 feet tall and have a 6–7.5 foot wingspread, access to suitable perches.

Winter is stressful because cold temperatures increase energy demands and food can be difficult to obtain. Eagles spend many winter hours perching quietly in a protected location. Eagles vary in their tolerance to human activity, depending on the individual eagle, the particular roost or perch, and even the individual human involved (*Snow 1973*). Human activity near roosts and perches can interfere with foraging and disturb eagles from protected perches (*Grier et al. 1984*), increasing energy demands and sometimes forcing eagles to perch in exposed locations.

In New Hampshire, wintering bald eagles occur in limited areas near open water in the Lakes Region, the Great Bay area, and along the Androscoggin, Merrimack, and Connecticut rivers.

OBJECTIVE

Manage for structural 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–March.

CONSIDERATIONS

- Consistently-used roost and perch sites are limited in number and extent and are documented from annual monitoring efforts since the early 1980s.
- Winter eagle roosts are difficult to recognize when the eagles are not present. Wildlife biologists can advise on whether or not a planned harvest is in a sensitive area.

RECOMMENDED PRACTICES

- ✓ When considering a white pine harvest within one half a mile of the shore in any of the identified wintering areas, or when planning a harvest in the vicinity of a known roost, consult the Nongame and Endangered Species Program coordinator at the New Hampshire Fish & Game Department for assistance in planning harvest activities.
- ✓ Avoid harvesting in stands where eagles are known to roost.
- ✓ Avoid routing recreational or logging trails in the immediate vicinity of known and potential night roosts and day perches.

CROSS REFERENCE

Bald Eagle and Osprey Nests 4.6.

LITERATURE CITED

Grier, J.W., F.J. Gramlich, J. Mattson, J.E. Mathison, J.V. Kussman, J.B. Elder, and N.F. Green. 1984. *Northern States Bald Eagle Recovery Plan.* USDI Fish & Wildlife Service, Denver, CO.

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 Technical Note TN-171.

4.8 OLD-GROWTH FORESTS

ISSUE **Old-growth forests in New Hampshire occupy only a tiny fraction of their original area. Preserving both identified and unidentified remnants of old-growth and restoring additional areas would provide many important habitat, aesthetic, educational, and other natural resource values.**

The forest that greeted New Hampshire's original European settlers exists today only as scattered remnants. These forest patches (commonly called old-growth, virgin, primeval, or ancient forests) traditionally refer to forests that have escaped harvesting or other human modification over the last 350 years. Carbonneau (1986) confirmed only 12 old-growth forest sites ranging in size from 2 to 400 acres and totaling about 3,000 acres statewide. It is possible that additional areas exist, but have not been identified; these will generally be small areas that escaped harvesting because of difficult access. Any harvesting in old-growth areas will diminish their value as examples of natural community composition and development.

Restoration of pre-settlement forest conditions is not possible. However, there are areas that may have seen some level of harvesting in the past but still exhibit many of the characteristics of old-growth. Rather than being an either/or situation, the presence of old-growth should be thought of as a continuum, with certain stands being more old-growth like than others. Defining old growth by its characteristics, rather than its history, means that old-growth can be restored, simply by allowing natural ecological processes to progress over time without human interference.

Old-growth forests have most or all of the following characteristics *(Davis, 1996)*:

- An abundance of 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, large thick limbs, and trunks often showing a twist that develops with age.
- An abundance of dead and downed logs in all stages of decomposition, criss-crossing the forest floor and lying in and across stream beds, covered with moss and lichens.
- An abundance of dead standing trees (called snags).
- Canopy gaps large and small, formed from trees that have fallen.

- Undulating forest floor expressed in randomly scattered pits and mounds where trees have fallen over and decomposed.
- Multiple growth layers: overstory (trees that make up the canopy); understory (trees beneath the canopy); and shrub, herbaceous, and ground layers visible to one degree or another, all reflecting a broad spectrum of age.
- Undisturbed soils with a relatively thick humus layer in some forest types.
- Abundance of lichens, mosses, and fungi, particularly in acid-based soils.
- Majority of tree species that fall into the late successional class (shade-tolerant trees) and a conspicuous absence of multiple-stemmed trees (called coppices).
- Absences of signs of human disturbance (lack of cellar holes, stone-walls, wire fence, roads, stumps).

Maintaining or restoring old-growth characteristics as a component of New Hampshire's forest would have many benefits:

- Maintaining biological diversity. Some species of flora and fauna are more abundant in older forests, and some species are found primarily in old-growth stands.
- Serving as controls for understanding the impacts of forest management.
- Providing opportunities for citizens to experience old-growth forests.
- Contributing natural resource and economic values of which we are not aware. (For example, the Pacific Yew was commonly called a "trash tree" until it was discovered to be an important source of taxol, an anti-cancer drug (*Kelly and Braasch, 1988*).

OBJECTIVE

Preserve existing stands of old-growth and restore additional areas where possible.

CONSIDERATIONS

- Managing to retain or develop old-growth characteristics may entail an economic loss to the landowner.
- Maintaining or restoring old-growth forests requires long-range planning and commitment (150 to 300 years).

RECOMMENDED PRACTICES

- ✓ Survey harvest areas and identify places that exhibit characteristics of old-growth described above.
- ✓ Avoid harvesting any areas suspected of being old-growth fragments.

- ✓ Consider restoring areas of old-growth within managed forests. Places that could be considered for old-growth management include areas already exhibiting some old-growth characteristics, inaccessible or inoperable terrain, or riparian management zones. These areas should be allowed to develop naturally, by letting ecological processes prevail over time (150 to 300+ years).
- ✓ When permanent areas for old-growth cannot be established, defer cutting 1 to 2 rotations (80 to 160 years) on 2.5% of ownership. This procedure is easy to apply in the field, it doesn't lock up large amounts of forest land, and most importantly, meets the old-growth habitat needs of New Hampshire wildlife (*Williamson, 1993*).

CROSS REFERENCE

Wetlands and Riparian Areas 2.1; Cavity Trees, Dens and Snags 3.7; Forest Structure 5.2.

LITERATURE CITED

Carbonneau, L. 1986. *Old-Growth Forest Stands In New Hampshire, A Preliminary Investigation.* University of New Hampshire.

Davis, Mary Byrd. 1996. *Eastern Old-Growth Forests, Prospects for Rediscovery and Recovery.* Island Press, Washington, DC.

Kelly, D. and Braasch, G. 1988. *Secrets of the Old Growth Forest.* Gibbs Smith.

Williamson, S.J. 1995. *Forester's Guide to Wildlife Habitat Improvement (2nd ed.).* University of New Hampshire Cooperative Extension Service, Durham, NH.

4.9 HIGH-ELEVATION FORESTS

ISSUE

High-elevation forest land in New Hampshire possesses unique ecological characteristics.

High-elevation spruce–fir forests are often characterized by shallow soils, steep slopes, short growing seasons, unique habitat qualities and high visibility. They provide habitat for pine marten, Bicknell's thrush, black-backed woodpecker, blackpoll warbler, spruce grouse and several other species. In order to safeguard habitat and soils, care must be taken when managing these sites.

Traditionally, high-elevation forest land in New Hampshire has been considered as those lands above 2,700 feet. Over eighty percent of high-elevation land in New Hampshire is publicly owned. The remaining high elevation land is in private ownership. The objectives of these owners vary, with timber production being a high priority for some owners.

OBJECTIVE

Maintain the long-term ecological integrity of high-elevation forests and the systems they influence.

CONSIDERATIONS

- Most private timberlands above 2,700 feet in elevation are managed under a voluntary agreement between private landowners and the state. The recommendations that follow were derived from this agreement which specifically addresses land above 2,700 feet.* If you own land above this elevation and would like information on the agreement, contact the New Hampshire Division of Forests & Lands or the New Hampshire Fish & Game Department.
- Land below 2,700 feet may exhibit characteristics of high elevation forests. These lands are also characterized by shallow soils, steep slopes, and are often dominated by spruce and fir. They may occur on lower elevations on summits and ridge-lines throughout the state.
- These practices may be applicable to lower lands; work with professionals to adapt these recommendations to lower elevation sites.

RECOMMENDED PRACTICES*

All Forest Types:

✓ Access should be carefully considered, with winter skidding of wood to lower elevation land preferred.

✓ Limit length of material to be skidded.

✓ Schedule harvest for winter conditions.

✓ Perform harvest layout during snow-free conditions.

✓ Avoid removing softwood limbs and tops from the harvest site.

- ✓ Avoid whole-tree harvesting of hardwood tree species.
- ✓ Retain large live cull or cavity trees.

Spruce–Fir Forest Types:

- ✓ Management on high elevation lands should be directed toward maintaining the proportion of softwood types.
- ✓ Forest management should be directed toward achieving the following composition and structure goals:
  - At least 60% of the management area should remain in stands with an average tree diameter of 4 inches or greater.
  - No more than 30% of the area should be in stands with an average tree diameter less than 4 inches or without adequate stocking.
  - At least 10% of the area should be designated to remain unharvested.

CROSS REFERENCE

Cavity Trees, Dens and Snags 3.7.

LITERATURE CITED

High Elevation Memorandum of Understanding. 1996. New Hampshire Division of Forests & Lands and the New Hampshire Fish & Game Department.

Section Five
Timber
Quality/Flow

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
1995

5.1 REGENERATION: THE RIGHT TREE ON THE RIGHT SITE

ISSUE

Carefully designed regeneration practices help perpetuate desired tree species.

Regeneration involves analyzing the capability of the site and deciding what species (or species mix) will meet your objectives. The appropriate practice is then implemented. The objective may be sustained production of certain timber species, valuable wildlife habitat, or other resource conditions. The choice of species to regenerate is limited by site capability, and the presence or absence of advanced regeneration.

Site Capability

Analysis of site capability will give insight about which species are best adapted to grow on a particular site. Site analysis may be complicated, requiring professional advice. However, some general guidelines are (*Leak 1982*):

SPECIES	PREFERRED SITE AND SOIL CONDITIONS
White ash (M), Sugar maple (T)	Moderately well-drained and enriched fine-textured tills, especially with low acidity.
Beech (T)	Sandy tills, but common on a wide variety of soils.
Red oak (M)*	Sandy tills and outwash (but poorly developed here).
White pine (M)*	Outwash and to a lesser extent on sandy tills.
Yellow birch (M)	Moderately well-drained, fine-textured tills; also on poorly-drained pan soils in mixture with softwoods.
Red spruce (T), hemlock (T), balsam fir (T)	Shallow pan soils, usually poorly drained; outwash and lake bed sediments; shallow-to-bedrock soils.
Paper birch (I), aspen (I), red maple (M)	Adapted to a variety of soils, but often associated with tolerant softwoods.

T= shade tolerant, M= intermediate shade tolerance, I= shade intolerant.

* *Currently found on a variety of soils due to agricultural history. They are generally difficult to regenerate on some sites.*

Site capability categories have been developed by the Natural Resources Conservation Service (NRCS) to correspond with their county soil survey maps. All counties in New Hampshire have been mapped at least once and some county maps are being updated. NRCS soil capability categories are referred to as Important Forest Soil Groups (IFSG).

Advanced Regeneration

The presence of seedlings and/or saplings in the stand is referred to as "advanced regeneration." Often advanced regeneration will determine what species of trees will regenerate in the stand and can reflect the site capability.

Some hardwoods such as beech and red maple are very aggressive as advanced regeneration on certain sites. When crushed during timber harvest operations they often sprout profusely. Other hardwoods are not as aggressive and may sprout from small stumps but their future in the stand is less certain.

Other species including most softwoods, may be persistent as advanced regeneration but may be easily eliminated from a stand if harvesting practices do not protect them. Most softwoods do not sprout. If advanced regeneration is destroyed during a timber harvest new stems must start over from seed. Many softwood species are slow starters from seed for the first few years, giving hardwoods a head-start in the regeneration process.

A lack of advanced regeneration may provide opportunities to establish a desired species group suitable to the site. Measures may be taken to establish the desired species as advanced regeneration, or harvest practices may be designed to encourage pioneer species.

Once the management objective is consistent with the site capability, an appropriate regeneration harvest method must be chosen as well as any incidental site preparation practices. 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, but should be carefully evaluated during harvest planning and implementation.

OBJECTIVE

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

CONSIDERATIONS

- Natural regeneration is prolific in New Hampshire due to favorable conditions of climate, soil, and native species. As a result, 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 cause the management objective or harvest method to be revised. 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 pine by gypsy moth.

- The success of regeneration practices can be clearly evaluated only after 5-10 years of observation 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.
- When timber production is the primary goal, some common tree and shrub species may out-compete more valuable commercial species. Among the common competitive, non-commercial species (hobblebush, striped maple, ferns and beech sucker growth), hobblebush and ferns are the most serious competitor to commercial species of regeneration (*Leak 1988*).

RECOMMENDED PRACTICES

✓ Determine the species to regenerate, based on site capability, the presence or absence of advanced regeneration, and long-term timber/wildlife values and biological and economic risks.

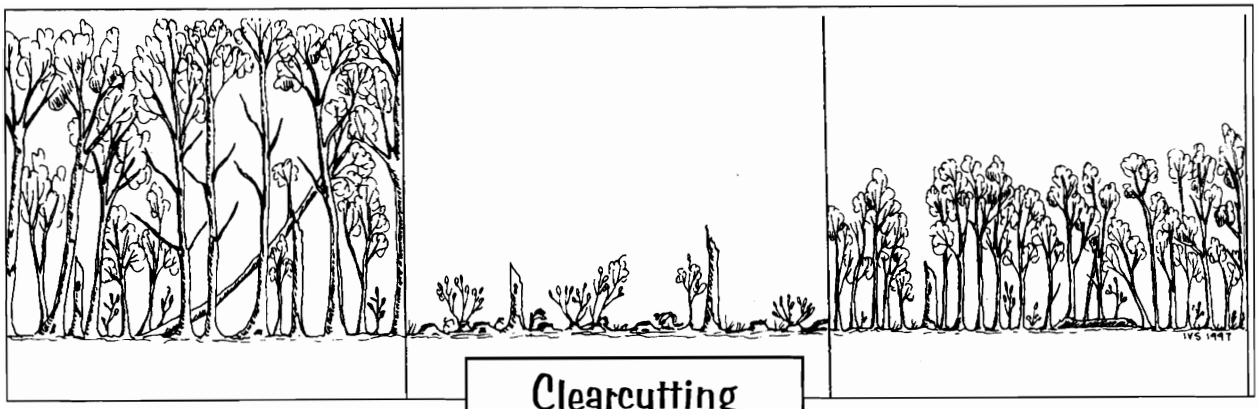
✓ Chose a regeneration method based on the general guidelines below (*Frank and Bjorkbom 1973, Lancaster and Leak 1978, Leak et al 1987*). Professional advice is recommended.

SPECIES	**HARVEST METHOD *(see illustrations)***
Beech sugar maple, red spruce*, balsam fir*, hemlock*	Single-tree/small group selection (< 1/4 acre) or narrow strips (< 50 feet wide)
White ash, yellow birch, aspen and paper birch (> 2/3 acre groups), red oak, white pine.	Group selection (1/4–2 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.	Clearcutting or wide strips (> 100 feet)

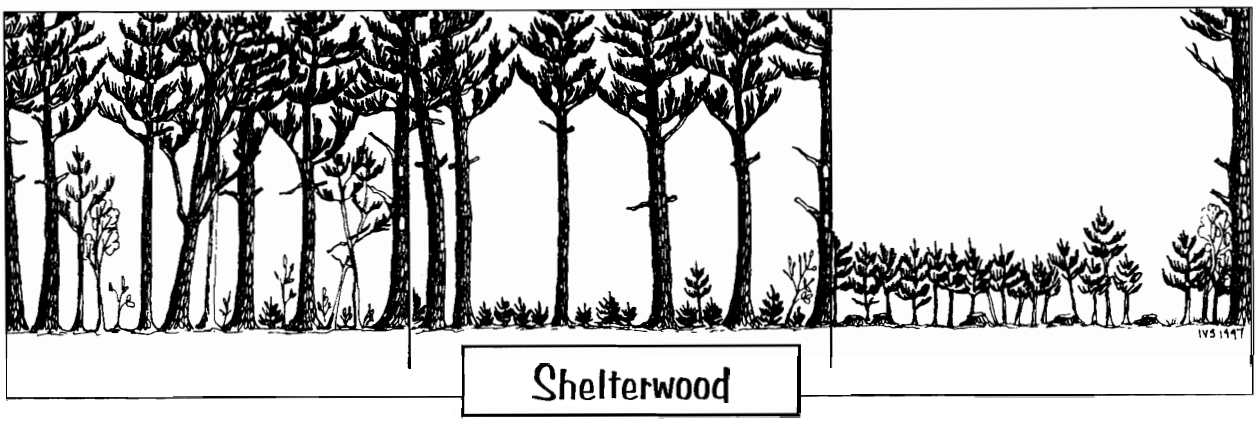
* *on wet and shallow soils windthrow can be a problem if using single tree selection.*

† *A natural shelterwood is a removal cut where there is advanced regeneration present.*

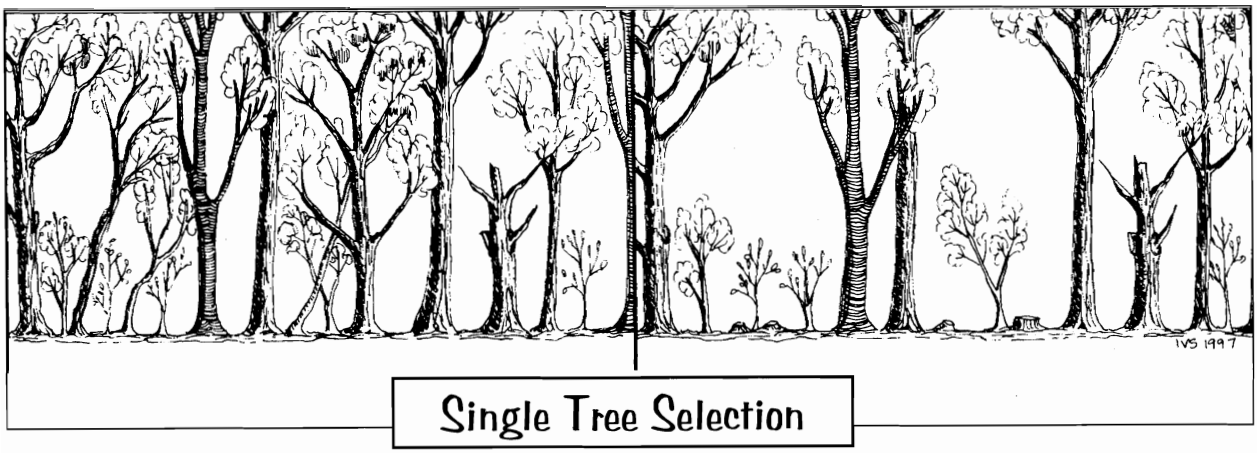
Regeneration Harvest Methods



Clearcutting



Shelterwood



Single Tree Selection

Group Selection

✓ 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 pole-timber or small sawlog trees

✓ Regenerate oak on better sites by encouraging small-stump sprouts *(Johnson 1993)*, or shelterwood cutting during the fall-winter of a good seed year coupled with harvesting activity or special treatment to bury the seed.

✓ Minimize beech-suckering by avoiding damage to beech roots by cutting in winter, minimizing skidder traffic especially near cut stumps, and winching.

✓ Reduce shade-tolerant competitive species through heavy cutting (complete removal of all vegetation in groups or larger patches) which converts the stand to earlier-successional species.

CROSS REFERENCE

Aspen Management 3.4; Dead and Downed Woody Debris 3.8; Forest Structure 5.2; Managing for High Quality Trees 5.3; Controlling Logging Damage 5.4; Clearcutting 5.5.

LITERATURE CITED

Frank, R.M. and J.C. Bjorkbom. 1973. *A Silvicultural Guide for Spruce-Fir in the Northeast.* USDA Forest Service General Technical Report NE-6. 29 pp.

Johnson, P.S. 1993. *Perspectives on the Ecology and Silviculture of Oak-Dominated Forests in the Central and Eastern States.* USDA Forest Service General Technical Report NC-153. 28 pp.

Lancaster, K.F. and W.B. Leak. 1978. *A Silvicultural Guide for White Pine in the Northeast.* USDA Forest Service General Technical Report NE-41. 13 pp.

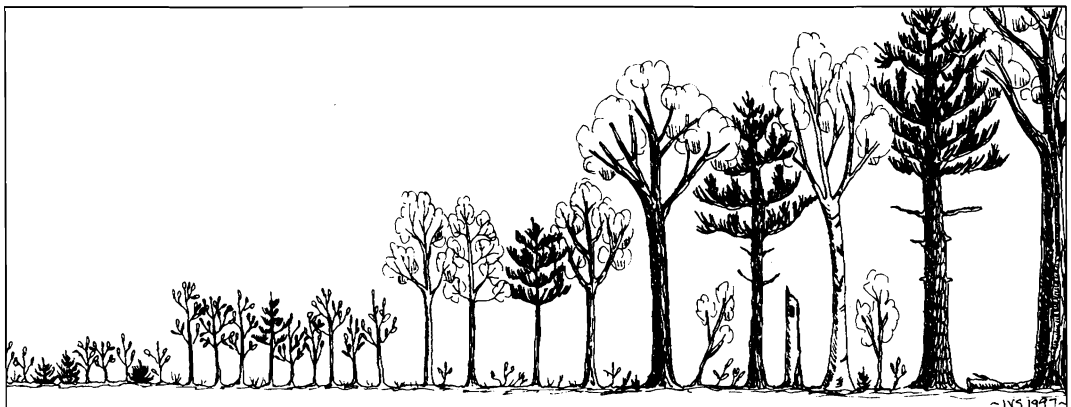
Leak, W.B., D.S. Solomon, and P.S. DeBald. 1987. *Silvicultural Guide for Northern Hardwood Types in the Northeast (revised).* USDA Forest Service Research Paper NE-603. 36 pp.

Leak, W.B. 1988 "Effects of Weed Species on Northern Hardwood Regeneration in New Hampshire." *Northern Journal of Applied Forestry* 5:235-237.

5.2 FOREST STRUCTURE

ISSUE

Managing forest structure can help landowners sustain quality timber production and meet a variety of goals.



Forest Structure

Forest Structure

Forest structure is a function of the trees, shrubs, and ground cover found within a forest. Structure, which looks at the proportion of small, medium, and large trees, is usually reported as trees per acre by diameter class.

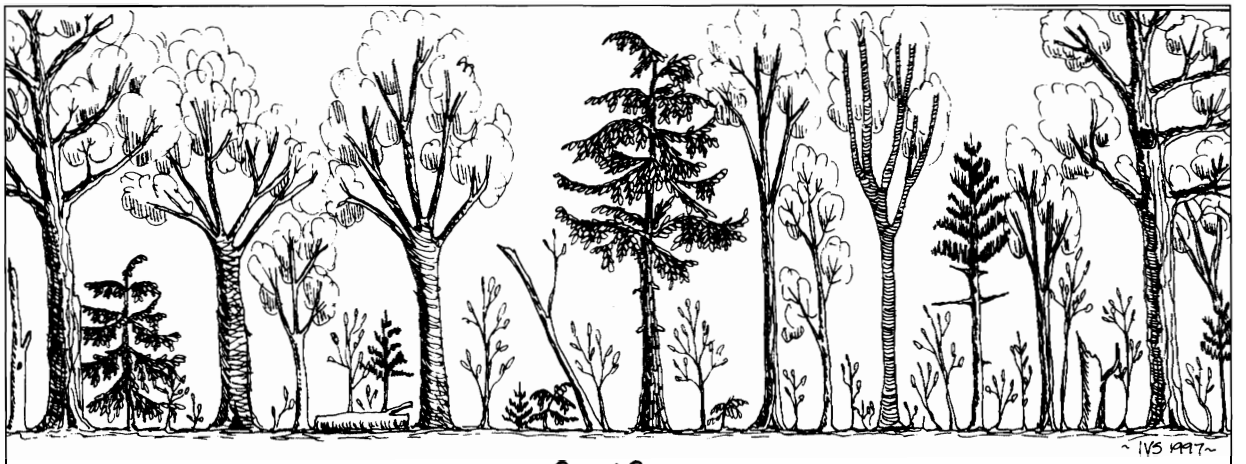
Forests may have a simple structure or they can be very complex. In a simple structure, tree communities are composed of few species and age classes, and most of the tree sizes come close to the average stand diameter. The most extreme example of a simple structure is a plantation. Forests resulting from even-aged regeneration techniques may display a simple structure.

As species and or age diversity increases within a stand or forest, structure becomes more complex. Different species often grow at different rates. A distinct canopy is no longer 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. When three or more age classes are present, foresters consider the stand uneven-aged.

Wildlife biologists are often interested in structure because of its relationship to biological diversity and wildlife habitat. Other chapters in this publication address these 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/forest structure.



Stand Structure

CONSIDERATIONS

- Maintaining a balanced stand structure is more practical on larger ownerships.
- Sustained production of quality timber is sometimes attempted by simple rules such as keeping harvest equal to growth. This is only possible after the stand structure becomes balanced at an optimum level, and may not account for other practices in this publication.
- Control of stand structure requires appreciable effort, and probably professional assistance with stand inventory and timber marking practices.
- Stand/forest structure and density guidelines vary by species. General guidelines are given to cover the likely range in conditions.
- Even-aged stands can provide horizontal diversity (i.e. a variety of forest types and age classes across the landscape) if harvesting is properly controlled. *(DeGraaf et al. 1992).*
- Uneven-aged stands often provide a variety of vertical structure (i.e. multiple canopy layers, for example; overstory, mid-story and shrub layers). *(DeGraaf et al. 1992).*
- Even-aged stands can provide some vertical structure, particularly when routinely thinned, and uneven-aged stands can provide some horizontal structure, especially when group selection is used.
- Site factors, such as soil, can influence stand structure.

RECOMMENDED PRACTICES

Inventory:

✓ Inventory the stand to gather data on the number of 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.

✓ Strive for the following percent of acres in seedling/sapling stands, pole-timber stands and sawlog stands *(Frank and Bjorkbom 1973, Lancaster and Leak 1978, Leak et al 1987)*:

TREE SIZE	PERCENT OF ACRES
Seedling/Sapling	20-30
Pole-timber	25-35
Sawlog	35-55

These 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).

✓ Lower the percents suggested in the above table in seedling/sapling stands and increase the percents in sawlog and mature stands, when rotation ages are extended for some biodiversity, wildlife or aesthetic goals.

Uneven-aged management:

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

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

TREE DIAMETER	PERCENT B.A	PERCENT NOS. TREES
6-10	30-50	60-80
12-14	20-30	15-20
16-22+	25-50	5-20

For example: 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. 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 when appropriate, important wildlife habitat inclusions (aspen, soft mast, hemlock, oak raptor nesting trees) as part of uneven-aged management practices.

CROSS REFERENCE

Overstory Inclusions 3.1; Aspen Management 3.4; Cavity Trees, Dens and Snags 3.7; Dead and Down Woody Debris 3.8; Old Growth Forests 4.8; Regeneration: The Right Tree on the Right Site 5.1; Managing for High Quality Trees 5.3; Clearcutting 5.5.

LITERATURE CITED

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and J.W. Lanier. 1992. *New England Wildlife: Management of Forested Habitats*. USDA Forest Service General Technical Report 144, Radnor, PA. 271 pp.

Frank, R.M. and J.C. Bjorkbom. 1973. *A Silvicultural Guide for Spruce–Fir in the Northeast.* USDA Forest Service General Technical Report NE-6. 29 pp.

Lancaster, K.F. and W.B. Leak. 1978. *A Silvicultural Guide for White Pine in the Northeast.* USDA Forest Service General Technical Report NE-41. 13 pp.

Leak, W.B., D.S. Solomon, and P.S. DeBald. 1987. *Silvicultural Guide for Northern Hardwood Types in the Northeast (revised).* USDA Forest Service Research Paper NE-603. 36 pp.

5.3 MANAGING FOR HIGH-QUALITY TREES

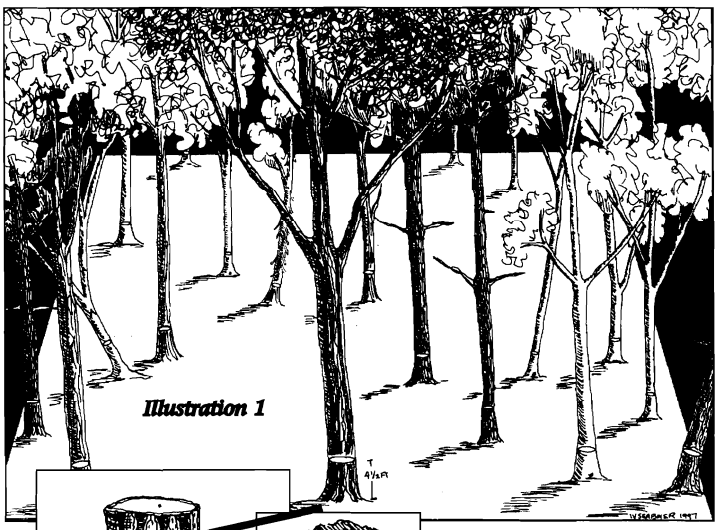
ISSUE **Quality trees are important to the region's wood products industry. However, lack of low grade markets, high-grading, and ignorance of proper forestry has resulted in many forests exhibiting timber quality well below the capability of the soil and site.**

Quality is a function of both tree size and the amount of clear knot-free lumber the tree can produce. Both are heavily influenced by the density of the stand.

The density of trees in a forest stand affects tree growth and quality. When the density is too high, tree growth will slow. When the density is too low, growth per acre diminishes and there may be problems with excessive branching. Low stand density interferes with natural pruning and can produce excessive branching resulting in reduced lumber quality. Pruning excess branches is expensive but can lead to increased timber quality in the right circumstances.

Stand Density

Stand density, or crowding, is based on tree size (diameter) and the number of trees per acre, and how close they are growing.



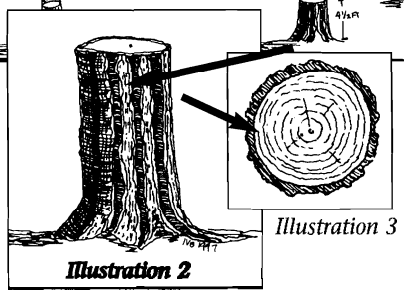


Illustration 3

Foresters usually calculate stand density in terms of basal area. Basal area is a measure of the area of the cross-section of tree at diameter at breast height, or DBH.

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)* would be measured to determine the basal area of that tree *(illustration 3)*. Basal area is usually expressed in square feet. If the basal area of all trees on an acre were added together, the result would be square feet of basal area per acre.

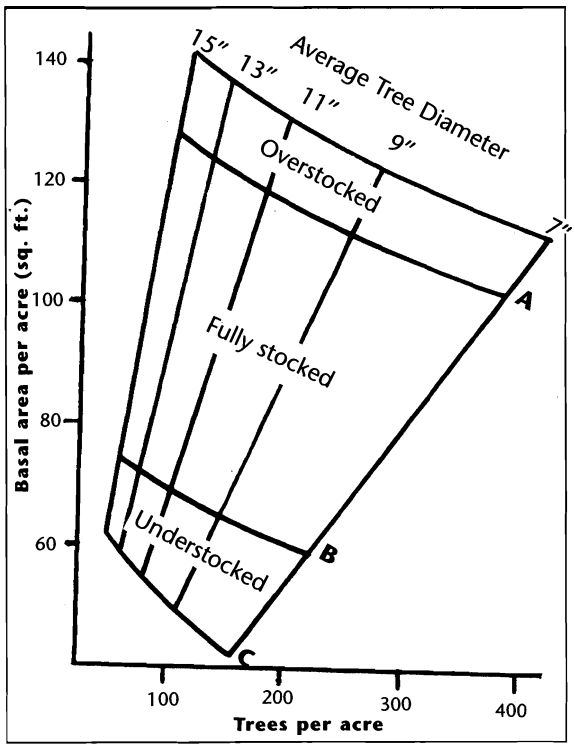
It takes several small trees to equal the basal area of a large tree. For example, the basal area of four 6-inch diameter trees equals the basal area of one 12-inch diameter tree. A stand's density can be adjusted by removing some of the trees through timber management. Different standards apply to even-aged and uneven-aged management techniques.

When a forest stand is managed for only one or two distinct age classes, it is termed even-aged management. These stands are regenerated by clearcut, shelterwood, or seed-tree cutting methods.

Even-aged management

The best density for even-aged stands is reflected in stocking guides *(see illustration)*. These guides assist the timber manager in determining 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 under-stocked, resulting in lower timber growth per acre and excessive branchiness (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 permits enough trees to be cut to provide for a commercial harvest, and increases diameter growth. The trees removed are often the poorest quality stems so that 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 stems most capable of achieving the desired goals, extra consideration should be used in deciding what the spacing around these trees should be and how much light these stems receive.

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.

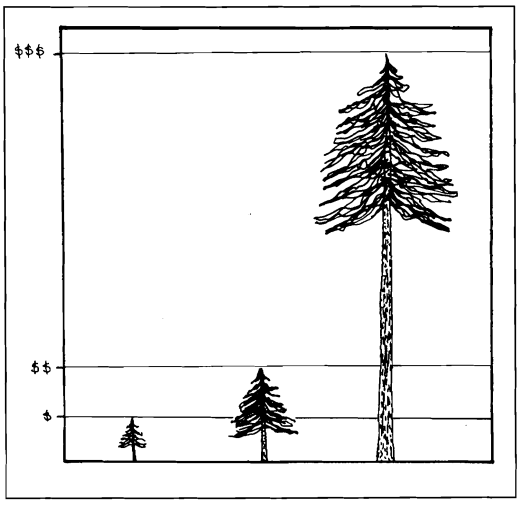
In uneven-aged management all diameter classes are represented in the stand. Since the relative proportions of the diameter classes to each other are the same, there is generally one best density range after the harvest. Foresters mark the trees to be cut in the stand to achieve a desired distribution 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 the maintenance of optimum stand densities.

CONSIDERATIONS

- Crop tree species susceptible to epicormic sprouting (most hardwoods) should be protected from receiving too much light. For those species not prone to epicormic sprouting it may be wise to provide extra light to increase diameter growth.
- Young stands, where most of the trees to be removed will not produce commercial products, may require non-commercial treatments. These stands may qualify for federal cost share assistance. Pruning also may qualify for federal cost sharing. Contact your county extension forester for more information.
- The following conditions will affect the optimum residual basal areas in uneven-aged stands:
  - The time between harvests (cutting cycle – which ranges from 10–25 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. This is due to 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 is to accommodate the longer period of growth available and to prevent overcrowding within the stand toward the end of the cutting cycle.
  - Occasionally, the stand density must be decreased to the lower ranges of suggested density to accommodate the harvesting of trees that would otherwise die or deteriorate to unacceptable levels. There are many causes for this such as insect attack and diseases, abiotic factors such as ice damage and drought stress, or uneven distribution of age classes.
- A dramatic jump in value usually occurs as a tree grows into the sawlog class (greater than 8–10 inches DBH for softwood and greater than 10–12 inches DBH for hardwoods). An even greater jump in value may occur as a tree grows past the 10–18 inch DBH size classes into the prime and veneer grades. The difference in value between a 12 inch DBH sawlog-grade tree and an 18 inch diameter veneer grade tree can be 400-500%. *(see illustration).*



- 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 hard woods and 60 square feet per acre of high quality trees in soft-woods and mixed-woods), that even-aged management of the stand may be a better option (*Leak et al. 1987*). Professional assistance should be sought in making this determination.
- Providing a sustainable flow of timber depends on maintaining density, stand structure, and providing for regeneration.

- Growing high quality trees cannot be accomplished through high-grading (removal of best trees) or liquidation (removal of all merchantable trees). Diameter-limit cuts also are not preferred, and, if used, must be carefully designed based on inventory data and use of different limits by species to qualify as a quality-sustaining practice.
- Stand density varies by the species mix. In using this chapter, remember the following:

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

	HARDWOOD		MIXED-WOOD		SOFTWOOD	
Mean DBH. (inches)	**A-line** sq. ft. / acre	**B-line**	**A-line** sq. ft. / acre	**B-line**	**A-line** sq. ft. / acre	**B-line**
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

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 over-topped by other tree crowns.

✓ Follow the density guidelines below. Thin when the density is halfway between A and B.

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 – 5.0 inches in DBH. (Since uneven-aged stands have a range of tree size, average stand diameter is not 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

*NOTE: lower end of the range is based on the 1973 spruce fir cutting guide and applies to longer cutting cycles. When considering a white pine stand the minimum residual basal area would be higher. The higher end of the range will maximize growth.

Pruning:

✓ Prune in pole-sized stands when crop trees can be well identified. No more than 100 softwood crop trees per acre should be pruned. In hardwoods, no more than 50 to 75 crop trees per acre should be pruned. This number represents how many crop trees can be carried to full maturity in a managed stand and add enough growth of clear, knot-free wood to justify the pruning investment. Trees selected should be 4 to 6 inches in diameter, and never larger than 10 inches. Pruning should follow, rather than precede, thinning.

✓ Keep damage to crop trees at an absolute minimum during harvest operations and document when and where pruning occurred. This will insure that the investment in pruning will be protected.

CROSS REFERENCE

Regeneration: The Right Tree on the Right Site 5.1; Forest Structure 5.2; Controlling Logging Damage 5.4.

LITERATURE CITED

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

Frank, R.M. and J.C. Bjorkbom. 1973. *A Silvicultural Guide for Spruce–Fir in the Northeast.* USDA Forest Service General Technical Report NE-6. 29 pp.

Leak, W.B., D.S. Solomon, and P.S. DeBald. 1987. *Silvicultural Guide for Northern Hardwood Types in the Northeast (revised).* USDA Forest Service Research Paper NE-603. 36 pp.

Solomon, D.S., D.A. Herman, W.B. Leak. 1995. *Fiber 3.0: An Ecological Growth Model for Northeastern Forest Types.* USDA Forest Service General Technical Report NE-204. 24 pp.

5.4 CONTROLLING LOGGING DAMAGE

ISSUE

Excessive damage to residual trees during a timber harvest can negate the intended benefits of harvest improvement operations *(Weinsauer and Mattson 1986).*

Damage to standing timber caused during a timber harvest operation is a major concern. Activities associated with felling, winching, and skidding can result in damage to 20 – 40% of the trees left behind *(Ostrofsky 1988).*

Young trees may be bent or broken during felling or crushed by harvesting equipment. Valuable lower trunks of larger trees may be wounded, allowing entry of fungi or insects that cause wood discoloration and decay. Branches and tops may be broken during felling, reducing crown area and eventually stand vigor.

Injuries resulting in exposed sapwood wounds of 100 square inches or greater are likely to develop decay (*Hesterberg 1957; Lavalle and Lortie 1968*). 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. Approximately 80% of skidding injuries to residual trees involves bark removal to the butt log *(Nyland and Gabriel, 1971).*

Logging may also combine with other stress factors to make individual trees and eventually stands more susceptible to die-back (Ostrofsky 1988). Poor vigor invites insect and disease. Even though stands may not be physically damaged during logging, the removal of trees may unavoidably reduce the ability of a stand to withstand wind (Smith 1962).

OBJECTIVE

Control and minimize logging damage to residual trees during harvest operations.

CONSIDERATIONS

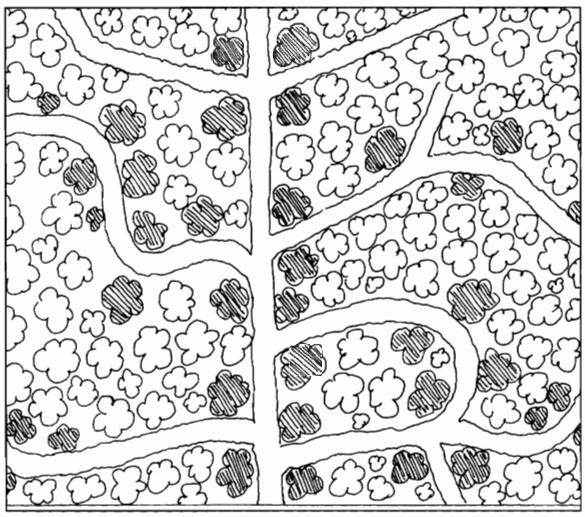
- Some damage is unavoidable. However, research indicates that damage levels to the residual stand of 10% or less is possible by experienced operators *(Cline et al. 1991).*
- Minimizing damage depends equally on supervision, careful planning of transportation systems, care in felling, and skidding. Of particular importance is skid road layout.
- More damage occurs when bark is loose during spring and early summer; however, it is not always possible to avoid harvesting during these times, so extra caution is warranted.
- Logger training, experience, attitude and motivation are more important than equipment size in minimizing logging damage.

- Certain species (e.g. paper birch and balsam fir) are more susceptible to damage than others.
- Trees which grow on very dry, wet or windy sites or that have a history of insect or disease attacks are less likely to survive logging damage.

RECOMMENDED PRACTICES

Planning Ahead For Damage Control:

✓ Plan the locations of skid trails before harvest to accommodate the equipment as well as skidding needs of future harvests.



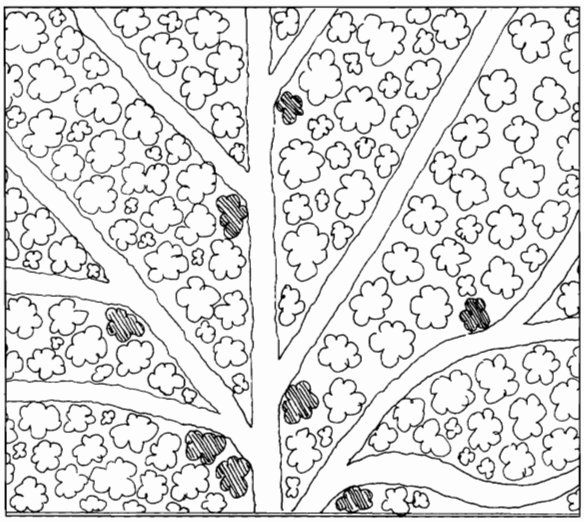
Too many bumper trees, poor road layout

✓ Avoid thinning stands during the spring and early summer. Wounds occur more frequently when the bark is loose.

✓ Use professional loggers skilled in proper directional felling, winching, and skidding procedures. Ask for references.

✓ Include contract provisions that provide incentives for loggers to minimize damage and impose sanctions in the event of careless damage to the residual stand.

✓ When stand conditions warrant, use group or patch cutting to reduce damage to the residual stand. Under this method trees can be felled toward the newly created opening, rather than the residual stand.



Fewer bumper trees, better road layout

✓ Use equipment appropriate for the size and density of the trees in the stand. Equipment which is too large will increase production costs and damage to the residual stand. Conversely, equipment which is under-sized for handling the timber in a stand can cause considerable damage.

✓ Harvest stands of shallow rooted species in frozen or dry conditions (generally winter north and mid-to-late summer south).

✓ Avoid exposing adjacent uncut stands to prevailing winds.

Damage Control During Operations:

- ✓ Minimize the number of skid trails by winching instead of driving the machine to each individual stump.
- ✓ Remove or hinge forks and large branches from felled trees before winching or skidding.
- ✓ The sharper the winching or skidding angle, the shorter the log needs to be. Research shows that damage rates of up to 30% are not uncommon in tree length harvesting *(Weinsauer and Mattson 1987).* When practical, limit length to 32 feet.
- ✓ The use of feller buncher type machines with booms, where skidding and felling equipment is restricted to designated skid trails, can greatly reduce damage.
- ✓ Work around pockets of advanced regeneration. Harvesting when a heavy snow cover is present will help protect small seedlings and saplings.
- ✓ Monitor the harvest to make sure the operation is being properly conducted.

CROSS REFERENCE

Erosion and Soil Damage 1.1; Regeneration: The Right Tree on the Right Site 5.1; Damage; Insects, Diseases and Wind Damage 5.6.

LITERATURE CITED

Hesterberg, G.A. 1957. *Deterioration of Sugar Maple Following Logging Damage.* USDA Forest Service Lakes States Experiment Station Standard Paper 51, St. Paul, MN. 58 pp.

Cline, M.L., B.F. Hoffman, M. Cyr, and W. Bragg. 1991. "Stand Damage Following Whole-Tree Partial Cutting in Northern Forests." *Northern Journal of Applied Forestry.* 8: 72-76.

Lavallee, A. and M. Lortie. 1968. "Relationships Between External Features and Trunk Rot in Living Yellow Birch." *Forestry Chronicle.* 44 (2): 5-10.

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. Research Report 5, Syracuse, NY. 78 pp.

Ostrofsky, W., 1988. "Health of Forests in Relation to Timber Management Practices." Pages 49-57 in *New Perspectives on Silvicultural Management of Northern Hardwoods,* USDA Forest Service General Technical Report NE-124. New York.

Smith D, M., 1962. *Practice of Silviculture.* Wiley & Sons, New York. 1962.

Weinsauer, J. and J.P. Mattson. 1986. "Harvesting Alternatives for Thinning Northern Hardwoods," pages 223-241 in *Managing Northern Hardwoods, Proceeding of a Silvicultural Symposium.* SUNY, Syracuse, NY.

5.5 CLEARCUTTING

ISSUE **Clearcutting is perhaps the most controversial of all forest management practices. Most resource professionals accept clearcutting as a legitimate tool for the management of timber or wildlife habitat. However, inappropriate or excessive clearcutting can have adverse environmental impacts.**

As with all forest management activities, clearcutting should only be used for well-defined silvicultural purposes and with consideration of the full range of forest values that may be affected. It is a tool that must be used carefully, as it creates the most extreme changes to the forest environment of any harvesting technique.

There is no universally accepted definition of what constitutes a clearcut. However, in this region a clearcut is often defined as any harvest that leaves less than 30-45 square feet of residual basal area per acre on a minimum area of 2-5 acres.

It is not the intent of this handbook to endorse or condemn the practice, or to answer all questions regarding clearcutting, but rather to suggest guidelines for its use if landowners or the professionals that work with them decide that it is an appropriate method for meeting their objectives.

Foresters and wildlife biologists have applied clearcutting for the following purposes *(BAG 1993, NHDRED 1995, MCSFM 1996)*:

- Regeneration of early successional species such as white birch and aspen (USFS 1986).
- Regeneration of areas occupied by low-quality stands with limited potential for improvement through partial harvesting.
- Harvest of stands with a high potential of blowdown or other losses if partially harvested, for example, stands of mature balsam fir.
- Creation of early successional wildlife habitat; including increases in herbaceous and shrub/woody regeneration layers, soft mast, and associated insects and earthworms that occur in such places *(Elliott 1988, Owen and Galbraith 1989; Krusic and Neeful 1996, Santillo et al. 1989; Tubbs et al. 1987; Vermont Fish and Wildlife Dept 1986; Williamson 1993).*
- Salvage of timber killed or damaged by natural disturbances such as blowdown, fire, insects or disease.
- Release of adequate, desired advanced regeneration, sometimes referred to as a natural or one-cut shelterwood.

Concerns about clearcutting include both site-specific effects and landscape-level effects. Among the primary concerns regarding clearcutting are:

- By removing most or all of the vegetation on a site, clearcutting may lead to a temporary increase in nutrient loss through leaching *(Bormann and Likens 1979).*

- Excessive clearcutting within an individual watershed reduces evapotranspiration and increases the rate of snowmelt and storm runoff, potentially increasing the size and frequency of floods which can lead to increased erosion or changes in streambed characteristics *(Lee 1980, Davies and Sowles 1984)*. It can take 5-10 years following clearcutting for streamflow to return to pre-harvest levels (*Hornbeck et al. 1987*).
- Large and rapid changes in the microclimate of the forest floor (including heating and drying) may adversely affect some herbaceous plants, amphibians, insects, lichens, fungi, mosses, and soil microbes. The time required for these organisms to recover is not well known and may range from a few years to many decades *(Chandler 1987, 1991; Chandler and Peck 1992; deMaynadier and Hunter 1995, in preparation; Selva 1994; Strayer et al. 1986, Moffat 1993, Petranka et al. 1993, Meier et al. 1995)*.
- Extensive clearcutting reduces the amount of mature or late-successional habitat and correspondingly increases the amount of early successional habitat. The overall effect depends on the forest age class distribution in the surrounding landscape. If there is little mature habitat in the area, clearcutting may further reduce habitat diversity. If, on the other hand, an area is dominated by mature habitat, a certain amount of clearcutting may increase habitat diversity.
- Extensive clearcutting creates relatively uniform even-aged stands that do not retain diverse structural characteristics.

A separate concern involves so-called "liquidation cuts", which are clearcuts or heavy partial cuts conducted without consideration of silvicultural need. These cuts may remove young or high-quality timber with the potential to grow into higher-value products, and are the most likely to ignore necessary protection for soil, water quality, wildlife habitat, long term forest productivity and other forest values. It is important to distinguish between these cuts and clearcuts prescribed by professionals for specific silvicultural reasons.

OBJECTIVE

Conduct clearcuts according to recognized silvicultural guidelines and with appropriate consideration of forest regeneration, soil productivity, water quality, and plant and animal habitat.

CONSIDERATIONS

- There is little agreement on the recommended maximum size for clearcuts. However, the two largest public ownerships in the state (the White Mountain National Forest and Nash Stream State Forest) limit clearcuts to 30 acres (*USFS 1986, NHDRED 1995b*). Some industrial owners operate under self-imposed limits of between 20-75 acres.

- The impact of clearcutting on some forest values, such as wildlife habitat, will depend on the nature and condition of the surrounding landscape over which a landowner may have little control.

RECOMMENDED PRACTICES

✓ Due to ecological and social concerns, clearcutting should be used only where other silvicultural methods will not meet landowner objectives.

✓ Clearcuts should be planned and conducted with the assistance of professionals. Layout of clearcuts must give full consideration to the landscape in which the cut occurs as well as any necessary site protection or mitigation measures.

✓ Clearcuts should be planned as part of an overall forest management strategy designed to maintain a sustainable balance of forest structures, age classes, and habitats across the landscape.

✓ Carefully consider how the site will be regenerated prior to harvest.

✓ Clearcuts should be avoided in the following areas:

- Slopes > 35%
- Thin organic soils on top of bedrock ("duff soils")
- Soils classified in Natural Resources Conservation Service 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

✓ Clearcuts should be separated by a manageable stand of at least the width of the area being harvested. This stand should be maintained with at least 70% crown closure or full stocking as recommended in silvicultural guides.

✓ Clearcuts should retain snags and patches of mature live trees for wildlife habitat.

✓ Minimize soil disturbance by careful adherence to *Best Management Practices for Control of Soil Erosion.* (Appendix C)

✓ Carefully consider the aesthetic impact of the proposed harvest. Use the visual quality protection techniques described in Chapter 6.5.

CROSS REFERENCE

Erosion and Soil Damage 1.1; Soil Nutrients 1.2; Wetlands and Riparian Areas 2.1; Water Quality 2.2; Aspen Management 3.4; Cavity Trees, Dens and Snags 3.7; Vernal Pools 4.2; Seeps 4.3; Regeneration: the Right Tree on the Right Site 5.1; Forest Structure 5.2; Aesthetics of Clearcutting 6.5.

LITERATURE CITED

Bormann, F.H. and G.E. Likens. 1979. *Pattern and Process in a Forested Ecosystem.* Springer-Verlag, New York, NY. 253 pp.

Chandler, D.S. 1987. "Species Richness and Abundance of Pselaphidae (*Coleoptera*) in Old-Growth and 40-Year-Old Forests in New Hampshire." *Canadian Journal of Zoology* 65:608-615.

Chandler, D.S. 1991. "Comparison of Some Slime-mold and Fungus Feeding Beetles (Coleoptera: Eucinetoidea, Cucujoidea) in an Old-Growth and 40-Year-Old Forest in New Hampshire." *The Coleopterists Bulletin* 45:239-256.

Chandler, D.S. and S.B. Peck. 1992. "Diversity and Seasonality of Leiodid Beetles (Coleoptera: Leiodidae) in an Old-Growth and a 40-Year-Old Forest in New Hampshire." *Environmental Entomology* 21:1283-1293.

Davies, S. and J. Sowles. 1984. *The Value of Headwater Streams and the Effects of Forest Cutting Practices on Stream Ecology.* Maine Department of Environmental Protection, Augusta, ME. 10 pp.

deMaynadier, P.G. and M.L. Hunter, Jr., in press. "Effects of Silvicultural Edges on the Distribution and Abundance of Amphibians in Maine." *Conservation Biology.*

deMaynadier, P.G. and M.L. Hunter, Jr. 1995. "The Relationship Between Forest Management and Amphibian Ecology: A Review of the North American Literature." *Environmental Review* 3: 230–261.

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

Krusic, R.A. and C.D. Neefus. 1996. "Habitat Associations of Bat Species in the White Mountain National Forest." Pages 185-198. In: Barclay, R.M., R.M. Brigham (editors). *Bats and Forests Symposium*, October, 1995.

Lee, R. 1980. *Forest Hydrology.* Columbia University Press, New York, NY. 349 pp.

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

Maine Council on Sustainable Forest Management. 1996. *Sustaining Maine's Forests: Criteria, Goals and Benchmarks for Sustainable Forest Management.* Maine Department of Conservation, Augusta, ME. 54 pp.

Meier, A.J., S.P. Bratton, and D.C. Duffy. 1995. "Possible Ecological Mechanisms for Loss of Vernal-Herb Diversity in Logged Eastern Deciduous Forests." *Ecological Applications* 5:935–946.

Moffat, A.S. 1993. "Clearcutting's Soil Effects." *Science* 261:1116.

New Hampshire Department of Resources & Economic Development. 1995a. *New Hampshire Forest Resources Plan Ecological Assessment Report.* NHDRED, Division of Forests & Lands, Concord, NH.

New Hampshire Department of Resources & Economic Development. 1995b. *Nash Stream Forest Management Plan.* NHDRED, Division of Forests & Lands, Concord, NH.

Owen, R.B., Jr., W.J. Galbraith. 1989. "Earthworm Biomass in Relation to Forest Types, Soil, and Land Use: Implications for Woodcock Management." *Wildlife Society Bulletin* 17(2). 130-136.

Petranka, J.W., M.E. Eldridge, and K.E. Haley. 1993. "Effects of Timber Harvesting on Southern Appalachian Salamanders." *Conservation Biology* 7:363-370.

Pierce, R.S. et al. 1993. *Whole-tree Clearcutting in New England: Manager's Guide to Impacts on Soils, Streams, and Regeneration.* USDA Forest Service General Technical Report NE-172, Radnor, PA. 23 pp.

Rubin, F. and Justice, D. 1995. *New Hampshire Timber Clear Cut Inventory.* Complex Systems Research Center, University of New Hampshire, Durham, NH. 12pp.

Santillo, D.J., D.M. Leslie, Jr., P.W. Brown. 1989. "Responses of Small Mammals and Habitat to Gyphosate Application on Clearcuts." *Journal of Wildlife Management.* 53(1): 164–172

Selva, S.B. 1994. "Lichen Diversity and Stand Continuity in the Northern Hardwoods and Spruce–Fir Forests of Northern New England and Western New Brunswick." *The Bryologist* 9:424–429.

Strayer, D., D.H. Pletscher, S.P. Hamburg, and S.C. Nodvin. 1986. "The Effects of Forest Disturbance on Land Gastropod Communities in Northern New England." *Canadian Journal of Zoology* 64:2094–2098.

Tubbs, C.H., R.M. DeGraaf, M. Yamasaki, and W.M. Healy. 1987. *Guide to Wildlife Tree Management in New England Northern Hardwoods.* USDA Forest Service General Technical Report NE–118, Broomall, PA. 30pp.

Turcotte, D.E., C.T. Smith, and C.A. Federer. 1991. "Soil Disturbance Following Whole-Tree Harvesting in North-Central Maine." *Northern Journal of Applied Forestry* 8:68–72.

USDA Forest Service. 1986. *White Mountain National Forest Land and Resource Management Plan.* USDA Forest Service Eastern Region, Milwaukee, WI.

Vermont Fish & Wildlife Department. 1986. *Model Habitat Management Guidelines for Deer, Bear, Hare, Grouse, Turkey, Woodcock, and Non-Game Wildlife.* Montpelier, VT. 64pp.

Williamson, S.J. 1995. *Forester's Guide to Wildlife Habitat Improvement (2nd ed.).* University of New Hampshire Cooperative Extension Service, Durham, NH.

5.6 INSECTS, DISEASES AND WIND DAMAGE

ISSUE

Forests in New Hampshire are stressed by many existing insects and diseases, and others (e.g. hemlock woolly adelgid) threaten to become epidemic in the future.

Many insect, disease and wind factors are difficult to control or predict. However, excessive damage from insects, diseases or wind results in severe economic loss and discourages investment in forest land and management practices.

Impacts vary with the cause. Periodic gypsy moth defoliation causes growth and quality losses, reduced mast crops, and increased mortality of oaks, white pine and hemlock. White pine weevil attacks top leaders of white pine, causing deformity of the stem and appreciable loss of value. Beech-bark disease begins with bark infestations by a white scale insect followed by infection with a disease organism (Nectria) that causes mortality or bark and stem disfiguration of beech, as well as reduced beechnut crops. Spruce budworm becomes epidemic at widespread intervals, causing repeated defoliation, top-killing, and mortality of overmature fir and associated spruce.

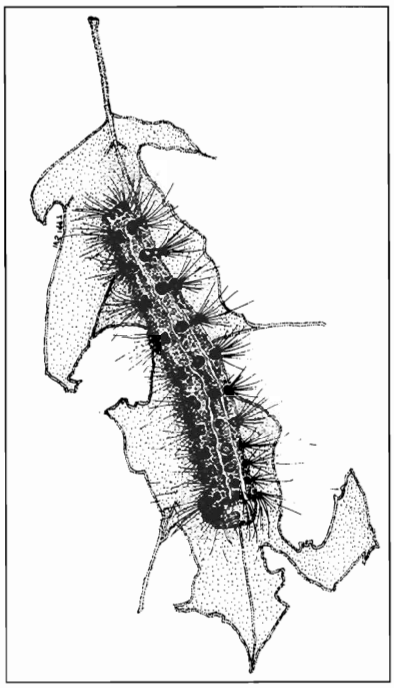
High winds blow over or break trees or cause root damage. Although hurricane-size storms are infrequent in New England, damaging wind storms can be expected every 15-30 years (*Leak et al 1994*). Species and forest cover types vary greatly in resistance to wind damage. White pine is most susceptible; losses of up to 80% of the volume were reported from the 1938 hurricane. Associated hemlock trees also were heavily damaged. Spruce-fir (especially the fir) is next in susceptibility to losses from wind damage. Northern hardwoods are least damaged; the 1938 hurricane produced losses of about 10-20%, even in stands that were hard hit. Factors other than cover type also are important: 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 most susceptible), and stand density (heavily thinned stands most at risk).

OBJECTIVE

Reduce mortality, growth loss, and defect due to insects, diseases, and wind damage.

CONSIDERATIONS

- There are well-recognized benefits from the natural-disturbance factors listed above including the provision of dead and down woody debris wildlife trees, and openings for regeneration. While native pests are part of natural functioning of ecosystems, many of the most destructive insect and disease problems occurring in New Hampshire are the result of exotic pests introduced into the state.



- Control of beech bark disease often means removing infected trees. This recommendation may conflict with recommendations for protection of mast-producing beech that show evidence of bear use.
- While predators such as birds cannot control outbreaks, they provide important constraints on insects at endemic population levels, and can extend the period of time between outbreaks (*Holling 1973, Reichert in Allen and Hoekstra 1992).*
- State law (*RSA 227-K:3*) allows the director of the Division of Forests & 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 undertake actions to control the infestation; if the landowner is unwilling, the State may take such actions.
- 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. Maintenance of populations of native predator species will help reduce intensity of infestation.

RECOMMENDED PRACTICES

Gypsy Moth (introduced):

✓ Over the long term, limit susceptibility to defoliation by reducing the percent of basal area of tree species preferred by the gypsy moth (*Gottschalk 1993*). Preferred species include: oaks, paper and gray birch, aspens. Less preferred species include: most northern hardwoods, pines, hemlock. Immune species include: white ash, balsam fir.

PREFERRED SPECIES (%)	RELATIVE SUSCEPTIBILITY
0-20	Low
20-50	Moderate
50-80	High
80-100	Very High

✓ Maintain crop trees with large crowns, dense foliage, few dead branches, and minimal epicormic sprouting (*Gottschalk and MacFarlane 1993*).

✓ If stand defoliation has occurred, wait 3 years before choosing a silvicultural course of action (regeneration, thinning, salvage), since the extent of mortality will become evident during that time period (*Gottschalk 1993*).

✓ Provide habitats that favor predators of Gypsy moth: black-billed and yellow-billed cuckoo, blue jay, black-capped chickadee, gray catbird, rufous-sided towhee, short-tailed and masked shrews, red-backed vole

and white-footed mouse. Examples include: thickets of regeneration and shrubs for cuckoos and towhees and large dead logs/branches on the ground for small mammals *(Smith 1985, Thurber et al 1994)*.

White Pine Weevil (native):

✓ Grow white pine seedlings and saplings in shade (40-80 square feet of basal area or in small openings less than one tree height in diameter) until at least one unweeviled log height (18 feet) is attained. 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 *(Houseweart and Knight 1986)*.

✓ 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 *(Graber 1986)*.

Beech-bark Disease (introduced):

✓ 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 *(Houston 1982)*. Remove non-resistant trees and encourage regeneration of the resistant. Leave trees with recent evidence of bear claw marks.

✓ In partial cutting operations (thinnings, selection cuts), remove trees that are heavily infested with the white, woolly scale and/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 (even slight damage) to beech roots by logging on snow and keeping skidding activity away from the cut beech trees to the extent possible. 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 *(personal communication: D. Houston, NEFES and J. Ecker, Maine BPL)*.

Spruce Budworm (native):

✓ Preferred food sources of the spruce budworm are balsam fir and white spruce *(Maclean 1980)*. Spruce budworm is most destructive and epidemic in 60 to 80 year old stands with a high proportion of balsam fir. Although silvicultural controls of the budworm are somewhat limited in effectiveness, the best approaches for avoiding serious damage are (1) to harvest fir stands prior to over-maturity, (2) to encourage higher spruce-to-fir ratios through regeneration practices and early cultural work, (3) to break up extensive stands of fir and spruce–fir with intervening stands of hardwood or mixed-wood provided that management objectives and site conditions permit *(Baskerville,. 1975, van Raalte 1972)*, and (4) to encourage budworm predators.

✓ At least 49 bird species are known to prey on budworm pupae, and 11 species are considered important predators at low to moderate levels *(Jennings and Crawford 1985)*. 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 (*Crawford et al. 1983*).

Wind Damage:

✓ Landowners can limit their losses from wind (especially in areas with a history of wind damage) by:

- Maintaining a diverse forest of mixed species to spread the risk; especially by limiting the acreage in susceptible types such as mature white pine on wet soils.
- Limiting partial harvests in susceptible stands to no more than 1/3 of the basal area, and perhaps leaving an uncut buffer on the windward side of the stand (*Frank and Bjorkbom 1973*).
- Orienting strip cuts at right angles to the prevailing winds if possible.

CROSS REFERENCE

Mast 3.6; Controlling Logging Damage 5.4.

LITERATURE CITED

Allen, T.F. and T. W. Hoekstra. 1992. *Toward a Unified Ecology*. Columbia University Press, New York. 384 pp.

Baskerville, G.L. 1975. "Spruce Budworm: The Answer Is Forest Management: Or Is It?" *Forestry Chronicle* 51(4): 157-60.

Crawford, H.S., R.W. Titterington, and D.T. Jennings. 1983. "Bird Predation and Spruce Budworm Populations." *Journal of Forestry* 81:433-435.

Frank, R.M. and J.C. Bjorkbom 1973. *A Silvicultural Guide for Spruce-Fir in the Northeast.* USDA Forest Service Technical Report NE-6. 29 pp.

Gottschalk, K.W. 1993. *Silvicultural Guidelines for Forest Stands Threatened by the Gypsy Moth.* USDA Forest Service Technical Report NE-171. 50 pp.

Gottschalk, K.W. and W.R. MacFarlane. 1993. *Photographic Guide to Crown Condition of Oaks: Use for Gypsy Moth Silvicultural Treatments.* USDA Forest Service Technical Report NE-168. 8 pp.

Graber, R.E. 1986. "Stem Quality of White Pine Direct-Seeded in Furrows vs. Conventional Planting." In *Eastern White Pine: Today and Tomorrow.* USDA Forest Service Technical Report WO-51. 124 pp.

Holling, C.S. 1973. "Resilience and Stability in Ecological Systems." *Annual Review of Ecology and Systematics* 4:1-23.

Houseweart, M.H. and F.B. Knight. 1986. "Entomological Problems in Growing White Pine." In *Eastern White Pine: Today and Tomorrow.* USDA Forest Service General Technical Report WO-51. 124 pp.

Houston, D.R. 1983. "American Beech Resistance to *Cryptococcus fagisuga*." In Proceedings, IUFRO Beech Bark Disease Working Party Conference. USDA Forest Service General Technical Report WO-37. 140 pp.

Jennings, D.T. and H.S. Crawford, Jr. 1985. *Spruce Budworm Handbook – Predators of the Spruce Budworm.* USDA Forest Service Cooperative State Research Service Agricultural Handbook No. 644. 77 pp.

Leak, W.B., M. Yamasaki, M. Smith, and D.T. Funk. 1994. "Selection Criteria for Forested Natural Areas in New England, *USA*". *Natural Areas Journal* 14(4): 300-305.

Maclean, D.A. 1980. "Vulnerability of Fir-Spruce Stands During Uncontrolled Spruce Budworm Outbreaks Review and Discussion." *Forestry Chronicle* 56: 213-221.

Smith, H.R. 1985. "Wildlife and the Gypsy Moth." *Wildlife Society Bulletin* 13:166-174.

Thurber, D.K., W.R. McClain, and R.C. Whitmore. 1994. "Indirect Effects of Gypsy Moth on Nest Predation." *Journal of Wildlife Management* 58(3): 493-50.

van Raalte, G.D. 1972. "Do I Have a Budworm-Susceptible Forest?" *Forestry Chronicle* 48: 190-192.

Section Six
Aesthetics and Visual Quality/Recreation

Additional Reading:

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

Visual Quality Best Management Practices for
Forest Management in Minnesota
Minnesota Department of Natural Resources et al.
1994

Rural Fire Resource Quick Guide
New Hampshire Rural Fire Protection Task Force
Department of Resources & Economic Development
1995

Stonewalls and Cellarholes: A Guide for Landowners on Historic Features and Landscapes in Vermont's Forests
Robert Sanford, Donald Huffer, and Nina Huffer
Vermont Agency of Natural Resources
1994

6.1 TIMING OF FOREST MANAGEMENT ACTIVITIES

ISSUE

The timing of forest management activities can impact how a job looks.

If roads are built during dry seasons, they are cheaper to construct and look much nicer. Operating on frozen ground that has a good snow cover will result 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 that are scheduled to avoid peak use will help to minimize potential conflicts.

OBJECTIVE

Minimize visual and audible impacts of forest management activities by scheduling such activities during the appropriate seasons of the year and during lower levels of recreational use.

CONSIDERATIONS

- Bark on trees is very tender and easily damaged from first bud break through mid-July.
- Many aesthetic concerns are exacerbated during wet conditions.
- Tourism and recreation are an important part of the state's economy that depend upon an attractive forest background. Many outdoor activities take place during specific seasons of the year.

RECOMMENDED PRACTICES

Before the Harvest:

✓ Because many aesthetic concerns are caused by running water and soil erosion, limit or prohibit access during mud season when road or skid trails are especially susceptible to damage.

✓ Minimize the impact on sensitive sites by limiting harvests to dry or frozen ground conditions.

✓ Avoid thinning stands during the late spring/early summer, when the bark is still soft and vulnerable to damage.

✓ When operating near residential areas 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.

✓ Notify abutters or others that may be impacted by the harvest, so that they are aware of the details.

During the Harvest:

- ✓ Supervise the job on a regular basis so that problems can be identified and solved in a timely fashion.
- ✓ Avoid operating during or immediately following prolonged periods of wet weather.

CROSS REFERENCE

Erosion and Soil Damage 1.1; Woodland Raptor Nests 4.4; Heron Colonies 4.5; Bald Eagle and Osprey Nests 4.6; Controlling Logging Damage 5.4; Timber Harvesting in High-Use Recreation Areas 6.7.

LITERATURE CITED

Jones, G. T. 1993. *A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners*. NRAES-60. Northeast Regional Agricultural Engineering Service. Cooperative Extension, Ithaca, NY.

Maine Council on Sustainable Forest Management. 1996. *Sustaining Maine's Forests: Criteria, Goals and Benchmarks for Sustainable Forest Management*. Maine Department of Conservation, Augusta, ME. 54 pp.

McEvoy, Thom J. 1995. *Introduction to Forest Ecology and Silviculture*. University of Vermont, School of Natural Resources and Extension System, Burlington, VT.

Minnesota Department of Natural Resources. 1994. *Visual Quality Best Management Practices for Forest Management in Minnesota*.

Weyerhaeuser Forestry Harvest Aesthetics Team. 1994. DRAFT *Harvest Aesthetics*.

6.2 TRUCK ROADS AND SKID TRAILS

ISSUE

Permanent truck roads and skid trails can create some of the most visually dramatic and permanent changes in a woodlot.

They can also be the greatest expense of a timber harvest. Construction and use of truck roads demands careful planning to reduce cost and to minimize the impact. When truck and skid roads are built and used during the dry season (on some sites, frozen ground may be preferable, especially for temporary winter use), they hold up better, look neater, erode less, and are less expensive to construct and use. Cutting and removing trees on the road right-of-way in advance of bulldozing results in better looking roads.

OBJECTIVE

Reduce visual impacts associated with the design, construction, use, maintenance, and closure of forest access roads and skid trails.

CONSIDERATIONS

- Frequency of access, amount of anticipated traffic, seasons during which access is required, and safety concerns affect the number, type and layout of forest access roads.
- The limited road-construction season generally coincides with the tourist season in many recreationally-sensitive areas.
- Shielding the location of new roads from highway view may impact ecologically-sensitive areas.
- Building forest access roads to accommodate visual quality concerns – or using existing roads that require traveling greater distances – may involve increased costs.
- Traffic during wet periods can increase maintenance needs and create unsightly ruts and mudholes.
- Roads provide access for undesirable activities such as dumping and/or undesirable traffic that could damage roads.
- Leave damaged bumper trees for future protection or as future cavity trees.
- Post-harvest use of roads by all-terrain vehicles can have negative aesthetic impacts.
- State laws must be observed when constructing or using roads. The state or towns may hold landowners, loggers, or foresters responsible for damage to public roads.

RECOMMENDED PRACTICES

Design/Planning:

✓ Consult *Best Management Practices for Erosion Control* (*Appendix C*) when constructing new or upgrading existing roads. Consult the

Natural Resources Conservation Service or the county extension forester for help and the availability of federal cost-share funds.

- ✓ Near public highways, reduce visibility by curving access roads.
- ✓ Look for opportunities to create scenic vistas.
- ✓ Minimize the number of roads approaching highways or recreation areas.
- ✓ Install a gate or block access with boulders or other obstacles, to keep vehicles off roads during and after use. Post signs that help send a positive stewardship message, yet restrict harmful uses.
- ✓ Designate "bumper trees" along skid trails and on sharp turns to minimize damage to the residual trees.

Construction & Use:

- ✓ When constructing a new road, if stumps cannot 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, which helps to further soften their impact.
- ✓ Slash from roads and trails should be disposed of without filling vernal pools or cultural features such as old cellar holes.
- ✓ Utilize merchantable timber within road clearings.
- ✓ 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 onto highways by using clean fill, wood chips, or mats, etc. on truck roads from landing to highway.
- ✓ Check state and local regulations pertaining to gravel operations.

When using on site gravel (borrow) pits:

- ✓ Locate borrow pits and crushing operations out of the visible corridor as much as possible.
- ✓ Screen pits from travel routes or recreation areas using existing vegetation or landscape berms. Avoid facing them directly toward the road.
- ✓ Have a plan for how the gravel will be taken out and the area rehabilitated.
- ✓ Rehabilitate pits upon completion of use as per guidelines in RSA 155-E.
- ✓ Regularly inspect roads and trails, and maintain as necessary.
- ✓ Shape and seed ditches and exposed areas to avoid erosion and to improve visual impact and place waterbars as recommended in the BMP's.

CROSS REFERENCE

Erosion and Soil Damage 1.1; Wetland and Riparian Areas 2.1; Water Quality 2.2; Dead and Down Woody Debris 3.8.

LITERATURE CITED

Jones, G. T. 1993. *A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners.* NRAES-60. Northeast Regional Agricultural Engineering Service. Cooperative Extension, Ithaca, NY.

Maine Council on Sustainable Forest Management. 1996. *Sustaining Maine's Forests: Criteria, Goals and Benchmarks for Sustainable Forest Management.* Maine Department of Conservation, Augusta, ME. 54 pp.

McEvoy, Thom J. 1995. *Introduction to Forest Ecology and Silviculture.* University of Vermont, School of Natural Resources and Extension System, Burlington, VT.

Minnesota Department of Natural Resources. 1994. *Visual Quality Best Management Practices for Forest Management in Minnesota.*

Weyerhaeuser Forestry Harvest Aesthetics Team. 1994. DRAFT *Harvest Aesthetics.*

6.3 LANDINGS

ISSUE

The portion of a timber sale where neatness and organization is the most noticeable is the landing – the nerve center of every logging operation.

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 the 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.

While economics and logistics may dictate certain location requirements, equal thought should be given to the impact of merging people and machinery on these openings in the woods. A clean, properly sized, well-organized landing, will help improve productivity, provide a safer work environment, reduce clean-up costs, and will draw positive attention from the public.

OBJECTIVE

Minimize the impact of landing operations on the traveling public and recreational users, both during and after the operation.

CONSIDERATIONS

- The volume of timber to be cut and the need to sort logs by species and/or products often dictate landing size.
- Topography and location of timber can limit the placement and number of landings.
- The proximity of harvest to highways or high-use areas can affect the placement of landings.
- The placement and size of landings may depend upon additional uses such as parking, camping, wildlife openings or future harvest operations.
- Landing clean-up and seeding practices will increase costs.

RECOMMENDED PRACTICES

Before the Harvest:

✓ Consult *Best Management Practices for Erosion Control (Appendix C)* when planning landings.

✓ Plan landings to access future sales.

✓ If possible, avoid landings within view of travel routes, recreation, or residential areas. Consider a short, curved road to landings.

✓ In extremely sensitive areas, consider leaving a buffer of 150 feet or more between landings and major roads, recreational trails, rivers, and residential areas.

✓ Keep the number of landings to a minimum, and size landings to accommodate products and equipment needs.

✓ Reduce clean-up costs by identifying 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 operations buried on site are exempt from New Hampshire Department of Environmental Services permitting requirements for stump dumps.

During the Harvest:

✓ Organize landings to accommodate sorting, processing, and short-term storage and to allow safe movement of workers and equipment. Remove wood on a regular basis, especially in high-visibility areas.

✓ Minimize the amount of wood waste on the landings, through good utilization, and by cutting and leaving unmerchantable sections in the woods or hauling unused blocks back to the woods.

✓ Treat any slash at landings as soon as possible.

✓ Avoid using landings that evolve into one continuous zone along roadsides.

✓ Limit the number of skid trails entering and leaving the landing in order to minimize the amount of disturbance.

✓ Remove and properly dispose of all trash, motor oil, and other refuse from the landing daily.

After the Harvest:

✓ When the job is done, clear landings of all debris by burying, trucking it to another location or piling it. 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 the Natural Resources Conservation Service for information on site specific seeding prescriptions.

CROSS REFERENCE Permanent Openings 3.2.

LITERATURE CITED

Jones, G. T. 1993. *A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners.* NRAES-60. Northeast Regional Agricultural Engineering Service. Cooperative Extension, Ithaca, NY.

Maine Council on Sustainable Forest Management. 1996. *Sustaining Maine's Forests: Criteria, Goals and Benchmarks for Sustainable Forest Management.* Maine Department of Conservation, Augusta, ME. 54 pp.

McEvoy, Thom J. 1995. *Introduction to Forest Ecology and Silviculture.* University of Vermont, School of Natural Resources and Extension System, Burlington, VT.

Minnesota Department of Natural Resources. 1994. *Visual Quality Best Management Practices for Forest Management in Minnesota.*

Weyerhaeuser Forestry Harvest Aesthetics Team. 1994. DRAFT *Harvest Aesthetics.*

6.4 SLASH DISPOSAL

ISSUE **Unlopped tops (slash) can be particularly unsightly.**

When the presence of tops on the ground is not properly addressed, their appearance is one of the first things that people criticize. Such appearance is not important to the public alone. Many landowners are concerned about the impact that logging will have on the recreational and aesthetic use of their forest. Studies and experience demonstrate that top lopping will help to significantly increase the aesthetic recovery rate for most timber sale areas.

OBJECTIVE **Minimize the visual impacts of slash.**

CONSIDERATIONS

- Slash is unavoidable when harvesting timber.
- Slash near roads, lakes, streams, and property boundaries is subject to special 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, public highway or active railroad bed; and 100 feet of any occupied structure.

- Slash helps to maintain soil on site and protect developing seedlings from temperature extremes and over-browsing by deer.
- Slash can benefit wildlife by creating micro-habitats for small mammals, birds, and other species.
- Slash treatment has an associated cost and, when done manually, can be dangerous to the operator.
- Maximum utilization of merchantable wood conflicts with recommended practices regarding dead and down woody debris.
- Slash provides soil nutrients. The branches, twigs, leaves, and needles of trees contain a higher percentage of nutrients than the trunk of a tree. 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.

RECOMMENDED PRACTICES

- ✓ Eliminate or minimize slash consistent with the slash law, RSA 227-J:10.
- ✓ **Lop tops to a** height of 2 feet or less within 50 feet of a recreational trail. In some instances it may be desirable to pull the tops back 50 feet or more before they are lopped. Otherwise lop tops 4 feet or less above the ground throughout the harvested area.
- ✓ In areas where the presence of slash is a visual quality problem, consider using mechanized operations that remove slash and low-grade wood that has traditionally been left behind.

CROSS REFERENCE

Dead and Down Woody Debris 3.8.

LITERATURE CITED

Jones, G. T. 1993. *A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners.* NRAES-60. Northeast Regional Agricultural Engineering Service. Cooperative Extension, Ithaca, NY.

Maine Council on Sustainable Forest Management. 1996. *Sustaining Maine's Forests: Criteria, Goals and Benchmarks for Sustainable Forest Management.* Maine Department of Conservation, Augusta, ME. 54 pp.

McEvoy, Thom J. 1995. *Introduction to Forest Ecology and Silviculture.* University of Vermont, School of Natural Resources and Extension System, Burlington, VT.

Minnesota Department of Natural Resources. 1994. *Visual Quality Best Management Practices for Forest Management in Minnesota.*

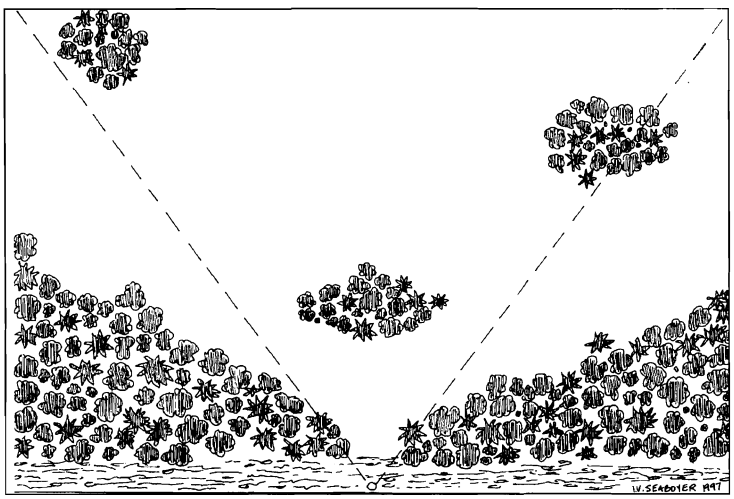
Weyerhaeuser Forestry Harvest Aesthetics Team. 1994. DRAFT *Harvest Aesthetics.*

6.5 AESTHETICS OF CLEARCUTTING

ISSUE

Clearcutting is a forest management practice that causes sudden and drastic visual change to a forest.

Public concern about the visual impacts of clearcutting has lead to development of systematic scenery management techniques, some of which have been in use for 15-20 years, or longer. Concerns often relate to size, arrangement and amounts of clearcutting, the effects of which may be tempered by patterns in vegetation, landform and rockform. Recent studies in mountainous terrain, including public opinion, contribute to further understanding of the visual impacts of clearcutting. It was found, for example, that while many people have favored smaller sized patches, a size of 10-14 acres viewed from 2-5 miles apparently has less impact on scenic value than smaller (eg 4-5 acre) or larger (20-30 acre) harvest areas. Also, while effects on scenic values increase as more clearcut harvesting occurs, the greatest impact is the change from no harvest to 1% removal per decade (*Gobster, et al. 1995*).



OBJECTIVE

Minimize the negative visual impact of clearcuts in high visibility areas.

CONSIDERATIONS

- The visual impact of a clearcut area will vary depending upon the size, shape, location, and time of year it is viewed.
- Clearcuts are most unsightly in the first few years following the harvest.
- Aesthetic impact decreases as the area regenerates.
- Aesthetic considerations may conflict with other forest management goals such as creation of early successional habitat.

RECOMMENDED PRACTICES

✔ In visually sensitive areas, harvest in multiple stages.

✔ Leave patches (or islands) of varying

sizes and shapes of trees to break-up the cut area and reduce apparent size.

- ✔ Keep openings into harvest area narrow to limit view from public roads, lakes and rivers, or recreation areas (*see illustration previous page*).
- ✔ Utilize natural terrain to minimize apparent size.
- ✔ Shape clearcuts to resemble natural openings where ownership patterns allow and by integrating more partial harvest treatments along roadsides and highly visible slopes (*Maine Council on Sustainable Forest Management, 1996).*
- ✔ Avoid long straight edges for harvest bounds that intersect with roads at hard angles, or that are visible from roads or water bodies *(Maine Council on Sustainable Forest Management, 1996).*
- ✔ Maintain an uncut or partially cut buffer of 150' along recreational trails and in residential areas, as well as the roads and streams required by the basal area law.
- ✔ When cutting next to a highway:
  - Adhere to the basal area law (*RSA 227-J:9*).
  - Avoid operating during mud season; follow all *Best Management Practices for Erosion Control* (*Appendix C*).
  - Obtain maximum utilization of all merchantable wood.
  - Lop tops and keep evenly distributed, or remove and chip, if economically feasible.
  - Keep stumps low.
  - Eliminate whips, bent saplings, and broken trees.
- ✔ Design clearcuts to take into account slope, topography, existing vegetation patterns, and principle viewing points.

CROSS REFERENCE

Aspen Management 3.4; Deer Wintering Areas 3.5; Forest Structure 5.2; Clearcutting 5.5.

LITERATURE CITED

Jones, G. T. 1993. *A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners.* NRAES-60. Northeast Regional Agricultural Engineering Service. Cooperative Extension, Ithaca, NY.

Gobster, P.H., M.A. Harrilchak, T. Kokx, J.F. Palmer, S. Shannon. 1995. "Esthetics of Clearcutting; Alternatives in the White Mountain National Forest." *Journal of Forestry.* 93(5): 37-42.

Maine Council on Sustainable Forest Management. 1996. *Sustaining Maine's Forests: Criteria, Goals and Benchmarks for Sustainable Forest Management.* Maine Department of Conservation, Augusta, ME. 54 pp.

McEvoy, Thom J. 1995. *Introduction to Forest Ecology and Silviculture.* University of Vermont, School of Natural Resources and Extension System Burlington, VT.

Minnesota Department of Natural Resources. 1994. *Visual Quality Best Management Practices for Forest Management in Minnesota.*

Weyerhaeuser Forestry Harvest Aesthetics Team. 1994. DRAFT *Harvest Aesthetics.*

6.6 CULTURAL RESOURCES (adapted from Stone Walls and Cellarholes)

ISSUE **Cultural resources can be inadvertently damaged during logging operations.**

Cultural resources are the evidence left by people who once inhabited the land. Knowing about these resources can provide an important link to the past. They also may be of religious significance, provide information to archeologists, be of interest to the local historical society, or provide an attraction for visitors.

In New Hampshire, cultural resources may include stone walls, cellar holes, sugar shacks, logging camps, old dam sites, or cemeteries. Cultural resources include archeological sites such as Native American ceremonial grounds, or the trash dump of an old farmhouse. Landscapes can also be resources, generally a combination of structures and sites that give a sense of a time or lifestyle. Old farmsteads with fields and apple orchards and lilac bushes are a good example.

The key to protecting cultural resources is to be able 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 site. In these instances it is important to photograph the site and mark its location on a map for future historians.
- Native American sites and cemeteries have certain legal protections, see RSA 227-C. Stone walls along scenic roads also may have legal protection, depending on whether your town has designated the road as scenic under RSA 231:157-158. Stone walls that serve as boundaries are protected under RSA 472:6.

RECOMMENDED PRACTICES

✓ When property is being evaluated for timber resources, include cultural resource locations and issues.

- ✓ Determine the management strategy to be used around the cultural feature. It may include:
  - No disturbance
  - Minimal disturbance, felling but no equipment
  - Minimal disturbance, light equipment or operations on frozen ground
  - Contact the New Hampshire Division of Cultural Resources at 603-271-2394 for additional advice
  - Flag the area and show contractor and crew the areas to protect
- ✓ Do not pile slash or garbage in cellar holes, quarry sites, or other depressions with historic significance. Fell trees away from any structures.
- ✓ Avoid skidding over stone-faced bridges or culverts. If existing roads and bridges are to be used, use a deck to cover old culverts.
- ✓ If stone walls must be crossed, use existing openings (barways) when possible. If new openings need to be made, limit the number of crossings, cut only the minimum width necessary. Restore the wall when work is completed or leave open for future use.
- ✓ Protect wells by installing concrete well covers whenever possible.

CROSS REFERENCE

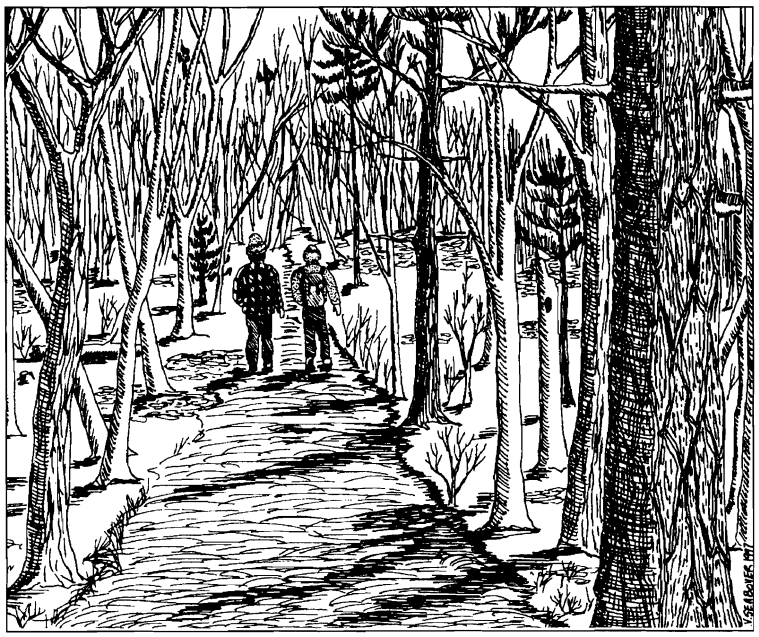
Permanent Openings 3.2.

LITERATURE CITED

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. 52pp.

6.7 TIMBER HARVESTING IN HIGH-USE RECREATION AREAS

ISSUE **Most visitors to any recreational forest are seeking a peaceful outdoor experience. Minimizing conflicts between timber harvesting and recreation use can leave visitors with a positive impression of forest management.**



OBJECTIVE

Minimize the negative visual and audible impacts of timber harvesting in or near areas of high recreational use.

CONSIDERATIONS

- Scheduling a timber harvest during low use may not coincide with the best season to operate.
- Recreational use of private forest land can conflict with forest management activities.
- Many hiking trails use old logging routes, while many logging roads often become new hiking trails.

RECOMMENDED PRACTICES

✓ Before the harvest, erect signs to inform, educate, and/or warn recreational users regarding management issues, harvesting activities, and safety concerns.

✓ Notify abutters, recreation officials, conservation commissions, or others that may be impacted by the harvest, so that they are aware of the details. Consider having a local newspaper run a story on the sale.

✓ Leave large attractive trees in high-use public areas.

✓ Lay out skid trails and logging roads with future recreational use in mind so that they can be easily incorporated into trail systems.

✓ Leave buffer zones along recreational trails. Limit the number of skid road crossings, keeping them at right angles to the hiking trails when possible.

✓ Lop tree tops 2 feet or less in high-use areas. Otherwise lop tops 2 to 4 feet above the ground throughout the harvested area. (Where deer severely disrupt natural regeneration, leave slash higher to protect new seedlings. Contact the New Hampshire Fish & Game Department for more information).

- ✓ Conduct disruptive phases of management operations, such as road or landing construction, during periods of low recreational use.
- ✓ When harvesting operations cannot avoid peak recreational use, consider the following:
  - Temporarily relocate trails away from management activity areas.
  - Reduce the impact of noisy equipment by modifying working hours, shut 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, where practical.
- ✓ Protect recreational trails that are impacted by skidding from soil erosion, leave free from woody debris, smooth ruts, and seed as necessary.
- ✓ Monitor the job on a regular basis so that problems can be identified and solved in a timely fashion.
- ✓ Consider inviting the public to tour your woodlot to learn more about harvesting operations.

CROSS REFERENCE

Truck Roads & Skid Trails 6.2; Landings 6.3; Slash Disposal 6.4; Cultural Resources 6.6.

LITERATURE CITED

Jones, Geoffrey T. 1993 *A Guide To Logging Aesthetics: Practical Tips For Loggers, Foresters, and Landowners*. NRAES-60. Northeast Regional Agricultural Engineering Service. Cooperative Extension, Ithaca, NY.

Glossary

Glossary

Access road
A temporary or permanent route into forest land for over-the-road vehicles.

Age class
Intervals of tree age used to describe stand characteristics, for example, 10 or 20 year age class.

Basal area
A measure of tree density. It is 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. (*See page 101*)

Beaver flowage
Flat water behind a beaver dam.

Best management practices (BMPs)
A practice or combination of practices determined to be the most effective and practicable means of preventing negative impacts of silvicultural activities.

Biodiversity
The variety and variability of all living organisms.

Borrow pit
The area from which gravel is removed to build up a road bed.

Browse
Leaves, buds and woody stems used as food by woodland mammals like deer and moose.

Bucking
Cutting a felled tree into segments.

Canopy
The more or less continuous cover of branches and foliage formed by the crowns of adjacent trees and other woody growth.

Cavity trees
Trees, either live or dead, which contain hollowed out areas. Used as shelter for a variety of animal species.

Clearcutting
See even-aged management

Community
A group of species that occur together in a particular habitat.

Crop tree
A tree which is retained for maximum longevity in a stand due to desired characteristics such as commercial quality or biotic contribution.

Crown
The above-ground portion of a tree extending up and out from the first main branches on the stem.

Cutting cycle
The interval between harvesting operations when uneven-aged methods are employed using group or single-tree selection.

DBH
(diameter at breast height) The average diameter of 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. For example 10" or 12" diameter class.

Diameter limit cutting
Harvesting practice in which trees within a designated diameter class are cut.

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 rep-

resented 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.

Ephemeral
Existing for a short time; short lived.

Epicormic sprouting
Small branches occuring on the stem and branches of some tree species, as a response to increased light often from thinning or removal of substantial portions of the tree crown.

Even-aged management
A timber 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 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 are: (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, is secured 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 cannot 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 tree height.

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 the establishment of 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 youngest trees does not exceed 20 percent of the length of the rotation. From an ecological viewpoint, the minimum size of an uneven 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 the mature trees.

Forb
An herb 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 from a forest (see Forest sustainability).

Forest type
A natural group or association of different species of trees which commonly occur together over 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 bological integrity on which future generations will depend.

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.

Landing
A place where trees and logs are gathered in or near a harvest site for further processing and transport.

Lopping
Cutting off branches, tops and small trees after felling, into lengths such that the resultant slash will lie close to the ground.

Overstory
The upper crown canopy of a forest, usually stated in reference to the largest trees.

Patch clearcutting
See even aged management

Plantation
A stand of trees that has been planted or direct seeded.

Pole timber
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.

Regeneration
The renewal of a stand of trees either by natural or artificial means.

Residual trees
Trees that are left to grow in the stand following a silvicultural treatment.

Revegetation
The re-establishment of vegetation on bare soil by natural or artificial means.

Rotation
The age at which a stand is considered ready for harvest.

RSA
Revised Statutes Annotated, the compilation of the laws of the State of New Hampshire.

Sapling
Trees that are 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 seedfall.

Seedlings
Trees that are less than 4.5 feet tall.

Seed tree method
See even-aged management.

Seep
A spot where groundwater oozes slowly to the surface, forming a small pool.

Selection harvesting
The removal of trees, either as single scattered individuals or

in small groups, at relatively short intervals, repeated indefinitely, so that the continuous establishment of reproduction is encouraged and an uneven-aged stand is maintained.

Shelterwood
See even-aged management

Silviculture
The art and science of managing a forest.

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, followed by cultivation 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, for example poletimber or saw-timber stand.

Slash
The residue left on the ground after felling, lopping, storm, fire, girdling or poisoning. It includes nonmerchantable portions of trees, such as stumps, broken branches, dead trees and other debris left on the ground.

Snag
A standing dead tree generally left for wildlife management purposes.

Stand
A group of trees reasonably similar in age structure and species composition as 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.

Strip cut
See even-aged management.

Succession
The orderly and predictable replacement of one plant community by another over time in the absence of disturbance.

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 does not impair the productivity of the land, generally harvesting equal to growth.

Timber stand improvement (TSI)
Silvicultural activities that improve the composition, constitution, condition and growth of a timber stand.

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 trees as either single, scattered individuals or in exceedingly small groups at relatively short intervals, repeated indefinitely, by encouraging the continuous establishment of 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 leading to the formation of an uneven-aged stand with a mosaic of small and variable sized age class groups. Differing from sin-

gle 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.

Vernal pool
An ephemeral body of water that fills in the spring, holds water for at least 10 days, and dries up by fall in some or all years and that does not contain fish.

Windfirm
The ability of the root system of a tree to withstand wind pressure and keep the tree upright.

Windrow
Slash, residue and debris raked together into piled rows.

Appendices

Appendix A: Information Directory

UNH COOPERATIVE EXTENSION FORESTERS:

Belknap County Cooperative Extension 603-524-1737
Beacon Street East
PO Box 368
Laconia, NH 03247

Carroll County Cooperative Extension 603-447-5922
34 Main Street
PO Box 367
Conway, NH 03818

Cheshire County Cooperative Extension 603-352-4550
33 West Street
PO Box 798
Keene, NH 03431

Coos County Cooperative Extension 603-788-4961
Route 3 North
RR 2 Box 242
Lancaster, NH 03584

Grafton County Cooperative Extension 603-787-6944
County Court House, No Haverhill
PO Box 191
Woodsville, NH 03785

Hillsborough County Cooperative Extension 603-673-2510
468, Route 12 South
Milford, NH 03055

Merrimack County Cooperative Extension 603-225-5505
327 Daniel Webster Highway
Boscawen, NH 03303

Rockingham County Cooperative Extension 603-679-5616
North Rd., Brentwood
PO Box 200
Epping, NH 03042

Strafford County Cooperative Extension 603-749-4445
Unit 5
259 County Farm Road
Dover, NH 03820-6015

Sullivan County Cooperative Extension 603-863-9200
24 Main Street
Newport, NH 03773

NEW HAMPSHIRE DEPARTMENT OF RESOURCES & ECONOMIC DEVELOPMENT:

Division of Forests and Lands 603-271-2214
172 Pembroke Road
PO Box 1856
Concord, NH 03302-1856

New Hampshire Natural Heritage Inventory 603-271-3623
172 Pembroke Road
PO Box 1856
Concord, NH 03302-1856

New Hampshire Department of Fish & Game 603-271-3421
2 Hazen Drive
Concord, NH 03301-6500

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES:

DES Wetlands Bureau 603-271-2147
6 Hazen Drive
PO Box 95
Concord, NH 03302-0092

Division of Water Supply & Pollution Control 603-271-3504
6 Hazen Drive
PO Box 95
Concord, NH 03302-0092

State Geologist 603-271-6482
6 Hazen Drive
Concord, NH 03302-0092

NATURAL RESOURCES CONSERVATION SERVICE:

USDA Natural Resources
Conservation Service 603-868-7581
Federal Building
2 Madbury Road
Durham, NH 03824-1499

NATURAL RESOURCES CONSERVATION SERVICE FIELD OFFICES
AND NEW HAMPSHIRE CONSERVATION DISTRICTS:

Belknap County
Conservation District 603-528-8713
719 North Main Street, Rm. 203
Laconia, NH 03246-2772

Carroll County Conservation District 603-447-2771
44 Main Street
PO Box 533
Conway, NH 03818-0533

Cheshire County Conservation District 603-756-2988
Route 12, South
R1 Box 315
Walpole, NH 03608-9744

Coos County Conservation District 603-788-4651
RR 2 Box 235
Lancaster, NH 03584-9612

Grafton County Conservation District 603-747-2001
Swiftwater Road
RR 2 Box 148-B
Woodsville, NH 03785-0229

Hillsborough County
Conservation District 603-673-2409
Chappell Professional Center
468 Route 13, South
Milford, NH 03055-3442

Merrimack County
Conservation District 603-223-6023
The Concord Center
10 Ferry Street, Box 312
Concord, NH 03301-5081

Rockingham County
Conservation District 603-679-2790
118 North Road
Brentwood, NH 03833-6614

Strafford County
Conservation District 603-749-3037
USDA Agriculture Service Center
259 County Farm Road, Unit #3
Dover, NH 03820-6015

Sullivan County
Conservation District 603-863-4297
24 Main Street
Newport, NH 03773-1500

PRIVATE AGENCIES/NON-PROFITS:

Society for the Protection of New Hampshire Forests
54 Portsmouth Street 603-224-9945
Concord, NH 03301-5400

New Hampshire Timberland Owners Association
54 Portsmouth Street 603-224-9699
Concord, NH 03301-5400

New Hampshire Timber Harvesting Council and
New Hampshire Professional Loggers Program
54 Portsmouth Street 603-224-9699
Concord, NH 03301-5400

Audubon Society of New Hampshire
3 Silk Farm Road 603-224-9909
Concord, NH 03301-8200

The Nature Conservancy
2 1/2 Beacon Street 603-224-5853
Concord, NH 03301

New Hampshire Association of Wetland Scientists
c/o Robert Todd 603-487-2997
40 Colburn Road
New Boston, NH 03070

Appendix B:

3rd Order and Higher Streams & Rivers in New Hampshire

Abbott Brook - jct. West Branch, Atkinson and Gilmanton Grant, just west of Maine line
Alder Brook - jct. Gulf Brook, Dixville (1820') -NW corner of town
Amey Brook - jct. Warner Brook, Henniker, just north of hwy. interchange, 500'
Ammonoosuc River - jct. Jefferson Brook, Crawfords Purchase
Ammonoosuc River (4th) - jct. Crawford Brook, Carroll (Bretton Woods)
Ammonoosuc River (5th) - jct. Gale River, Lisbon
Andrew Brook - jct. Ring Brook, South Newbury
Androscoggin River (5+) - jct. Magalloway River, outlet of Umbagog Lake
Ash Swamp Brook - jct. White and Black Brooks, Keene (just west of urban area)
Ashuelot River - jct. Richardson Brook, Lempster (< 460 m)
Ashuelot River (4th) - jct. Grassy Brook, Marlow (< 325m)
Ashuelot River (5th) - jct. The Branch, Keene
Atwell Brook - jct. north trib, 980', Wentworth
Atwood Brook - jct. north trib, east of North Sandwich

Baboosic Brook - jct. Joe English Brook, Amherst
Baboosic Brook (4th) - jct. Riddle Brook, Merrimack (170')
Back River - jct. north trib, South Hampton, east of Rt. 150 (50')
Bailey Brook - jct. NW trib, SE corner of Stoddard (> 389 m bridge)
Baker River - jct. East Branch (1300'), Warren
Baker River (4th) - jct. Ore Hill Brook, south of Warren village
Baker River (5th) - jct. South Branch, Wentworth
Bean River - jct. west and north tribs (300'), Nottingham - just east of Deerfield line
Bean River (4th) - jct. north outlet Pawtuckaway Pond, Nottingham
Bear Brook - jct. Catamount Brook, Allenstown
Bearcamp River - jct. NW trib, Sandwich (720') (NNE of Center Sandwich)
Bearcamp River (4th) - jct. Atwood Brook, Sandwich, NE of Bearcamp Pond
Beards Brook - jct. Woodward Brook, East Washington (284 m)
Beards Brook (4th) - jct. Shedd Brook, NE of Hillsboro Lower Village
Beards Brook (5th) - jct. North Branch, Hillsboro
Beaver Brook (Amherst) - jct. Ceasars Brook from west, Amherst village
Beaver Brook (Colebrook) - jct. North Branch (1100')
Beaver Brook (Croydon) - outlet Kenellie Pond (317 m)
Beaver Brook (Derry/Pelham) - jct. outlet Adams Pond, West Derry
Beaver Brook (Derry/Pelham) (4th) - jct. Golden Brook, Pelham village
Bee Hole/Giddis Brook - jct. Loudon (just west of Chichester line)
Beebe River - jct. outlet Hall Ponds, Sandwich
Beech River - jct. Dan Hole River, Ossipee - just east of old RR (450')
Bela Brook - jct. One Stack Brook, Bow, just east of Dunbarton line
Bellamy River - jct. Pierce Brook, Barrington - just NW of Madbury line
Bellamy River (4th) - outlet Bellamy Reservoir
Bicknell Brook - jct. outlet Grafton Pond, Enfield
Big Brook - final segment, 2nd Conn. Lake quad
Big River - jct. Little River, Barnstead
Bishop Brook - jct. Cedar Brook, Stewartstown (1150')
Black Brook - jct. Purgatory Brook, Goffstown (400')
Blackstrap Brook/Silver Stream - their jct. Success (1610')
Blackwater River - jct. Cascade Brook, Wilmot Flat
Blackwater River (4th) - jct. Frazier Brook, Cilleyville (Andover)
Blood Brook (Goshen) - jct. Giles Brook (299m)
Blood Brook (Wilton) - jct. Temple Brook, West Wilton
Bloods Brook - jct. unnamed trib & Newton Brook, Meriden
Blow-Me-Down Brook - jct. trib from southwest at 800', north of Cornish Flat
Bog Branch - in wetland, jct. at 1610', Lake Francis quad, Clarksville
Bog Brook (Alexandria) - jct. Patten Brook, east of Alexandria village
Bog Brook (Cambridge) - jct. south trib (outlet Mud Pond) (1190'), south end of huge bog
Bog Brook (New Boston) - jct. NE and SW tribs (520')
Bog Brook (Springfield) - jct. Grove Brook, SW of Washburn Corner
Bog Brook (Stratford) - jct. East Branch, (940')
Bow Bog Brook - jct. west trib, below Rt. 3A, Bow
Boyce Brook - third jct. north of Mass. line, Richmond (980')
Branch River - jct. Churchill and Pike Brook, Brookfield/Wakefield line
Brown Brook [inlet Ellsworth Pond] - jct Buzzell Brook, Ellsworth - 1st jct. above Ellsworth Pond (1160')
Bryant Brook (Canterbury) - jct. Hazleton Brook (Big Meadows)
Bryant Brook (Plaistow) - jct. Bryant Brook, Atkinson/Plaistow line - west of Westville
Bull Brook - jct. west trib, Beans Purchase (1570')
Burnside Brook - jct. trib from west, Lancaster (990')

Carrigain Branch - jct. SE trib at 2167' (NW of Mt. Carrigain), Lincoln
Cascade Brook - jct. east trib, NE corner of New London (780')
Catsbane Brook, jct. Hubbard Brook, Chesterfield (south of Rt. 9)
Cedar Stream - jct. West & Middle Branches, Lake

Francis quad, Clarksville
Chickwolnepy Stream - jct. Blackstrap/Silver Stream and outlet Success Pond, Success (1600')
Childs Brook - outlet of pond at 860', Bath
Chocorua River - jct. NE trib, West Ossipee, just south of Tamworth line
Clark Brook (Alexandria) - jct. Davis Brook (1110'), just above Welton Falls
Clark Brook (Haverhill) - 1 jct. above Conn. River
Clark Pond Brook - outlet Clark Pond, Auburn
Clay Brook (Bridgewater) - jct. Reed Brook, just south of Plymouth line
Clay Brook (Charlestown) - jct. Benware Brook, Snumshire
Clay Brook (Lyme) - outlet Post Pond
Clear Stream - jct. Millsfield Pond Brook, Millsfield/Errol line
Clifford Brook - jct. Hurricane Brook (900'), Warren (just N of Wentworth)
Cocheco River - jct. outlet Sunrise Lake, New Durham, just west of Middleton line
Cocheco River (4th) - jct. Isinglass River, Rochester
Cockermouth River - jct. NW trib, Groton, 1 jct. above outlet Spectacle Pond
Cohas Brook - jct. outlet Calef Pond from NW, and E trib, Auburn, just S of Rt. 121
Cohas Brook (4th) - jct. outlet Massabesic Lake, Manchester
Colby Brook - jct. Bartlett Brook, Danville, just south of Rt. 111
Cold Brook (Freedom) - jct. west trib (610'), approx. 2 miles north of village
Cold Brook (Randolph) - jct. Spur Brook, just north of Low and Burbanks Grant
Cold River (Acworth) - jct. Dodge Brook, south of East Acworth
Cold River (Acworth) (4th) - jct. Warren Brook, above Alstead village
Cold River (Chatham) - 4 short segments in North Chatham, along Maine border
Cold River (Sandwich) - jct. SW trib, east of Guinea Pond, Sandwich
Connecticut River - jct. Scott Brook (inlet Second Conn. Lake)
Connecticut River (4th) - outlet Second Connecticut Lake
Connecticut River (5th) - jct. Passumpsic River from Vermont
Connecticut River (6th) - jct. Ammonoosuc River, Woodsville
Contoocook River - jct. outlet of Mountain Brook Res. and outlet Contoocook Lake, just south of Jaffrey village
Contoocook River (4th) - jct. Town Farm Brook, E of Jaffrey/Peterborough line
Contoocook River (5th) - jct. Nubanusit Brook, Peterborough
Contoocook RIver (6th) - jct. Beards Brook, Hillsboro
Crawford Brook, - jct. Sebosis Brook, Carroll (1610')
Crystal Lake Brook - outlet Crystal Lake, Enfield.

Dart Brook - jct. outlet Cranberry Pond, Alstead (just north of Gilsum line)
Dead Diamond River (5th) - jct. East and West Branches, Atkinson and Gilmanton Grant
Dead River - jct. Jericho Brook, Berlin
Dead Water Stream - jct. at 1615', Diamond Pond quad
Dodge Brook - jct. south trib, Lempster, just west of state forest
Dudley Brook - jct. Patten Brook from NW, Deering (930')
East Branch Baker River - jct. Blodgett Brook (1311'), Warren
East Branch Dead Diamond River - jct. short west trib, Pittsburg (2050'), east of Diamond Ridge, SW of Haystack Mtn.
East Branch Dead Diamond River (4th) - jct. Middle Branch, Atkinson & Gilmanton Grant
East Branch Hix Brook - jct. at 1630', Colebrook
East Branch Pemigewassett River (4th) - jct. Carrigain Branch & NE trib, Stillwater (Lincoln)
East Branch Saco River - jct. Slippery Brook, Jackson (1140'), west of Chatham line
East Inlet - jct. at 1950', 2nd Conn. Lake quad, Pittsburg
Eastman Brook - outlet Eastman Pond, Grantham
Ellis River - jct. Wildcat Brook, Jackson
Exeter River - jct. outlet Hunt Pond from north, Sandown (215') (northwest of village)
Exeter River (4th) - jct. Great Brook, Exeter (just north of Kensington line)
Flatrock Brook - jct. outlet Mitchell Pond, Windham (250')
Flints Brook - jct. west trib, Hollis (190')
Fourmile Brook - jct. East Branch, Dix's Grant/2nd College Grant line (1600')
Fowler River - jct. Clark Brook, Alexandria
Fowler River (4th) (inlet Newfound Lake) - jct. Bog Brook, Alexandria
Franconia Branch - jct. Redrock Brook, Franconia (1830')
Frazier Brook - jct. Walker Brook, South Danbury
Franzier Brook (4th) - jct. Kimpton Brook (outlet Eagle Pond), Wilmot
Fresh Creek - jct. Rollins Brook and Twombly Brook, Rollinsford (just north of Rt. 4)

Gale River - jct. North and South Branches, Bethlehem
Gale River (4th) - jct. Ham Branch, Franconia
Garland Brook - jct. Great Brook, Kilkenny (3 jcts. up from town line)
Giles Brook - jct. Cold Brook, Lempster, E of Rt. 10 at 330 m.
Glebe Brook - jct. northeast trib, Westmoreland
Golden Brook - jct. NW trib, Windham (170'), 1 jct. north of jct. w/outlet from Cobbetts Pond
Goose Pond Brook - outlet Goose Pond, Canaan
Grant Brook - first jct. above Conn River, Lyme
Grassy Brook - jct. Whittemore Brook (Gould Pond), Marlow
Great Brook (Antrim) - jct. south trib, NW end of Antrim village
Great Brook (East Kingston) - jct. west trib, SE of Rt. 108
Great Brook (Lebanon) - jct. trib from east - 2nd jct. downstream from Rt. 120, north of Plainfield line
Great Brook (Langdon) - jct. Little Brook - just west of Langdon village
Great Brook (Milford) - jct. Ox Brook, South Milford (265')
Gulf Brook (Brookline) - MA/NH line (just west of

Hollis line)
Gulf Brook (Danbury) - jct. SW trib, north base of Ragged Mtn. (820')

Hall Stream - jct. just north of Metallak Mtn./Pittsburg quad boundary, Pittsburg
Halls Brook - jct. just west of North Groton
Ham Branch - jct. Slide Brook, Easton (west of village)
Hampton Falls River - jct. Winkley Brook, Hampton Falls - just north of Seabrook line
Hancock Branch - jct. North and South Branches, 1755', Lincoln
Harper Brook - jct. outlet Pemigewasset Lake from SE, New Hampton, 550'
Harvard Brook - jct. NE trib, Lincoln (880'), just west of Pemigewasset River
Hayward Brook - jct. Hackett Brook, Concord (just south of Canterbury line)
Hewes Brook - jct. trib. from south, Hanover Center Road crossing, Lyme/Hanover line
Hittytity Brook (inlet, Millville Lake) - jct. Flatrock Brook, Salem/Windham line
Hix Brook - jct. East Branch, Upper Kidderville (Colebrook)
Hog Hill Brook - outlet, Hog Hill Pond, Hampstead (205'), just north of Rt. 111
Hook Brook - jct. Murry Mill Brook, Auburn, just south of Candia line
Horne Brook - jct. Red Brook, Success, at quad corner (1300')
Hoyt Brook - jct. SE trib, Bradford, 890' (west of Bradford Ctr.)
Hubbard Brook (Chesterfield) - jct. Town Brook, west of Chesterfield village
Hubbard Brook (Ellsworth) - jct. SW trib, 1620', just south of Woodstock line

Indian Pond Brook - jct. Bean Brook, Piermont (between Rt. 10 and Orford line)
Indian River - jct. Orange Brook, canaan
Indian Stream - junction of all branches, Pittsburg
Isinglass River - jct. unnamed north trib, Barrington, just east of Strafford line
Isinglass River (4th) - jct. Nippo Brook, Barrington
Israel River - jct. The Mystic and Castle Brook (below 560m) Low & Burbanks Grant
Israel River (4th) - jct. Mill Brook, Jefferson (east of 115A corner)

Jackman Brook - jct. SW trib at 1460', Woodstock (south of Rt. 118)
Jacobs Brook - jct. North and South Branches, Orford - east of Quinttown
Jericho Brook - jct. west and SE tribs, Berlin, south of Jericho Lake
Joe English Brook - jct. SW trib (outlet Lincoln & Jakes Ponds), Amherst, 245'
Johns River - jct. Carroll Stream (Hazens Pond), Hazens, Whitefield
Kearsarge/Artist Brook - their jct., North Conway (500')
Keenan Brook - jct. just south of Berlin/Randolph line
Kelley Brook - jct. west trib, Pittsfield, due south of Lily Lake
Kimpton Brook - jct. north trib in bog, 1020', Wilmot (W of Bog Mtn.)

Labrador Brook - lowest jct. above Lake Francis, Clarksville
Lamprey River - jct. Hartford Brook, Deerfield
Lamprey River (4th) - jct. North Branch River, Raymond
Lamprey River (5th) - jct. North River, Epping
Lancy Brook - jct. Gould Mill Brook, Brookline (315')
Lary Brook - ME/NH line, Shelburne, 1020'
Lawrence Brook - outlet Sportsman Pond, Fitzwilliam (1000')
Little Dead Diamond River - jct. South Branch, NW corner of 2nd College Grant (1560')
Little Massabesic Brook (4th) - jct. Hook and Preston Brooks, above Little Massabesic Lake, Auburn
Little River (Exeter) - jct. Bloody Brook (70'), north of Rt. 111A
Little River (North Hampton) - jct. SW trib (30'), just below Mill Pond
Little River (Nottingham) - jct. Pea Porridge Brook, just west of Lee line
Little River (Plaistow) - jct. NW and NE tribs, Plaistow/Newton line (100')
Little River (Plaistow) (4th) - jct. Bryant Brook, just north of Atkinson Depot (Rt. 121)
Little Sugar River - jct. Meadow Brook, Unity (2 jcts. west of village)
Little Suncook River - jct. Lockes Brook, Epsom (halfway between Gossville and Epsom village)
Long Pond Brook - jct. Ledge Pond Brook, Croydon (>300 m)
Lost River - jct. Walker Brook, Woodstock, just west of Rt. 112
Lovell River - jct. SE trib (outlet Moody and Bean Ponds), Ossipee (900')
Lyman Brook - jct. Gore Branch and South Branch, Stratford (1470')

Mad River - jct. Kancamagus/Flume Brook, Livermore/Waterville Valley line
Magalloway River (4+) - ME/NH line, 2nd College Grant
Magalloway River (5+) - jct. Dead Diamond River, 2nd College Grant
Mallego Brook - jct. Calef/Wentworth Brook, Barrington - just above Madbury line
Maple Falls Brook (inlet, Clark Pond) - jct. Moose Meadow Brook, Hooksett (just west of Candia line)
Martin Brook - jct. Falls Brook, south of East Swanzey (150 m)
Mascoma River - outlet Cummins Pond, Dorchester
Mascoma River (4th) - jct. Indian River, Canaan
Mason Brook (Conway) - jct. west trib, Conway, just north of Saco River (410')
Mason Brook (Mason) jct. Rocky Brook, Mason (W of Rt. 123), 410'
Merrimack River (6th) - jct. Pemigewasset & Winnipesaukee Rivers, Franklin
Merrimack River (7th) - jct. Contoocook River, Penacook
Merrymeeting River - jct. Coffin Brook from SW, Alton (just west of New Durham line)
Middle Branch Dead Diamond River, jct. SW trib, Pittsburg, 2050'
Middle Branch Indian Stream - jct. south of 1879' elevation, Pittsburg
Middle Branch Piscataquog River - jct. Buxton Brook, New Boston (500')
Mill Brook (Carroll) - jct. Applebee Brook (just south of Jefferson Line)
Mill Brook (Cornish) - jct. trib. from east, Cornish City
Mill Brook (Orange) - jct. outlet Orange Pond w/NE trib, 1260', north of Orange/Grafton line

Mill Brook (Stark) - jct. East Branch (1530')
Mill Brook (Westmoreland) - jct. East Westmoreland Village (< 183 m)
Mink Brook, - jct. at Three Mile Road/Ruddsboro Road intersection, Hanvoer
Mink Brook (4th) - jct. unnamed trib from north, Etna (just below Ruddsboro Road)
Minnewawa Brook - jct. outlets Russell Res. and Chesham Pond, Harrisville
Mirey Brook - MA/NH line, Winchester
Mirey Brook (4th) - jct. Roaring Brook, Winchester
Mohawk River - jct. Moose Brook, Colebrook (1550')
Mohawk River (4th) - jct. Hix Brook, Kidderville (Colebrook) (1310')
Mollidgewock Brook - jct. east and south tribs, Cambridge (1330'), just west of Hampshire Hills
Moose Brook - jct. west trib, Gorham (1070') - just east of Randolph line
Moose Brook (4th) - jct. Perkins Brook, Gorham (930') in state park
Moose River - jct. Cold Brook, Randolph (west of Appalachia)
Mousilauke Brook (4th) - jct. Jackman Brook and Lost River, Woodstock
Mountain Brook (Andover) - lowest jct. (from NE), 610'
Mountain Brook (Jaffrey) (inlet, Mountain Brook Reservoir) - jct. Mead and Stony Brooks, Jaffrey Center
Mountain Brook (Marlborough) - jct. Gleason Brook (< 368 m)
Murray Mill Brook - jct. NW trib, Candia, just north of Auburn line (305')
Musquash Brook - jct. east trib, Hudson, 2nd jct. above unnamed pond (135')

Nash Stream - jct. Pond Brook, Stratford (1375')
Nashua River (5+) - MA/NH line, Hollis
NE tributary of East Branch Pemigewassett River - jct. Shoal Pond Brook & Norcross/Notch Brooks, Stillwater (Lincoln)
Needle Shop Brook - jct. west trib, SE of Hill Center (700')
Nelson Brook (inlet Crystal Lake) - jct. west and NW tribs, Gilmanton, due south of Manning Lake
Nesenkeag Brook - jct. NE trib, Londonderry (east of Litchfield line), 185'
Nester/Rockwood Brook - jct. Troy village
Newfound River (4th) - outlet Newfound Lake, Bristol
Nighthawk Hollow Brook - jct. Varney Brook, Gilmanton, just south of Rt. 140
Nippo Brook - jct. Stonehouse Brook, Barrington (305')
Nissitissit River (4th) - outlet Potanipo Pond (jct. Lancy Brook and North Stream), Brookline
North Branch [Contoocook River] (4th) - jct. outlet Island Pond (= outlet Highland Lake) & outlet Robb Reservoir (= Bailey Brook), South Stoddard
North Branch Millers River- jct. w/outlet Bancroft Res., East Rindge
North Branch River - jct. unnamed west trib. just west of Candia village (325')
North Branch Stearns Brook - jct. Shelter Brook, Success (1550'), just west of Maine line
North Branch Sugar River (4th) - jct. Sawyer Brook and Stocker Brook, Grantham
North Branch Upper Ammonoosuc River - jct. west trib, Copperville (Milan) (1050')
North Fork [East Branch Pemigewasset River] - jct. Whitewall Brook (from Zealand Notch), Lincoln
north outlet Pawtuckaway Pond - from outlet, Nottingham
North River - jct. outlet North River Pond w/outlet Lucas Pond, West Nottingham (350')
North River (4th) - jct. Bean River, Nottingham
North Stream - jct. Spaulding Brook, North Brookline (265')
Nubanusit Brook - jct. Jaquith Brook, Harrisville - east of Eastview (<306 m)
Nubanusit Brook (4th) - outlet MacDowell Reservoir (jct. Stanley Brook), Peterborough

Ogontz Brook - jct. Patten Brook, Lyman (between Ogontz Lake and Dodge Pond)
Oliverian Brook - jct. North Branch, East Haverhill
Orange Brook - jct. Number Seven Brook, Orange
Ore Hill Brook - jct. Black Brook, just above Warren Village
Ossipee River (5th - outlet Berry Bay (Ossipee Lake), Effingham Falls
Otter Brook (Lancaster) - jct. Burnside & Caleb Brooks, NE Of Grange
Otter Brook (Stoddard) - outlet Chandler Meadow (389 m), just above Woods Mill
Outlet, Adams Pond - from outlet (321'), Derry
Outlet, Arlington Mill Reservoir - from outlet, Salem
Outlet, Belleau Lake - from outlet, Wakefield (573')
Outlet, Conway lake - from outlet, Conway
Outlet, Crescent Lake/Lake Wentworth - from outlet, Wolfeboro
Outlet, Dublin Pond - jct south trib at 400 m., halfway betweeen Dublin Pond & Howe Reservoir, Dublin - becomes outlet Russell Reservoir
Outlet, Forest Lake - from outlet, Winchester
Outlet, Grafton Pond - jct trib. from north, between Oak Hill Road and Grafton Pond Road, Enfield
Outlet, Iona Lake - jct north trib. just NE of lake, Albany
Outlet, Island Pond - from outlet, Derry (= inlet, Arlington Mill Reservoir)
Outlet, Lake Winnipesaukee (4th) - from outlet, Lakeport (above Opechee Bay)
Outlet, Massabesic Lake (4th) - from outlet, Manchester
Outlet, Otter Pond - from outlet, Georges Mills [= inlet Lake Sunapee]
Outlet, Purity Lake - from outlet, East Madison (458')
Outlet, Upper Baker Pond - from outlet [= inlet Lower Baker Pond], Orford
Oyster River - jct. north and west tribs, Madbury (110') - SW of Bellamy Res.

Partridge Brook - jct. Chesterfield Gorge brook, Chesterfield
Partridge Brook (4th) - jct. Glebe Brook, Westmoreland (<138 m)
Pauchaug Brook - outlet Bent Pond, Mass. line, Winchester
Paugus Brook - jct. Durrell Brook, Tamworth (790'), just south of Albany line
Pawtuckaway River - south outlet Pawtuckaway Pond, Nottingham
Peabody River - jct. Nineteenmile Brook, Greens Grant (1440')
Peabody River (4th) - jct. West Branch, Greens Grant, just south of Martins Location
Pemigewasset River - jct. Cascade Brook, Lincoln (1470')
Pemigewasset River (4th) - jct. Harvard Brook, Lincoln (820')
Pemigewasset River (5th) - jct. East Branch, North Woodstock
Pemigewasset River (6th) - jct. Baker River, Plymouth
Pennichuck Brook - jct. Witches Brook, Merrimack/Nashua line

Pequawket Brook - jct. Banfield Brook, Madison (west of Pea Porridge Ponds)
Pequawket Brook (4th) - outlet Upper Pequawket Pond (= jct. with outlet of Iona Lake), Madison
Perkins Brook - jct. north and NE tribs, Gorham (1370') - east of Randolph line
Perry Brook - jct. Sanborn Brook, Chichester (next to Rt. 28)
Perry Stream - jct. at 2015', 2nd Conn. Lake quad, Pittsburg
Phillips Brook - jct. West Branch, Millsfield (1680')
Pickard Brook - jct. NE trib, Canterbury (just NW of Loudon line)
Pickering Brook - Great Bog, Portsmouth (30'), west of RR, close to RR
Pine River - jct. Poland Brook, Ossipee (south of White Pond, NE of Rt. 16)
Pine River (4th) - jct. Beech River, east of Center Ossipee
Piscassic River - jct. NW trib, Newmarket, just north of Newfields line
Piscataquog River - jct. northwest trib, Deering (in 784' pond)
Piscataquog River (4th) - jct. Dudley Brook, Weare
Piscataquog River (5th) - jct. South Branch, Goffstown
Policy Brook - jct. Porcupine Brook, Salem, south of Rockingham Park Blvd.
Pond Brook - outlet Lower Baker Pond, Wentworth
Powwow River - jct. outlet Country Pond (= Colby Brook), Kingston (116')
Pressey Brook - jct. Tunis Brook, Hanover
Preston Brook - Spruce Swamp, Auburn (325'), just west of Chester line
Priscilla Brook - jct. east of Rt. 115A, Jefferson
Providence Hill Brook - jct. Hog Hill Brook, Atkinson, just north of Salem line
Punch Brook - jct. NW trib, Franklin, just below Salisbury line
Purgatory Brook - jct. Curtis Brook, Lyndeborough (400') - just below falls

Quabbinnight Brook - jct. Spring Farm Brook, Puckershire (Claremont) (<170 m)
Quarry Brook - jct. outlet Perkins Pond, Troy (<374 m)

Red Hill RIver - jct. Cook Brook, Center Sandwich (north of Big Rock Corner)
Redwater Brook - jct. Whitewater Brook, Claremont
Riddle Brook - jct. short SW trib, Bedford (west of village), 260'
Roaring Brook (Northunberland) - jct. Ames Brook (1010')
Roaring Brook (Richmond) - jct. Sprague Brook (765')
Roby Brook - outlet of pond, jct. Pisgah Brook, Clarksville (1660')
Rocky Brook - jct. stream from North Dorchester, just south of Wentworth line
Rocky Pond Brook - jct. N trib just west of Hollis/Brookline line
Rollins Brook - jct. NW trib, Rollinsford (60'), just west of RR
Round Pond Brook - jct. at 1750', Lake Francis quad, Pittsburg

Saco River - jct. Dry River, Harts Location
Saco River (4th) - jct. Sawyer River, Harts Location
Saco River (5th) - jct. Swift River, Conway village
Salmon Brook (Nashua) - MA/NH line, Nashua
Salmon Brook (Sanbornton) - jct. Hermit Brook, North Sanbornton
Salmon Falls River - outlet Great East Lake, Wakefield
Salmon Falls River (4th) - outlet Milton Pond (jct. Branch River), Milton
Sand Brook - center of Farrar Marsh, NE part of Hillsboro
Sawyer Brook - jct. Skinner Brook, NW of Grantham interchange (I-89)
Sayer River - jct. NW trib, Livermore (1820')
Schoodac Brook - jct. Frazier Brook, Warner (395')
Sebbins/Pointer Club Brook - jct. at Bedford/Merrimack line (150')
Second Brook - outlet unnamed pond at 175', Hudson
Shaker Brook - jct. Mountain Brook, Marlboro (> 320 m)
Shedd Brook - north outlet Highland Lake, Washington
Simms Stream - jct. East Branch, Columbia (1400')
Skinner Brook - jct. SW of Miller Pond, Grantham, east of Lily Pond
Smith Brook - jct. Sanders Brook, Robinson Corner (Grafton) -just north of Springfield line
Smith River - jct. Manfeltree/Halfmoon Pond Brook, Grafton Center
Smith River (4th) - jct. Smith Brook, Grafton village
Snow Brook (inlet Conway Lake) - jct east and SE tribs, Eaton (east of Snowville)
Soucook River - jct. Academy Brook, Loudon (470') - due east of Loudon Speedway
Soucook River (4th) - jct. Picard Brook, Loudon
Souhegan River (4th) - jct. South and West Branches, New Ipswich
Souhegan Rive (5th) - jct. Stony Brook, Wilton
South Branch Ashuelot River (4th) - jct. Nester/Rockwood & Quarry Brook, Troy village
South Branch Baker River - jct. Bucks Brook, Dorchester, just west of Groton line
South Branch Baker River (4th) - jct. Rocky Brook, Dorchester, just south of Wentworth line
South Branch Gale River - jct. Thompson Brook, Franconia/Bethlehem line
South Branch Piscataquog River - jct. west trib, SE of Francestown village (630')
South Branch Piscataquog River (4th) - jct. Middle Branch, New Boston
South Branch Souhegan River - MA/NH line, New Ipswich
South Branch Sugar River - jct. Blood and Gunnison Brooks, Goshen village
South outlet Highland Lake - from outlet, Mill Village, Stoddard
South River - jct. Hobbs Brook from NW, Effingham (410') - west of Maine line
Spaulding Brook - jct. Black Brook, Mason (525')
Spicket River (4th) - jct. Providence Hill Brook and outlet Arlington Mill Res., Salem
Spruce Brook - jct. west and north tribs, south of Spruce Ponds, Strafford (515')
Squam River - jct. Owl Brook, just below outlet Little Squam Lake, Ashland
Stalbird Brook - jct. Garland Brook, Jefferson
Stanley Brook - jct. Mills Brok, Dublin (northwest of Frost Pond)
Stearns Brook - jct. North and South Branches, Success (1250')
Stickney Brook -jct Wallace and Wolf Brooks, South Brookline
Stinson Brook - outlet Stinson Lake, Rumney
Stocker Brook(4th) - jct. Eastman Bk. & Bog Bk., Eastman/East Grantham
Stonehouse Brook - jct. Spruce Brook, Barrington (360')
Stony Brook (Grantham) - jct. Butternut Brok (east of I-89)
Stony Brook (Wilton) - jct. NE trib just south of

Lyndeborough/Wilton line (500')
Stony Brook (Wilton) (4th) - jct. SW trib, (also outlet of Wilton Reservoir), 440'
Sucker Brook (4th) - jct. Clark Pond and Little Massabesic Brooks, above Auburn village
Sugar River - outlet Lake Sunapee, Sunapee village
Sugar River (4th) - jct. Trask Brook, Newport (between Guild and Wendall)
Sugar River (5th) jct. North Branch, Newport
Suncook River - outlet Crystal Lake, Gilmanton Ironworks
Suncook River (4th) - jct. Nighthawk Hollow Brook, Barnstead (= Upper Suncook Lake)
Swift Diamond River - jct. Alder Brook, Dixville (1780')
Swift Diamond River (4th) - jct. Fourmile Brook, 2nd College Grant (1500')
Swift River (Livermore/Conway) - jct. Pine Bend Brook, Livermore, 1360' (first junction above Waterville Valley line)
Swift River (Livermore/Conway) (4th) - jct. Pequaket Brook, Conway village
Switft River (Tamworth) - jct. Wonalancet River and Paugus Brook, Tamworth

Tannery Brook - jct. Cold Brook, Boscawen (290'), NW of Rt. 3/4 jct.
Tarbell Brook - outlet Damon Reservoirs, Fitzwilliam (906')
Taylor River - jct. Old River, Hampton Falls/Hampton line (15')
Temple Brook - northwest outlet large reservoir, SE corner Temple (876')
The Branch (4th) - jct. Otter and Minnewawa Brooks, South Keene
Thompson Brook - jct. NW trib, Alstead (just above Rt. 12A crossing, just N of Surry line)
Tioga River - jct. Pumping Station Branch, just west of Belmont village
Town Farm Brook - jct. north trib, just east of Jaffrey/Peterborough line (860')
Town Line Brook - jct. south trib, Sharon/Peterborough line (1000')
Townline/Clay Brook - jct. between Rt. 16 and Peabody R., Gorham, just north of Martins Location line
Trask Brook - jct. E trib, S of Bradford Rd., E of Nutting Rd., Sunapee
Trout Brook [= inlet Post Pond] - jct. trib from east, Lyme, 670' (first jct. below road crossing)
Turee Brook - jct. White Brook, Concord, just north of Bow line
Turkey River (4th) - outlet Little Turkey Pond (jct. Turee and Bela Brooks), Concord

unnamed southeast tributary of Contoocook River - lowest jct. Deering (620') just S of Hillsboro village
unnamed southwest tributary of Stoney Brook (Wilton) - jct. in NW corner of town, 856'
unnamed tributary of Baker River - 1st jct. east of Rt. 3A, south of Rt. 25 (West Plymouth)
unnamed tributary of Bloods Brook - jct. northeast of Meriden, elev 315 m, Plainfield, along Rt.. 120
unnamed tributary of Mink Brook - jct. south of Dogford Road, north of Ruddsboro Road, Hanover
unnamed tributary of Mohawk River - jct. at 1530', Colebrook
unnamed tributary of North Branch River - jct. NW and SW tribs, Candia (north of Rt. 27 at 410')
unnamed tributary of Rocky Brook - jct. at 1630', west of North Dorchester

Upper Ammonoosuc River - jct. just south of 528 m bridge, Randolph
Upper Ammonoosuc River (4th) - jct. Keenan Brook, Berlin

Village Brook - jct. Stonehouse Brook, Brookline village (230')

Appendix C:
Best Management Practices for Erosion Control in New Hampshire

BEST MANAGEMENT PRACTICES for

Erosion Control on Timber Harvesting Operations in New Hampshire

April 1996

Prepared By: **J.B. Cullen**
State of New Hampshire
Department of Resources and Economic Development
Division of Forests and Lands
Forest Information and Planning Bureau

In cooperation with:

UNIVERSITY OF NEW HAMPSHIRE
COOPERATIVE EXTENSION

Forestry and Wildlife Resources Program
Pettee Hall
55 College Road, UNH
Durham, NH 03824-3599

For more copies, contact:
UNH Cooperative Extension Publications
12B Forest Park
Durham, NH 03824
603-862-2346

TABLE OF CONTENTS

INTRODUCTION

Every timber harvesting operation involves some risk of soil erosion and sedimentation that may affect water quality. With a common understanding of the risks and through the use of this publication, the forest industry, landowners, and the government working together can protect our state's water resources.

This publication is primarily a reference and training tool designed to help foresters and loggers become better informed about the best management practices for reducing soil erosion and controlling sedimentation from timber harvesting activities.

When using this publication, it is important to remember that for every situation encountered, there may be more than one correct method to prevent erosion and sedimentation. Flexibility and understanding are important, since the intent of any best management practice is to **keep sediment out of the streams**.

ACKNOWLEDGEMENT

The author has drawn freely from the publications listed in the reference section and received assistance and suggestions from county, state, and federal foresters as well as the forest industry. The reader is urged to consult these publications if detailed information beyond the scope of this publication is desired. When needed, help and advice for the implementation of the Best Management Practices can be obtained from any of the agencies listed in the Available Assistance Section. Your comments about this publication are welcome.

Assistance in the preparation of this publication was contributed by:

- State of New Hampshire - Department of Resources & Economic Development
  Division of Forests and Lands
- State of New Hampshire - Department of Environmental Services
  Water Supply and Pollution Control Division
  Water Resources Division
  Wetlands Bureau
- University of New Hampshire Cooperation Extension
- USDA - Natural Resource Conservation Service
- USDA - Forest Service - White Mountain National Forest
- USDA - Forest Service - State and Private Forestry
- New Hampshire Timberland Owners' Association
- Numerous professional loggers and foresters who have reviewed drafts

DEFINITIONS

Best Management Practices - Proper methods for the control and dispersal of water on truck roads, skid trails, and log landings to minimize erosion and reduce sediment and temperature changes in streams.

Bog - A low-lying area with standing water or saturated soil for a significant portion of the year that is dominated by grass-like vegetation, shrubs and dwarf trees and which has a thick vegetative mat under foot.

Erosion - Wearing away of the surface of the land, by action of water or wind due to timber harvesting operations.

Facultative Species: Trees and shrubs that are equally likely to occur in wetlands or uplands (estimated probability 34-66%).

Facultative Upland Species: Trees and shrubs that usually occur in uplands (non-wetlands) (estimated probability 67-99%), but occasionally found in wetlands (estimated probability 1-33%).

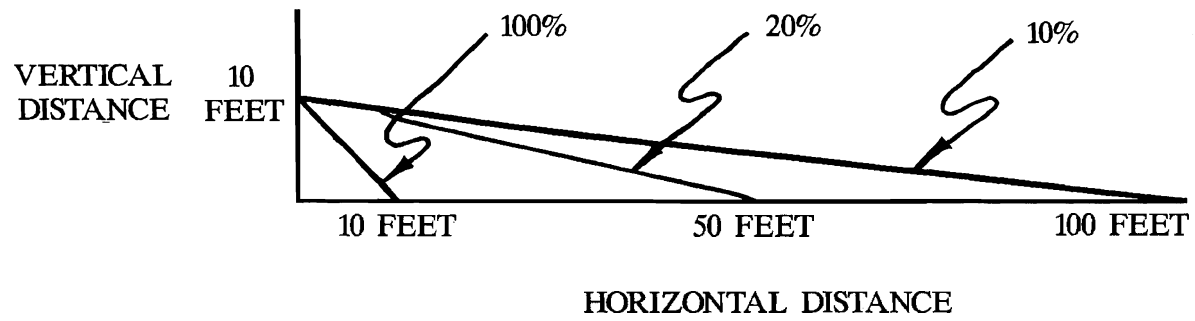
Facultative Wetland Species: Trees and shrubs that usually occur in wetlands (estimated probability 67-99%), but occasionally found in uplands (non-wetlands) (estimated probability 1-33%).

Forested Wetland - A wetland where trees are the dominant plants.

Freshwater Wetland - An area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetland permits are required for any dredge, fill, or construction in a wetland, intermittent or perennial stream or other surface water.

Geotextile - A product used as a soil reinforcement agent and as a filter medium. It is made of synthetic fibers manufactured in a woven or loose non-woven manner to form a blanket like product.

Grade - Expressed in percent, the distance a road or trail rises or falls over a horizontal distance. For example, a road or trail that rises or falls 10 feet over 100 feet in horizontal distance has a 10% grade.



Intermittent Stream - A water course that flows in a well defined channel during the wet periods of the year or after major storms.

Marsh - A low-lying area with standing water or saturated soil for a sufficient portion of the year that is dominated by reeds, cattails, sedge, or grasslike vegetation.

Minimum Impact Forest Management Project - A temporary wetland crossing for forest management or timber harvesting purposes which is less than 50 feet in length and requires less than 3,000 square feet of fill, and which follows the Best Management Practices.

Mulch - A natural or artificial layer of plant residue or other materials covering the land surface that conserves moisture, holds soil in place, aids in establishing plant cover, and minimizes temperature fluctuations.

Obligate Upland Species: Trees and shrubs that almost always occur in uplands (non-wetlands) (estimated probability >99%).

Obligate Wetland Species: Trees and shrubs that almost always occur in wetlands (estimated probability >99%).

Perennial Stream - A watercourse that flows throughout the year or nearly so (90 percent) in a well defined channel. Same as a live stream.

Riprap - Rock or other large aggregate that is placed to protect streambanks, bridge abutments, outflow of drainage structures, or other erodible sites from runoff.

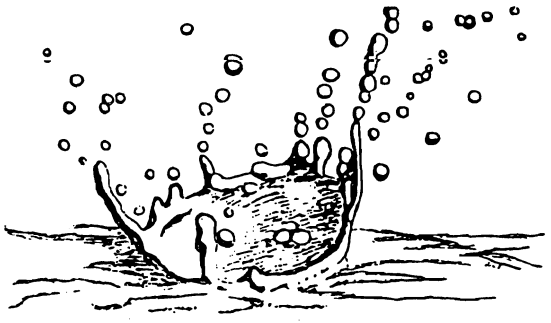
Sediment - Soil material that has been detached, transported, suspended, or settled in water

Slope - Degree of deviation of a surface from the horizontal, measured as a numerical ratio, as a percent, or in degrees. Expressed as a ratio, the first number is the horizontal distance (run) and the second number is the vertical distance (rise), as 2:1. A 2:1 slope is a 50% slope. Expressed in degrees, the slope is the angle from the horizontal plane, with a 90 degree slope being veritcal (maximum) and a 45 degree slope being a 1:1 slope.

Stream - Any channel for the passage of surface water having a defined bed and banks whether natural or artificial, with perennial or intermittent flow.

Swamp - A tree or shrub wetland, with standing water or saturated soils for a sufficient portion of the year, that often has a "hummocky" appearance and buttressed roots. Dominant full sized trees may include red maple, black ash, black willow, black spruce, tamarack, or white cedar.

Wetland - An area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic (water loving) vegetation and which has soils indicative of wet conditions.



RAINDROP ON BARE SOIL

PLANNING THE OPERATION

When the forest floor is disturbed and truck haul roads and skid trails are constructed, the natural filtering action of the soil is reduced. Trucks and skidders may compact the underlying soil. When it rains or the snow melts, surface water is not readily absorbed. Instead, the surface water flows into the roads and trails which can act as channels that increase the velocity and volume of the water as it flows downhill. As the water flows it may erode the soil and destroy the road and other capital improvements.

Water quality management through systematic planning helps prevent erosion. This kind of management can be achieved by planning and laying out the roads and skid trails correctly, and by finding ways to get the water off the roads and trails as quickly as possible, before erosion can accelerate. Careless construction leads to rebuilding, lost time, higher costs and harm to soil, water, and fish habitat.

If systematic planning does not take place before the operation begins, then there is the risk that the ditches, the crossdrains, culverts and water bars may not provide adequate drainage.

Guidelines:

Layout

- Obtain topographic maps, soils maps, aerial photographs and property maps.
- Use topographic maps, soils maps, and aerial photos to identify streams, forested wetlands, other bodies of water, steep slopes, flood plains, property boundaries, and harvest area boundaries.
- Locate the property lines and the area to be harvested on each of the maps and photographs.
- Walk the area and see how the land lays and where the stands for harvesting are located.
- Outline areas on the maps that are near streams, ponds, lakes, or wetlands, and mark very steep and very wet areas, and areas with poor timber.
- Consider the following for maximum erosion control:
  - ♦ Minimize the amount of soil disturbance
  - ♦ Minimize the amount of cut and fills
  - ♦ Minimize the number of stream crossings
  - ♦ Provide adequate drainage of the road and main skid trail area
  - ♦ Plan buffers around sensitive areas

- Draw on the maps the proposed location of your haul roads, main skid trails, and log landings. Look for the best placement on slopes, the position of streams and wetlands, possible stream crossings, and areas of soil instability.

- Walk the proposed location of haul roads and main skid trails. Establish control points along the way. These should be points you can identify on a map, aerial photograph, and on the ground.

- Flag this route as you walk in. Check skidding distances on both sides of your proposed route.

- Walk back out following your flagged route.

    1. Adjust flagging to take advantage of natural features that will make road and trail construction and drainage easier.

    2. Check the grades to make sure that they meet guidelines for truck haul roads and skid trails.

    3. Flag areas suitable for landings and borrow pits.

    4. Make sure the route provides the best access to present and future harvest areas

- Draw on your maps the final proposed location of your truck haul roads, skid trails, stream crossings, erosion control devices, etc.

- Be aware of applicable state and local laws which relate to timber harvesting, wetlands, surface waters and fish and wildlife habitat. Obtain all necessary permits prior to any construction or timber harvesting. (See Logging and the Law)

Construction

During the construction of truck haul roads and skid trails, there are certain activities that must be planned because they directly relate to the amount of erosion that can occur.

- **Timing** - Most problems can be prevented or minimized by timing the harvesting operation to take advantage of seasonal conditions.

    1. Winter harvesting to take advantage of snow cover and frozen ground.

    2. Bridge construction and culvert installation should be done during summer when streamflow is low.

3. On streams having important fisheries value, bridge and culvert installation should be avoided during egg incubation period of October to April.

4. If construction is necessary, it should be done well ahead of time to permit disturbed soil to stabilize before the road or trail is to be used.

- **Design** - The entire road and trail system should be designed before any construction begins. This process may seem to take more time, but the system will be more efficient, less costly, and easier to maintain.

  1. **Grade** - Keep grades low except where short, steep sections are needed to take advantage of favorable topography and to avoid excessive cut and fill.

  2. **Width** - The width of the road or trail should be designed for the equipment to be used on the timber harvesting operation.

  3. **Angle** - Consider the proper angle for cuts and fills in designing roads on varying types of soils and rock materials. Make road cuts reasonably steep in order to minimize surface exposed to erosion.

  4. **Alignment** - Avoid the toes of slopes, breaks in a slope, and running parallel to a streambank.

  5. **Surface** - Crushed rock and gravel may be needed to keep the road surface from washing out during rainfall and runoff.

  6. **Drainage** - Provisions must be made for the passage of surface water from adjacent slopes, as well as for rapid drainage of the roadbed itself.

  7. **Stream Crossings** - All crossings sites should be selected at right angles to the stream and should not interfere with natural streamflow.

Retirement

A plan should be developed that provides for the retirement of truck haul roads, skid trails, and log landings.

- Smooth and shape all road and landing surfaces.
- Remove all temporary culverts and replace them with water bars, broad based dips, or ditches.
- Permanent culverts must be sized properly and provisions made for their continued maintenance.
- Remove all temporary stream and wetland crossings.
- Seed, mulch, lime, and fertilize.

ARE YOU IN A WETLAND?

Wetlands Characteristics:

Hydrology, or the presence of water in or above the soil;

Signs on the surface of the ground include:

- Waterstained (dark) or silt covered leaves;
- Lines of organic debris such as leaf litter on tree and shrub stems above soil surface;
- Water or silt stained plant stems;
- Swollen bases of tree trunks (an adaptation to wet soils);
- Exposed plant roots (an adaptation to wet soils).

Soils, which show observable features when saturated or flooded for long periods of time;

Signs in the soil include:

- Sphagnum moss on the surface;
- A thick upper layer of peaty organic matter;
- Soils mostly neutral grey in color (gleyed), or grey soils with rust colored (orange-brown and yellow-brown) splotches within 18" of the surface.

Vegetation, which is usually composed of a predominance of species suited to hydric (largely anerobic) soil habitats.

Signs in the composition of plant species include:

- More than half the plant species being those that grow most often in wetland soils. Plant species have been classified by the US Fish & Wildlife Service based on how frequently they occur in wetlands. All plants, including herbaceous groundcovers, are important in wetland determination. However, only trees and shrubs are included here because there are fewer species than herbaceous plants, they are more easily identified by most people and they can be observed and identified at all times of the year. The species are grouped into five categories, listed here from most to least wetland adapted:

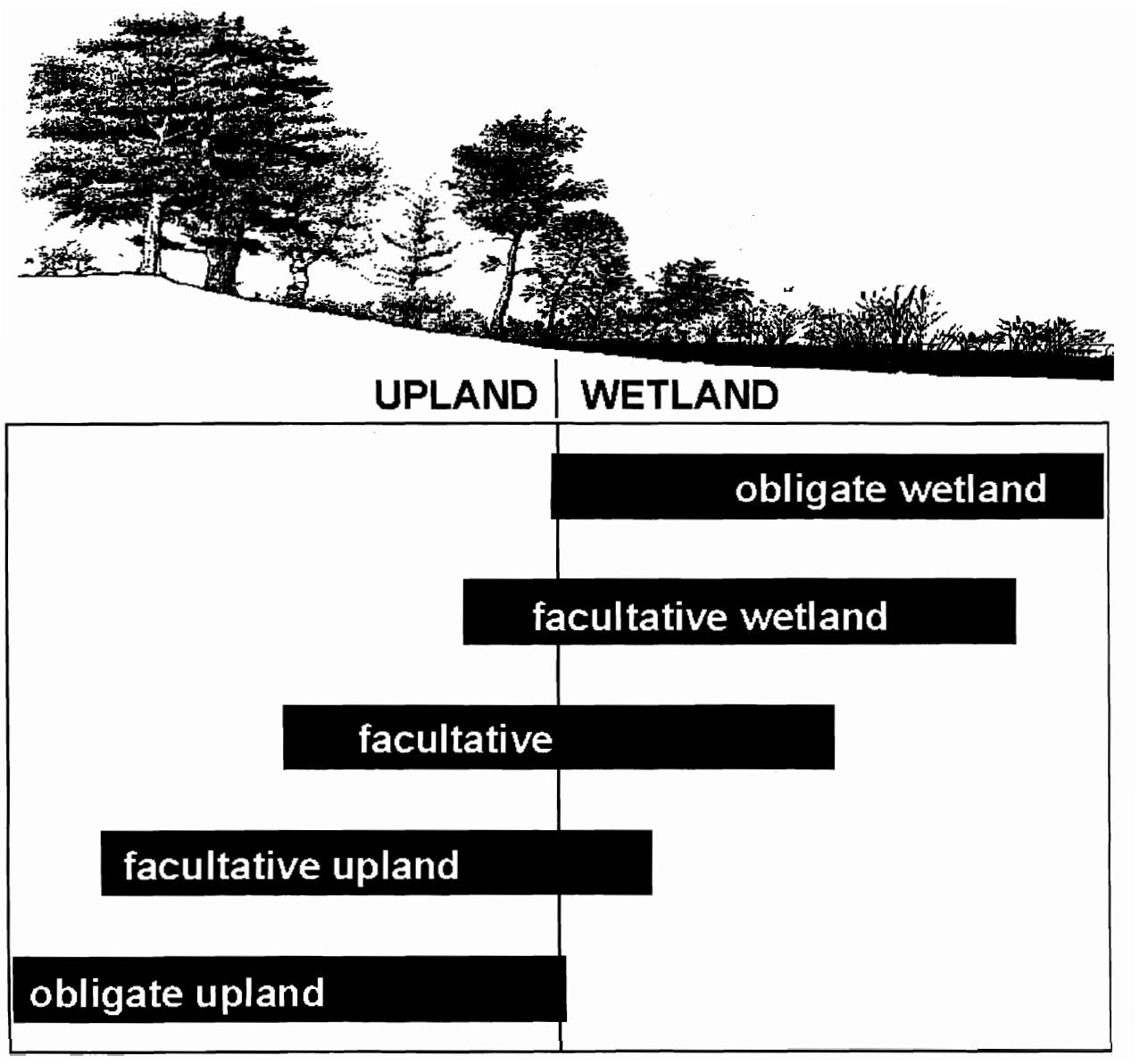
Obligate Wetland.....Species occur more than 99% of the time in wetlands.

Facultative Wetland.....Species occur between 67-99% of the time in wetlands.

Facultative.....Species occur equally in uplands and wetlands.

Facultative Upland.....Species occur between 1-33% of the time in wetlands.

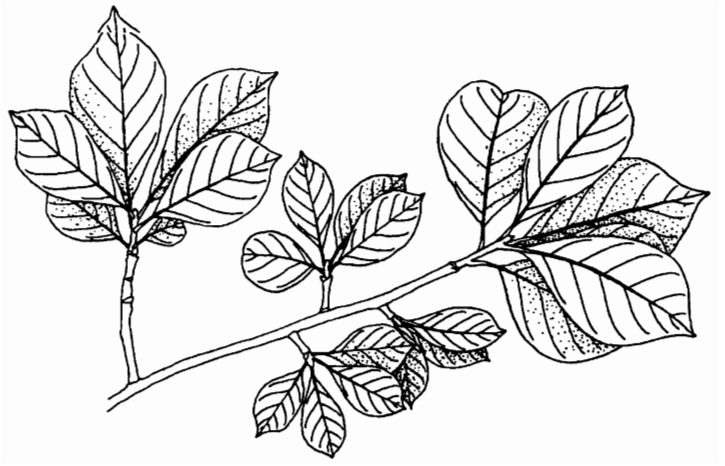
Obligate Upland.....Species occur less than 1% of the time in wetlands.



Care must be taken when estimating wetland conditions using only plants. One reason is that common trees in the most marginal (least wet) wetlands (forested wetlands) are often the facultative species Red maple and Balsam fir and the facultative upland species Eastern hemlock. Even White pine and other species more commonly found in drier sites will grow on raised hummocks in a forested wetland. In these cases, a survey of the shrubs present will often provide a better indication of wetland conditions, as will groundcovers if they are present. In many forested wetlands, Highbush blueberry and Winterberry holly are common and readily identified at any time of the year.

The technical determination of wetland boundaries incorporates all these characteristics, but is not practical for informal determination of whether you are working in a wetland. However, a rough estimate of a wetland boundary can be made using the signs given above. Begin by finding an area that seems obviously to be a wetland. Then, walk toward the upland, noting changes in vegetation as you go. If possible, sample the soil for the characteristics and look for above-ground signs noted above. When you no longer observe a majority of wetland plants or soil conditions, consider this the approximate wetland edge. This process can be repeated at intervals around the wetland edge, marking as you go.

If you're not sure about wetland determination, refer to section in this manual on Available Assistance.



Black Gum *Nyssa sylvatica*

Speckled Alder *Alnus rugosa*

FREQUENCY OF OCCURRENCE OF SELECTED NEW HAMPSHIRE *SHRUB SPECIES* IN WETLANDS AND UPLANDS

OBLIGATE WETLAND SPECIES (>99% in wetlands, <1% in uplands)

Buttonbush	*Cephalanthus occidentalis*
Cranberry, Large	*Vaccinium macrocarpon*
Cranberry, Small	*Vaccinium oxycoccos*
Labrador Tea	*Ledum groendlandicum*
Leatherleaf	*Chamaedaphne calyculata*
Mountain Holly	*Nemopanthus mucronatus*
Rose, Swamp	*Rosa palustris*
Rosemary, Bog	*Andromeda polifolia*
Sumac, Poison	*Toxicodendron vernix*
Sweetgale	*Myrica gale*

FACULTATIVE WETLAND SPECIES (67 - 99% in wetlands, 1 - 33% in uplands)

Alder, Speckled	*Alnus rugosa*
Arrow-Wood	*Viburnum recognitum*
Azalea, Swamp	*Rhododendron viscosum*
Blueberry, Highbush	*Vaccinium corymbosum*
Chokeberry, Red	*Aronia arbutifolia*
Dogwood, Red Osier	*Cornus stolonifera*
Dogwood, Silky	*Cornus amomum*
Elder, American	*Sambucus canadensis*
Maleberry	*Lyonia ligustrina*
Rhodora	*Rhododendron canadense*
Spicebush	*Lindera benzoin*
Steeple-Bush	*Spiraea tomentosa*
Winterberry Holly	*Ilex verticillata*
Withe-Rod	*Viburnum cassinoides*

FACULTATIVE SPECIES (Likely to occur equally (34 - 66%) in uplands and wetlands.)

Bayberry	*Myrica pensylvanica*
Chokeberry, Black	*Aronia melanocarpa*
Cranberry, Mountain	*Vaccinium vitis-idaea*
Ivy, Poison	*Toxicodendron radicans*
Meadow-Sweet	*Spiraea latifolia*
Nannyberry	*Viburnun lentago*
Pepper-Bush	*Clethra alnifolia*
Raspberry, Red	*Rubus idaeus*

Rhododendron, Rosebay	*Rhododendron maximum*
Rose, Virginia	*Rosa virginiana*
Sheep-Laurel	*Kalmia angustifolia*
Yew, American	*Taxus canadensis*

FACULTATIVE UPLAND SPECIES (1 - 33% in wetlands, 67 - 99% in uplands)

Barberry, European	*Berberis vulgaris*
Barberry, Japanese	*Berberis thunbergii*
Bitter-sweet, American	*Celastrus scandens*
Blackberry, Allegheny	*Rubus alleghaniensis*
Blueberry, Lowbush	*Vaccinium angustifolium*
Elder, Red	*Sambucus racemosa*
Hazel-nut, Beaked	*Corylus cornuta*
Hobble-Bush	*Viburnum lantanoides*
Juniper, Creeping	*Juniperus horizontalis*
Laurel, Mountain	*Kalmia latifolia*
Rose, Rugosa	*Rosa rugosa*
Teaberry (Checkerberry)	*Gaultheria procumbens*
Witch-Hazel	*Hamamelis virginiana*

OBLIGATE UPLAND SPECIES (< 1% in wetlands, >99% in uplands)

Juniper, Common	*Juniperus communis*
Sumac, Smooth	*Rhus glabra*
Sumac, Staghorn	*Rhus typhina*
Sweet Fern	*Comptonia peregrina*
Viburnum, Maple-leaved	*Viburnum acerifolium*

Pepper Bush *Clethra alnifolia*

FREQUENCY OF OCCURRENCE OF SELECTED NEW HAMPSHIRE *TREE SPECIES* IN WETLANDS AND UPLANDS

OBLIGATE WETLAND SPECIES (>99% in wetlands, <1% in uplands)

Atlantic White Cedar	*Chamaecyparis thyoides*

FACULTATIVE WETLAND SPECIES (67 - 99% in wetlands, 1 - 33% in uplands)

Black Ash	*Fraxinus nigra*
Green Ash	*Fraxinus pensylvanica*
River Birch	*Betula nigra*
Northern White Cedar	*Thuja occidentalis*
American Elm	*Ulmus americana*
American Larch	*Larix laricina*
Silver Maple	*Acer saccharinum*
Swamp White Oak	*Quercus alba*
Balsam Poplar	*Populus balsamifera*
Black Spruce	*Picea mariana*
Sycamore	*Platanus occidentalis*
Tupelo (Black Gum)	*Nyssa sylvatica*
Black Willow	*Salix nigra*

FACULTATIVE SPECIES (Likely to occur equally (34-66%) in uplands and wetlands.)

Gray Birch	*Betula populifolia*
Yellow Birch	*Betula alleghaniensis*
Cottonwood	*Populus deltoides*
Slippery Elm	*Ulmus rubra*
Balsam Fir	*Abies balsamea*
Honey Locust	*Gleditsia triacanthos*
Ironwood	*Carpinus caroliniana*
Red Maple	*Acer rubrum*

FACULTATIVE UPLAND SPECIES (1 - 33% in wetlands, 67 - 99% in uplands)

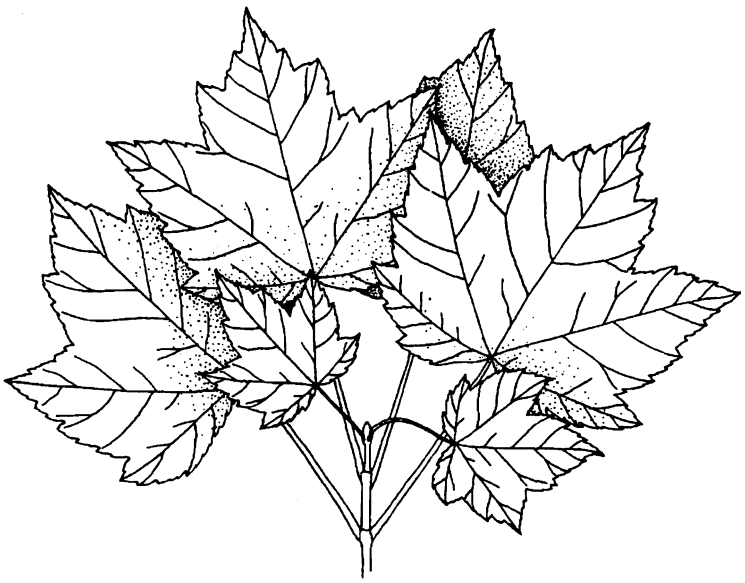
White Ash	*Fraxinus americana*
Big-tooth Aspen	*Populus grandidentata*
Quaking Aspen	*Populus tremuloides*
Basswood	*Tilia americana*
American Beech	Fagus grandifolia

Paper Birch	*Betula papyrifera*
Sweet Birch	*Betula lenta*
Butternut	*Juglans cinerea*
Red Cedar	*Juniperus virginiana*
Black Cherry	*Prunus serotina*
Choke Cherry	*Prunus virginiana*
Fire Cherry	*Prunus pensylvanica*
Flowering Dogwood	*Cornus florida*
Eastern Hemlock	*Tsuga canadensis*
Shagbark Hickory	*Carya ovata*
Hop Hornbeam	*Ostrya virginiana*
Black Locust	*Robinia pseudoacacia*
Striped Maple	*Acer pensylvanicum*
Sugar Maple	*Acer saccharum*
Red Oak	*Quercus rubra*
White Oak	*Quercus alba*
White Pine	*Pinus strobus*
Pitch Pine	*Pinus rigida*
Red Pine	*Pinus resinosa*
Sassafras	*Sassafras albidum*
Red Spruce	*Picea rubens*
White Spruce	*Picea glauca*
Black Walnut	*Juglans nigra*

OBLIGATE UPLAND SPECIES

(< 1% in wetlands, >99% in uplands)

None



Red Maple *Acer Rubrum*

TRUCK HAUL ROADS

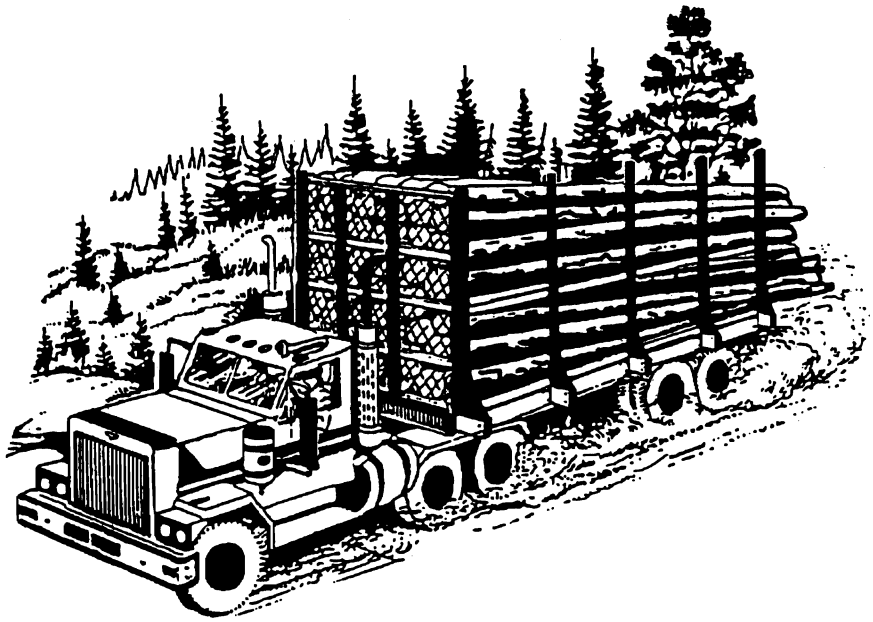
❑ **Definition:**
A road system, temporary or permanent, installed for transportation of wood products from the landing by truck.

❑ **Purpose:**
To provide for an efficient transportation system for forest products from the landing while also protecting forest land and water quality, for recreation, forest fire access, or other needed forest management activities.

❑ **Condition Where Practices Applies:**
Where area and volume to be harvested makes it necessary and economically feasible to install such a road system.

Guidelines:

- A well thought out efficient transportation system will minimize the area disturbed and vulnerable to erosion.
- Keep the length of the truck road, from the log landing to a public highway, to a minimum. Have gravel or wood chips for about 200 feet prior to entering on a public highway to keep mud off of the highway.



Road grades should be kept to 10% or less. Steeper grades are permissible for short distances. Long level sections are difficult to drain properly. Grades between 3% and 5% are desirable.

- Place roads on high ground with gentle grades. Avoid sharp curves. Use a fifty foot minimum radius for large trucks.

- Minimum tread width is 10 feet for one-way traffic and 15 feet for two-way traffic. Increase the tread width by a minimum of 4 feet for trailer traffic.

- Use a geotextile construction fabric underlayment when constructing roads on poorly drained surface.

- Move surface water quickly off road surfaces and onto undisturbed forest floor. Ditches should be used to efficiently divert water away from the road surface. Water entering a roadway should be moved under or away from the roadway before gaining sufficient flow and velocity to erode ditches. Drainage ditches should not end where they will feed water directly into streams or other surface waters. (See Erosion Control Devices)

- If streams must be crossed, do so by the most direct route and preferably at right angles to the stream. A bridge, culvert, or food of acceptable design may be required. (See Stream Crossings)

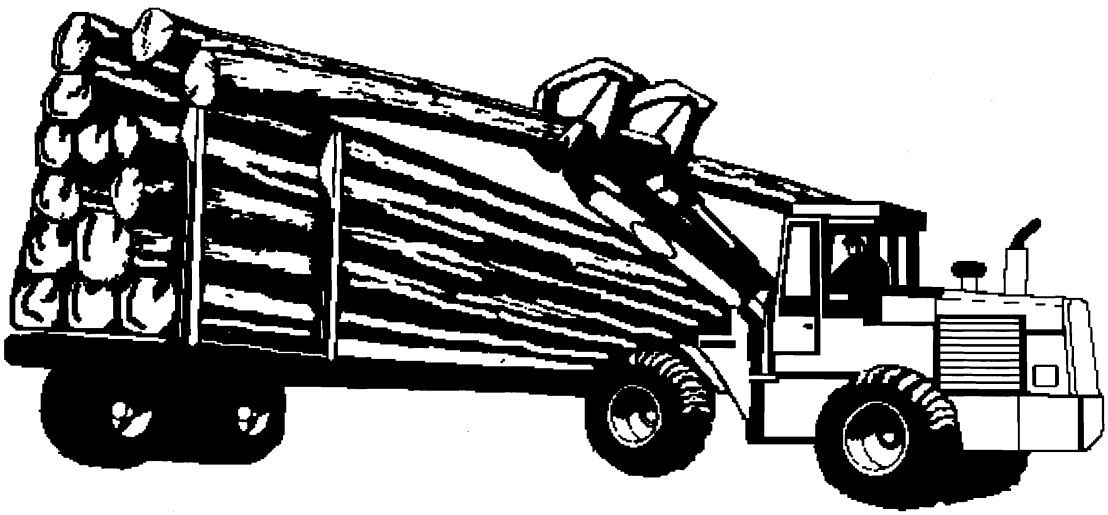
- Road grades approaching stream crossings shall be broken and surface water dispersed so it will not reach the watercourse. (See Erosion Control Devices)

- Restrict vehicle traffic on soft roads during Spring and Fall mud seasons.

- Restrict vehicle traffic during heavy rains.

- Do not allow skidding on truck roads.

- Check with the State of New Hampshire - Department of Transportation or the local town officials to determine if a driveway permit is required.



SKID TRAILS

❑ **Definition:**
An unsurfaced, single lane trail system usually steeper and narrower than a truck road and used for skidding harvested products.

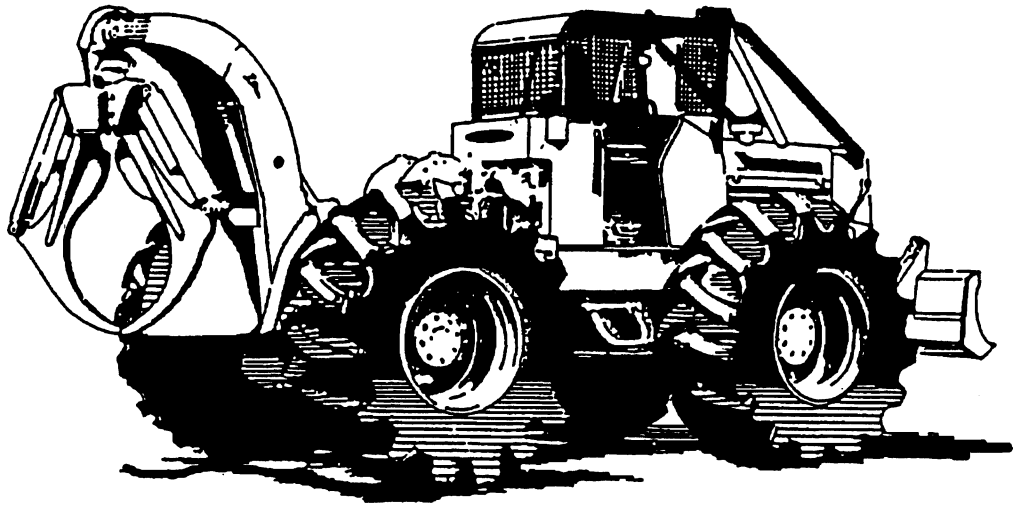
❑ **Purpose:**
To bring logs, tree lengths, or other roundwood products from the stump to a log landing or concentration area.

❑ **Conditions Where Practice Applies:**
Use where harvested products must be brought to one location for sawing, chipping or loading. Where topography and size of operation make this the most economical means of collecting logs, trees, or other roundwood products.

Guidelines:

A well thought out efficient transportation system will minimize the area disturbed and vulnerable to erosion.

- Trail grades should be kept to 15% or less. Steeper grades are permissible for shorter distances.
- Plan skid trails from the top down.



- Locate skid trails to take advantage of natural cross drainage.
- Use reverse grades and provide upgrade turns where natural reverse grades are not available. (See Erosion Control Devices - Reverse Grades)
- Major skid trails should be located away from streams, ponds, lakes, and wetlands. (See Erosion Control Devices - Streamside Management Zone)
- Move surface water quickly off trail surfaces and on to undisturbed forest floor. (See Erosion Control Devices)
- If streams must be crossed, do so by the most direct route and preferable at right angles to the stream. A bridge, culvert, or ford of acceptable design may be required. (See - Stream Crossings)

- Trail grades approaching stream crossings shall be broken and surface water dispersed so it will not reach the water course. (See Erosion Control Devices)
- **At no time will logs be permitted to be skidded or equipment driven through flowing streams.**
- Skid across slope where feasible.
- Skid uphill to the log landing whenever possible so that water running in the skid trails is dispersed away from landing.
- Silt fencing, haybale erosion checks or water diversions shall be used to prevent soil from skid trails from entering streams and other surface waters.
- Use brush to minimize rutting in soft soil.

LOG LANDINGS

❑ **Definition:**
An area where harvested logs and trees are temporarily stored and assembled.

❑ **Purpose:**
To provide an area where forest products are sorted and loaded onto trucks for transport to a mill.

❑ **Conditions Where Practice Applies:**
Should be so located as to minimize the adverse impact of skidding operations in sensitive areas and on the natural drainage pattern

Guidelines:

- Landings should not be located in streamside management zone.
- Set landings back 100 feet or more from streams, ponds, lakes, and wetlands.
- If landings cannot be set back 100 feet from streams, pond, lakes, and wetlands, sediment traps should be used to minimize sedimentation from surface runoff. Adequate streamside management zone should be left between landings and water courses.
- Locate landings away from low or poorly drained areas.
- Locate landings on gently sloping ground that allows for good drainage.
- Landings should be sized to the minimum required for the area to be cut, the equipment used and the diversity of products produced.
- Construct diversion ditch around uphill side of landings where seepage and lateral flow of water may be a problem.
- Provide adequate drainage on approach trails so that drainage does not enter landing area.
- Divert water draining from landings so that it does not enter truck roads, skid trails, or flow directly into streams, ponds, lakes, or wetlands.
- Servicing of equipment on site must be done in such a way that old oil, hydraulic fluid, etc., should be properly contained and removed from the site and disposed of in accordance with proper waste disposal procedures.

STREAMSIDE MANAGEMENT ZONE

❑ **Definition:**
A protective strip of undisturbed forest soil between disturbed areas (skid trails, truck roads, and log landings) and a water course (stream, pond, lake, and wetlands).

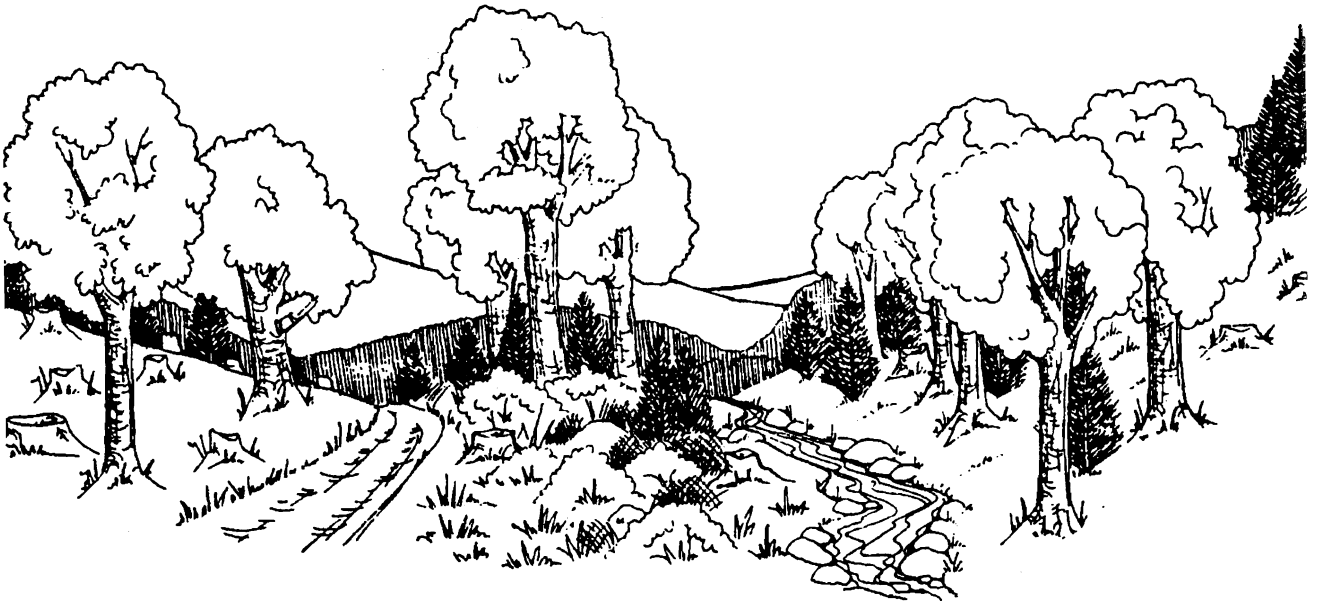
❑ **Purpose:**
To provide an undisturbed zone to slow runoff, allowing sediment to settle and be filtered out before reaching a water course.

❑ **Conditions Where Practice Applies:**
Should be maintained between all water courses and truck roads, major skid trails, or log landings where soil has been exposed.

Guidelines:

- The streamside management zone should be protected to prevent exposure of mineral soil. Equipment operation in this area should be limited. If mineral soil is exposed, it should be stabilized by seeding and/or mulching as soon as possible.

- Harvesting practices which do not expose mineral soil may take place in the streamside management zone such as felling and winching of timber.



- No log landings should be within the streamside management zone.

- Truck roads and major skid trails should not be within the streamside management zone except when entering and leaving stream crossings.

- New Hampshire law limits harvesting near surface waters and public roads.

STREAMSIDE MANAGEMENT ZONE WIDTHS

Side slope (percent)	Width (feet)
0 - 10	50
11 - 20	70
21 - 30	90
31 - 40	110

Note: Add 20 feet for each additional 10 percent of side slope.

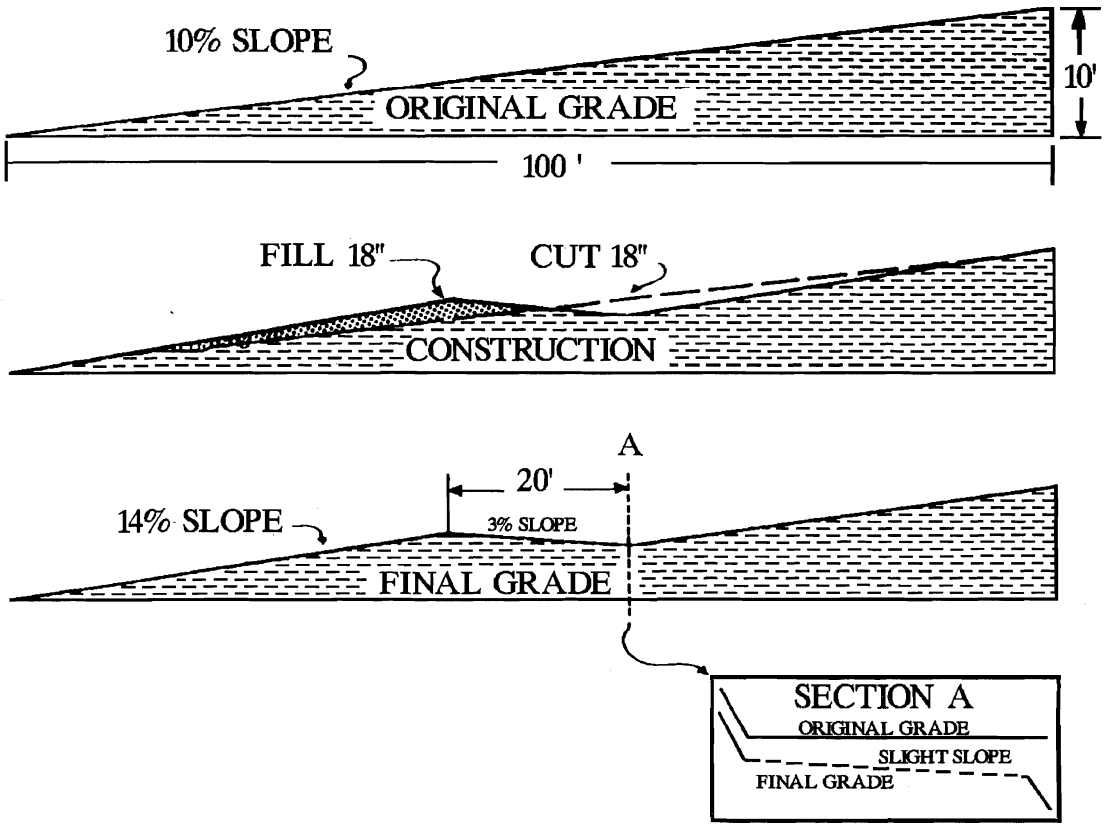
BROAD BASED DIPS

❑ **Definition:**
A dip and reverse slope in a truck road surface with an outslope in the dip for natural cross drainage.

❑ **Purpose:**
To provide cross drainage on insloped truck roads to prevent build-up of excessive surface runoff and subsequent erosion.

❑ **Conditions Where Practice Applies:**
Use on truck roads and heavily used skid trails having a gradient of 10% or less. May be substituted for other cross drainage structures where no intermittent or permanent streams are present.

Guidelines:



- Proper construction requires an experienced bulldozer operator.
- Installed after the basic roadbed has been constructed and before major hauling use.
- On grades steeper than 8%, surface dips with stone (approx. 3" diameter) or gravel.
- Use dips on approaches to steep declines in heavily used skid trails.
- Discharge area should be protected with stone, grass sod, heavy litter cover or slash and logs to reduce the velocity and filter the water.

SPACING FOR BROAD BASED DIPS

Road Grade (percent)	Spacing Between Dips (feet)
2	300
4	200
6	165
8	150
10	140
12	130

WATER BARS

❑ **Definition:**
An excavated channel with earthen or reinforced berm constructed across a truck road or skid trail.

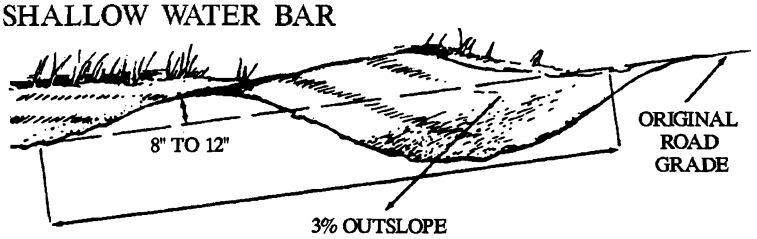
❑ **Purpose:**
To intercept and divert water from side ditches and truck road or skid trail surfaces, minimizing erosion by decreasing the slope length of surface water flow.

❑ **Conditions Where Practice Applies:**
On any sloping truck road or skid trail where surface water runoff may cause erosion.

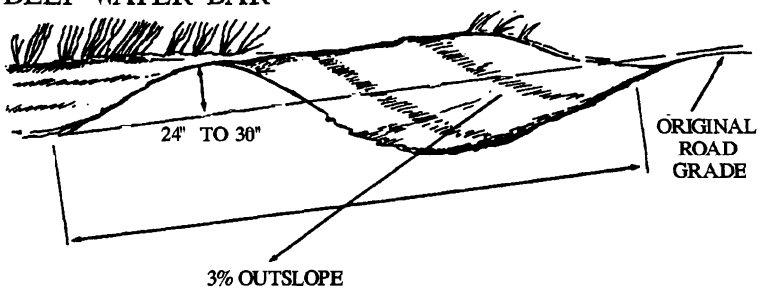
Guidelines:

- Start placement of water bars at the farthest skid trail and work back to the log landing and then to the truck road.
- Install water bars with a skidder blade, dozer blade, excavator or by hand.

SHALLOW WATER BAR



DEEP WATER BAR



- Install water bars at the top of any sloping road or trail and at proper spacing along steep sections.
- Water bars may be shallow or deep depending on the need.
- Soil should be left along the lower side of the water bar.
- Should be constructed at a 30° - 35° angle downslope from a line perpendicular to the direction of the truck road or skid trail.
- Should drain at a 3% outslope onto undisturbed litter or vegetation
- The uphill end of the water bar should extend beyond the side ditch line of the road or trail to fully intercept any water flow.
- The downhill end of the water bar should be fully open and extended far enough beyond the edge of the road or trail to disperse runoff water onto undisturbed forest floor.
- Place rocks, slash, or logs to disperse water coming from a water bar
- If the road or trail is to be kept open after the harvesting operation, the following guidelines should be used in order to preserve effective water bars.

-Reinforce the water bars

-Keep travel to a minimum

-Use only in dry weather

-Make frequent inspections

-Maintain as needed

SPACING FOR WATER BARS

Road/Trail Grade (percent)	Spacing Between Water Bars (feet)
2	250
5	135
10	80
15	60
20	45
30	35

REVERSE GRADES

❑ **Definition:**
A short rise in a downhill skid trail that forces any water in the trail to drain off to the side. Obtained by turning the skid trail up the hill a short distance then turning downhill again.

❑ **Purpose:**
To break the grade of the skid trail as often as practical, therefore limiting slope length.

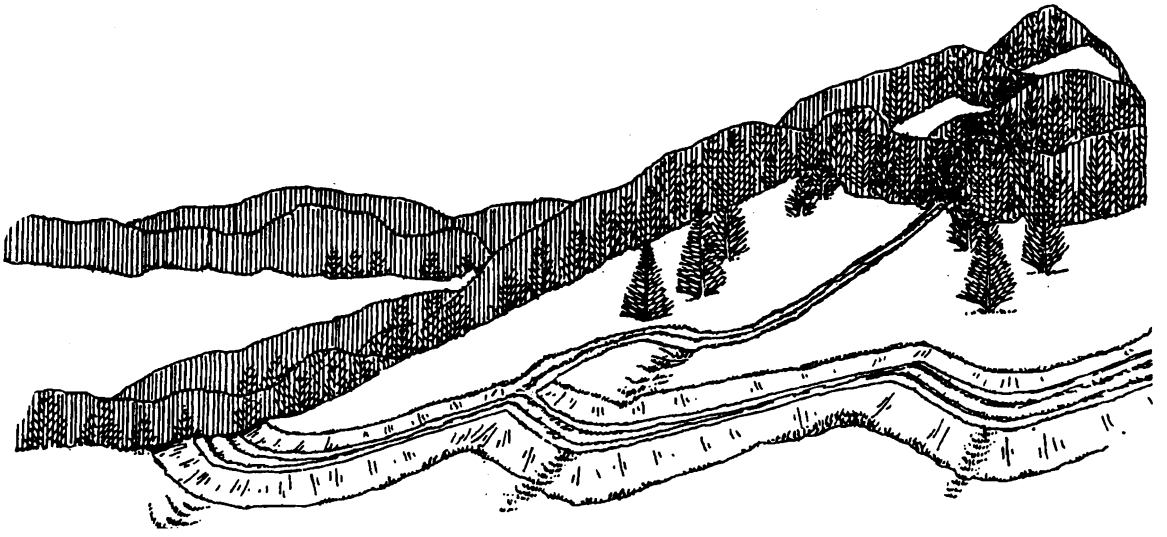
❑ **Condition Where Practice Applies:**
Where additional drainage can be provided by taking advantage of natural cross drainage on sidehill locations.

Guidelines:

Reverse grades are commonly applied to only skid trails.

Requires greater planning and layout of trail system.

- Use in conjunction with other water control measures.
- Requires minimum construction time and low maintenance.
- Unsuitable on very steep terrain and hardpan soils.



CROSS DRAINAGE CULVERTS

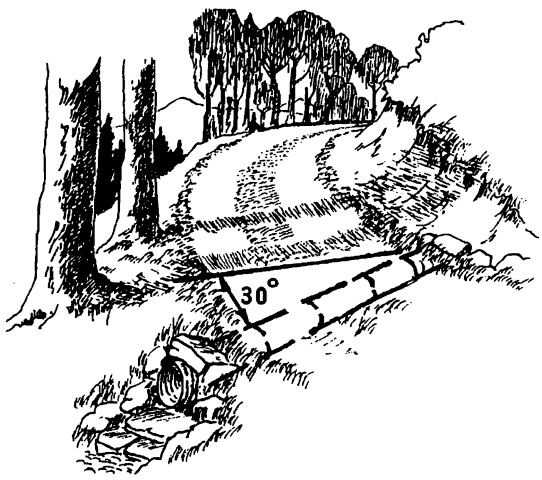
❑ **Definition:**
Corrugated pipe, well casing, dredge pipe, or other suitable material placed under a truck haul road or major skid road to transmit ditch runoff and seeps from a drainage area of less than 10 acres.

❑ **Purpose:**
To collect and transmit water flows from side ditches and seeps, under truck haul roads and major skid trails safely without eroding a drainage system or road surface.

❑ **Conditions Where Practice Applies:**
For any size operation where cross drainage of storm water is required temporarily or permanently.

Guidelines:

- This is the most expensive method of road cross drainage and should be used where heavy use is anticipated during and after the harvesting operation.
- When sizing culverts for temporary roads, allow for periods of high flow, such as spring runoff or cloudbursts.
- The minimum size culvert to be installed is 12 inch diameter and 20 feet in length.
- When constructing roads on sidehill locations, ditch the uphill side of the roadway to intercept surface runoff.
- Allow inlet end of culvert to extend into side ditch so that it intercepts water flowing in the ditch. Construct a berm across the side ditch to assist in diverting water into the culvert.



- Allow outlet end of culvert to extend beyond any fill and empty onto an apron of rock, gravel or logs.

- Space culverts according to road grade:

  On gentle slopes (1-2%).....300 feet

  On moderate slopes (3-10%).....150 feet

  On steep slopes (10%+).....100 feet or less

- Culverts should be installed at a 30-35 degree angle downgrade.

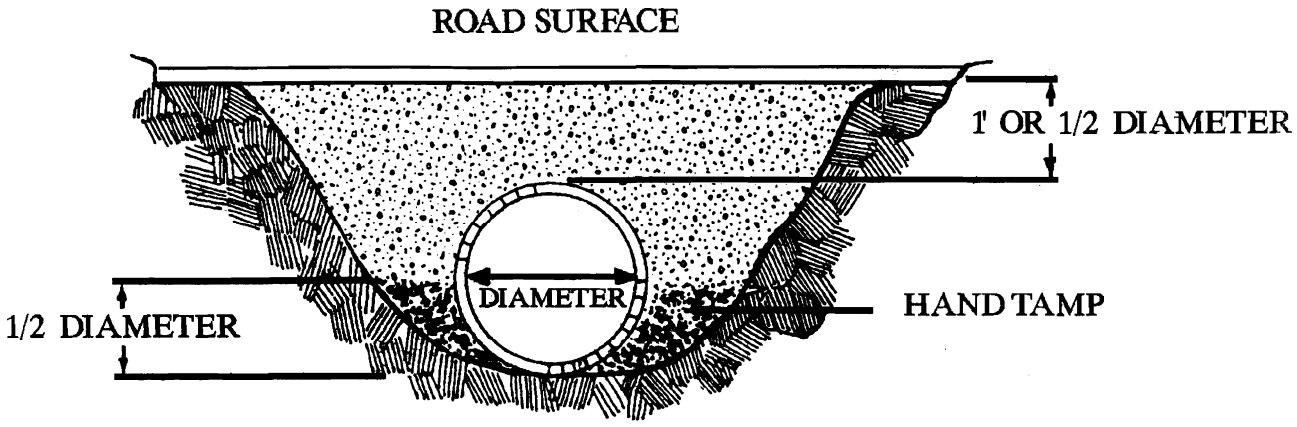
- Culverts should be sloped at least 5 inches for every 10 feet of length to permit self-cleaning.

- When harvesting operation has been completed, the road should be stabilized by installing water bars and removing all pipe culverts from truck roads which will not be maintained.

- Culverts, when not maintained, are very likely to become blocked with rocks, ice or other debris. Runoff water can become rerouted over and around the culvert and may wash out sections of road into brooks, streams, ponds or wetlands. It is important to clean culverts regularly. Check after every storm.

- Culvert size selection should be based on the size of the drainage area of the watershed and should be able to handle the largest flows.

- Estimate drainage area by taking measurements on a USGS topographic map, using contour lines to define the drainage limits. The Natural Resource Conservation Service can assist you with determination of drainage area.



OPEN TOP CULVERTS

❑ **Definition:**

A wooden, concrete, or slotted steel pipe culvert placed across truck haul roads to convey surface runoff and side ditch flows across to downslope side.

❑ **Purpose:**

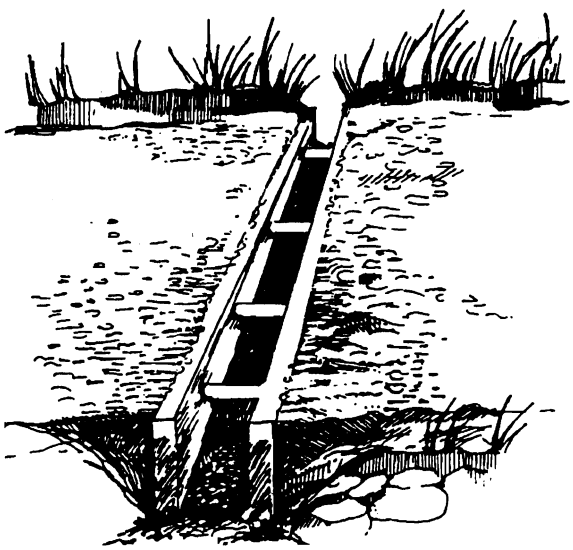
To collect and direct road surface storm runoff and upslope side ditch flows across road without eroding drainage system or road surfaces.

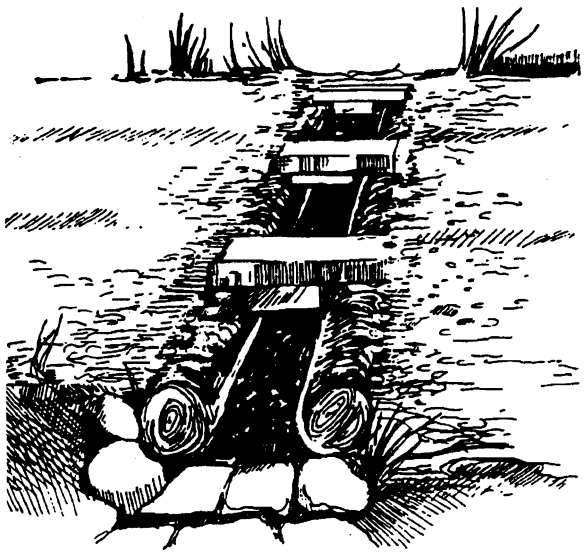
❑ **Conditions Where Practice Applies:**

This practice is a temporary or permanent drainage structure for truck haul roads. Properly built and maintained, it can be used for cross drainage on roads of smaller operations as a substitute for a cross drainage culvert. This practice should not be used for handling intermittent or live streams or skid trail cross drainage.

Guidelines:

- Can be constructed of cull logs or from sawn lumber. If made of durable wood or treated material, these culverts will give many years of service.
- Install flush with the road surface and skewed at an angle not less than 30 degrees downgrade.





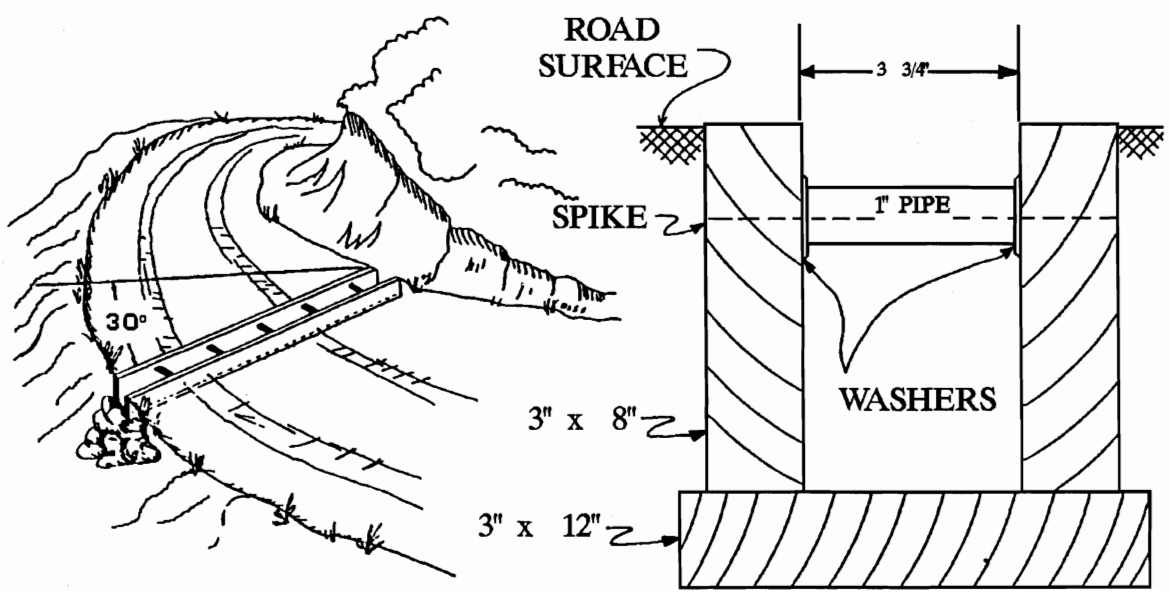
- Allow the inlet end to extend into the cut slope or side ditch so that it intercepts water.

Allow outlet end to extend beyond any fill and empty onto an apron of rock, gravel or logs.

- Open top culverts must be cleaned regularly to remove sediments, gravel, and logging debris to allow normal function of structure at all times.

SPACING FOR OPEN TOP CULVERTS

Road Grade(percent)	Spacing Between Culverts(feet)
1 - 2%	300
3 - 10%	150
10%+	100 or less

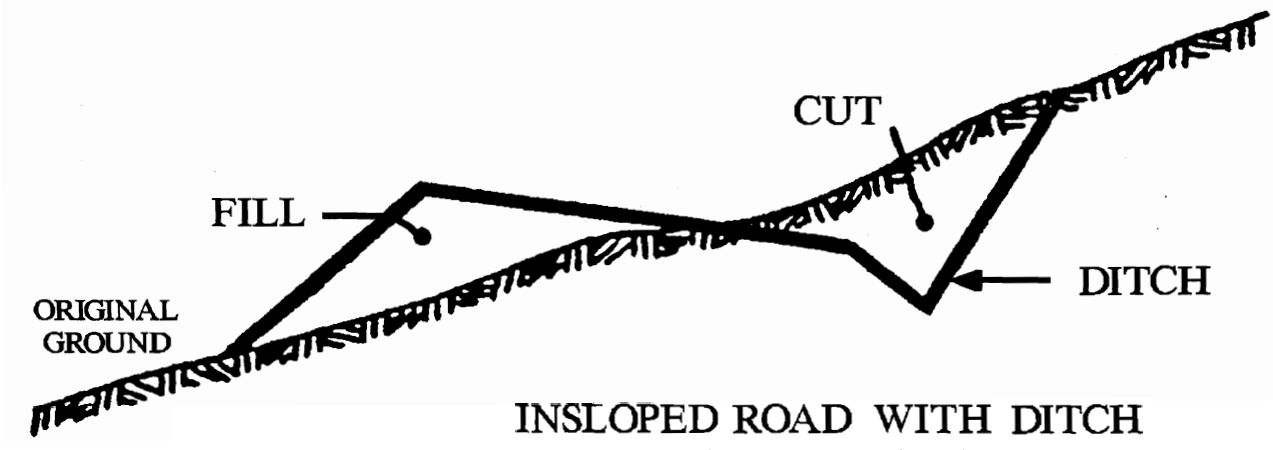


INSLOPING

❑ **Definition:**
A section of road is sloped slightly (1-3%) toward the cut bank.

❑ **Purpose:**
Effective way of limiting erosion because water is removed from the road surface quickly and diverted directly to the inside ditch which will carry the water into a culvert.

❑ **Condition Where Practice Applies:**
Used when the soils are easily saturated or highly erodible. This will limit the amount of ditch water which will flow on to unstable fills.



INSLOPED ROAD WITH DITCH
(cross section)

OUTSLOPING

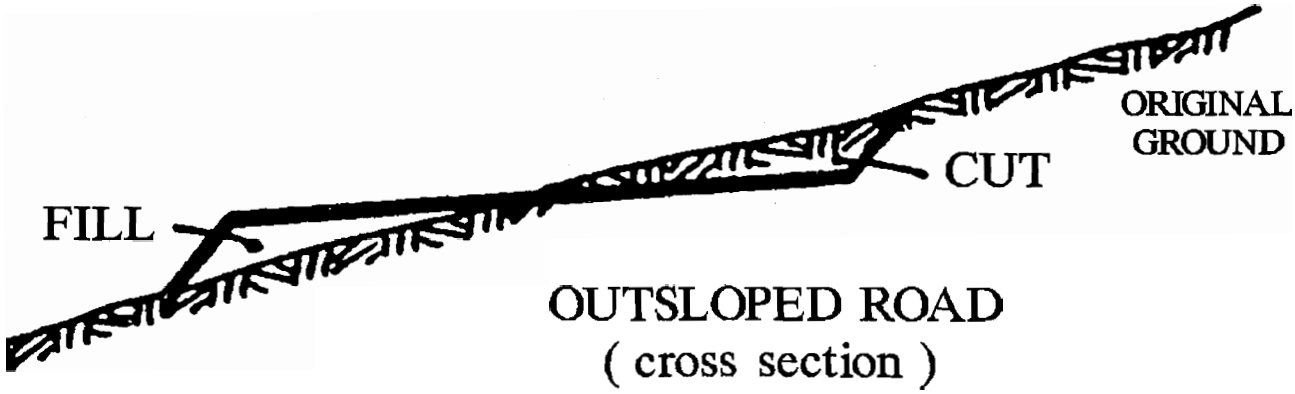
❑ **Definition:**
A section of road sloped slightly (1-3%) from the cut bank to the outside edge of the road bed.

❑ **Purpose:**
To prevent erosion by diverting runoff from a road surface on to undisturbed forest floor.

❑ **Condition Where Practice Applies:**
Used when the area is entirely rock, or when water can be diverted on to undisturbed forest floor.

Guidelines:

- Outsloping on fill is not desirable.
- For safety, do not use for trucking during freezing weather.
- Do not use on silty or hardpan soils when wet or if seeps are present.



OUTSLOPED ROAD
(cross section)

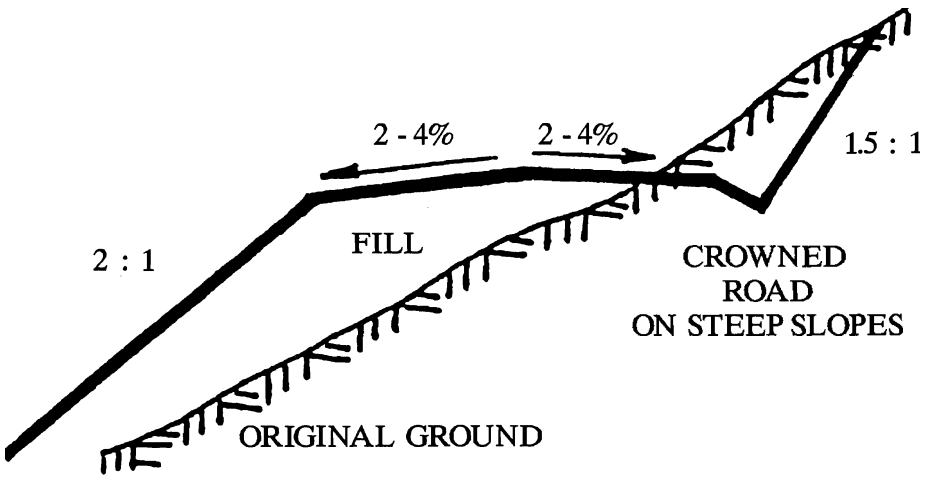
CROWNING

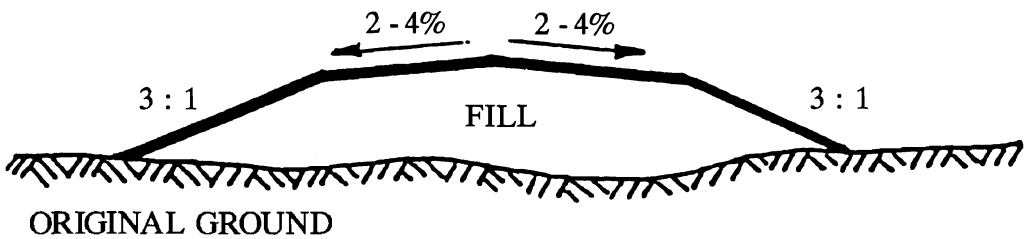
❑ **Definition:**
A section of road is sloped slightly (2-4%) from the center line of the road to the outside edges of the roadbed.

❑ **Purpose:**
Effective way of limiting erosion because water is removed from the road surface quickly and diverted directly onto the forest floor or into a ditch which will carry the water into a culvert.

❑ **Conditions Where Practice Applies:**
Used when soils are easily saturated or highly erodible when adjacent areas are relatively level with roadbed or on steep side hills.

Guidelines:





CROWNED ROAD

CORDUROY

❑ **Definition:**
Crossing of a wet area where there is not a defined channel using poles or cull logs as a roadbed.

❑ **Purpose:**
To be used as a wet area crossing by a skid trail where it is necessary to provide soil stability.

❑ **Conditions Where Practice Applies:**
To be constructed on wet soils subject to rutting and extreme compaction by timber harvesting equipment

Guidelines:

Use geo-textile fabric or other appropriate bedding.

- Place 8 - 10 inch diameter poles or cull logs side by side in wet area to serve as a roadbed.
- Place poles or cull logs perpendicular to the direction of travel across wet area.
- The top width of corduroy roadway should be at least 10 feet.
- Shall not be crossed when they are overtopped with water.

  After corduroy roadway has been overtopped with water, repair and maintenance will be required.
- Corduroy roadway should be inspected regularly.
- May be left in place after harvesting operation has been completed.

TEMPORARY BRIDGE

❑ **Definition:**
A structure of wood and steel materials installed across a natural or constructed channel or stream.

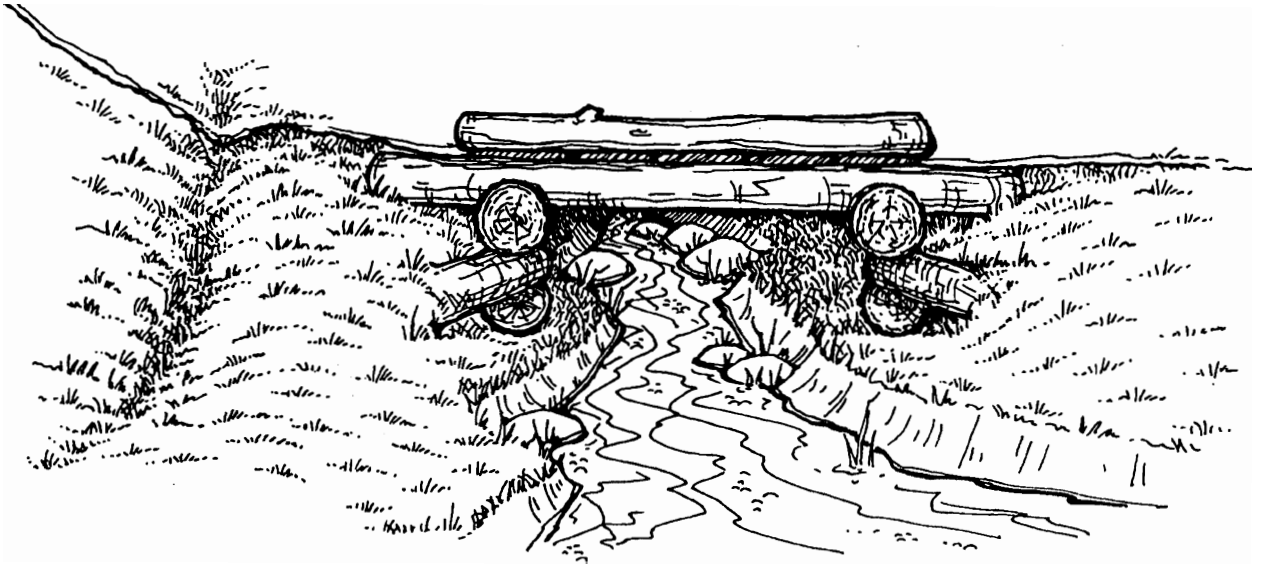
❑ **Purpose:**
To carry a single lane haul road or skid trail over a stream to enable more direct routing while keeping equipment and products out of the water.

❑ **Conditions Where Practice Applies:**
Where restrictions such as topography or property lines make it necessary to cross a stream. Stream crossings are a major concern in the construction and use of a truck haul roads and skid trails because of the potential for large amounts of sediment to enter a stream. Keep the number of stream crossings to a minimum.

Guidelines:

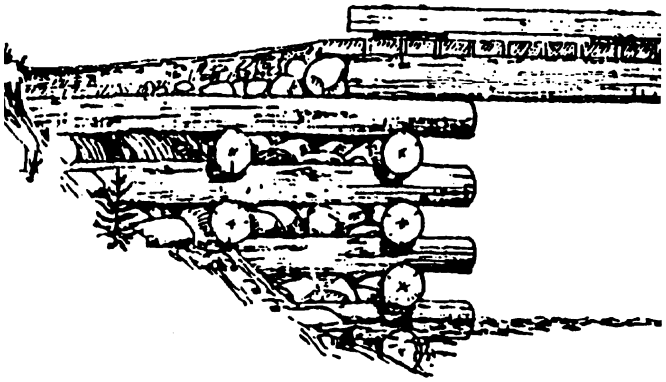
- Install bridges at right angle to the stream. A maximum of 15 degree skew may be allowed as an exception where approach conditions are difficult.
- Align approach and exit with the bridge's center line with as little curvature as possible.

Stream alignment should be straight at the point of crossing and of uniform profile.

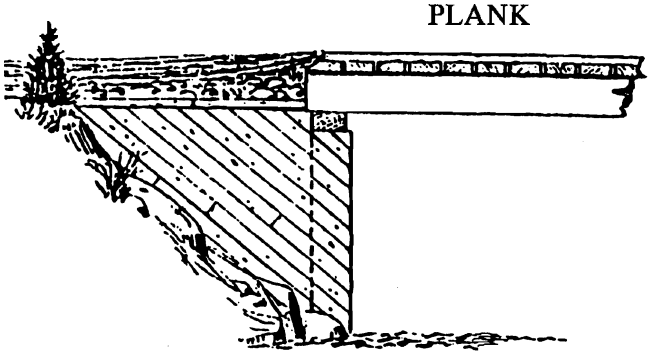


- Minimum acceptable bridge width is 10 feet.
- Firmly anchor abutments out of the water in stable bank material and parallel to the stream channel. Do not narrow stream channel with abutments.

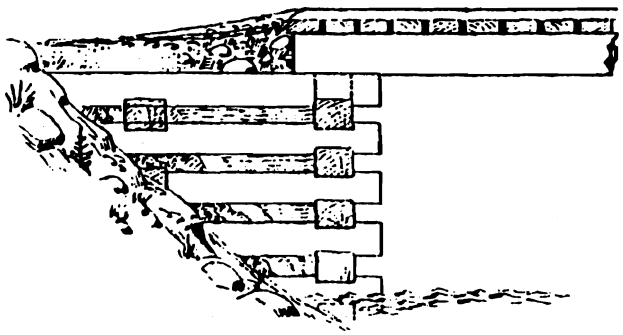
LOG CRIB



PLANK



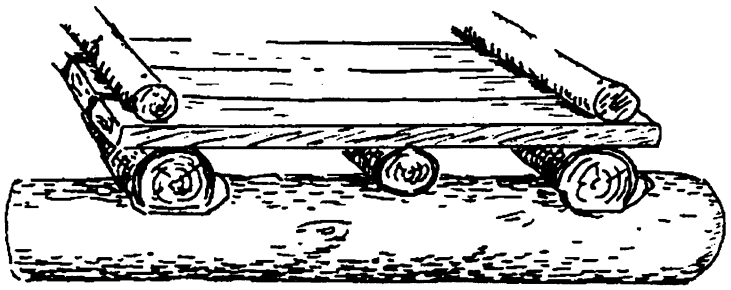
PREFABRICATED CRIB



- Acceptable abutment materials can be rock, logs, sawn timbers or a combination of any of the above. (See Logging and The Law)
- Place abutment aprons or approaches as close to gradient of bridge surface as possible. Avoid

abrupt rises and drops from bridge gradient to apron gradient. (See Logging and The Law)

- Stringer material may be either logs, sawn timbers or steel.
- Match center line gradients of span and stringers with that of the road or trail.
- It is recommended that a registered engineer be contacted to design the bridge.
- Log stringers should have a flat upper bearing face to accept a plank deck as well as a flat bearing surface on abutments. Placement of log stringers on abutments should alternate small and large ends.
- Deck material shall be placed perpendicular to the stringer direction and be tight.
- A curb shall be installed along the outer sides of the deck and be fastened tight to the deck. Minimum size will be 6" x 6" and will run the entire length of the span. Pole timbers can also be used, but must be straight and of sound quality.
- The bridge must be anchored so that it will not wash out during high water.
- Old trailer beds make excellent temporary bridges over small streams.
- Placement of bridges that require work in the stream should be done when the water level is low and in as short a period of time as possible. (See Logging and The Law)
- Do not gravel the deck. The gravel holds moisture that will cause the deck to rot.
- When the harvesting operation has been completed, stabilize the area by removing all bridges from truck haul roads and skid trails which will not be maintained.
- Road and trail grades approaching stream crossings shall be broken and surface water dispersed so it will not reach the watercourse. (See Erosion Control Devices)
- Find stream banks that are firm and level and approaches that are reasonably level for a distance of 50 feet on each side of the stream crossing.



STONE FORDS

❑ **Definition:**
Stream crossing using the stable stream bottom or stone fill as the roadbed.

❑ **Purpose:**
To be used on a truck haul road as a stream crossing rather than a bridge or culvert.

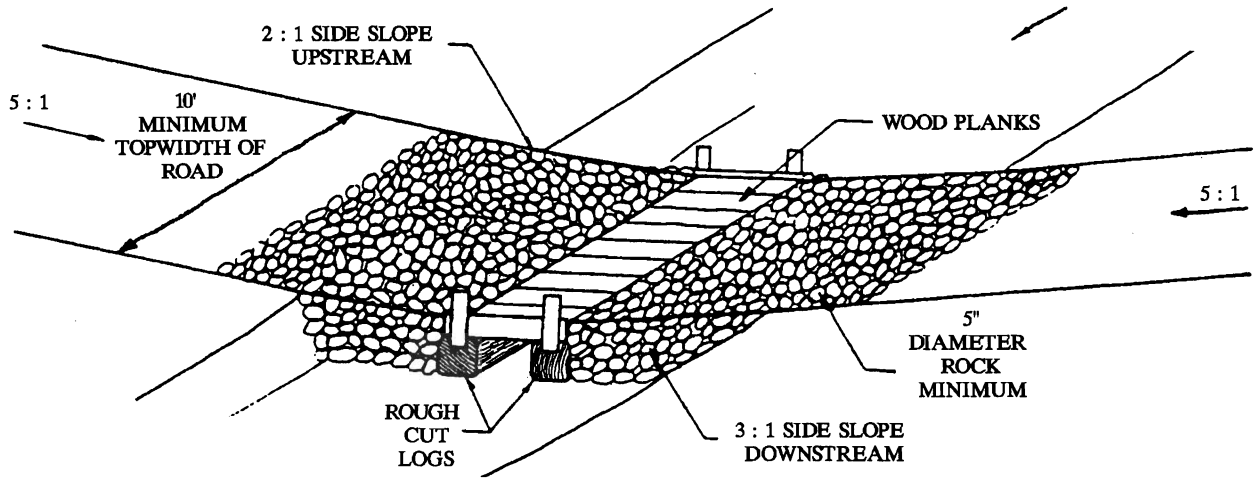
❑ **Conditions Where Practice Applies:**
Perennial Stream Ford - Can be constructed and used during periods of low flow. When drainage area exceeds one square mile, a log box culvert should be installed.

Guidelines:

- Installation of fords is permissible only when it is not feasible to construct a bridge or install a pipe culvert, i.e. streams having no or low banks.
- Fords are prohibited on all streams in watersheds tributary to drinking water intakes or reservoirs for public and private water supplies, where the ford is within 2,000 feet of such intake or reservoir.
- Shall not be crossed when they are overtopped with water.
- **Skidding across stone fords is prohibited.**
- Construct on sound stable stream bottoms, whenever possible.
- Use geotextile fabric or other appropriate bedding for approaches. Do not use in stream.
- Use angular rock fill material of at least 75% greater than 5 inches in diameter. Use larger sizes for large drainage areas.
- Use 2 inch round stone on surface of ford to protect tires from sharp edges of angular rock.
- Height of fill should be at least 1/2 foot above low flow water level. However, total fill should not to exceed 2 feet above stream bottom.
- The top width of the fords should be at least 10 feet.
- Side slopes of fords should be greater than or equal to; 2:1 upstream and 3:1 downstream.
- After fords have been overtopped with water, repair and maintenance will be required.

- Do not place gravel or fill on the top of stone fords.
- The log box culvert may float during overtopping and should be anchored.
- Large stones or boulders on the downstream face of a stone ford will increase its life.
- Roads and trail grades approaching stream crossings shall be broken and surface water dispersed so it will not reach the stream. (See Erosion Control Devices)
- Find stream banks that are firm and level with approaches that are reasonably level for a distance of 50 feet on each side of the stream crossing.

Number of 15"x15" Log Box Culverts	**Drainage Area (Square Miles)**	
	Shallow/High Elevation Soils	Normal Soils
1	1 - 5	1 - 8
2	5 - 10	8 - 17
3	10 - 15	17 - 20
4	15 - 20	



POLED FORDS

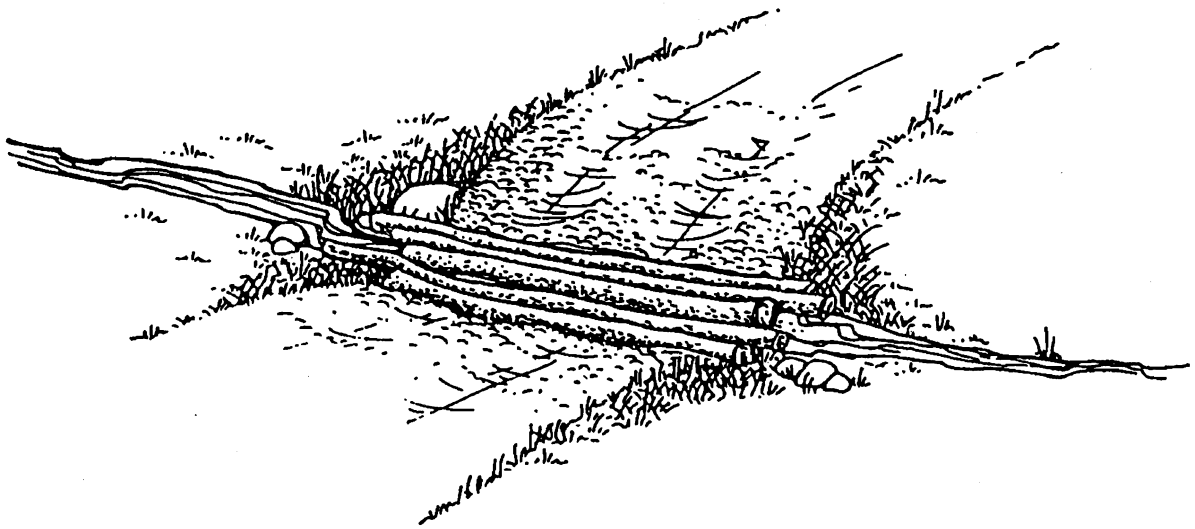
❑ **Definition:**
Temporary stream crossing in a defined channel using poles or cull logs as the roadbed.

❑ **Purpose:**
To be used as a stream crossing rather than a bridge or culvert.

❑ **Conditions Where Practice Applies:**
Can be constructed and used during periods of no or low flow. Fords are used for crossing streams with light use truck haul roads and skid trails where there is limited potential for sedimentation of the stream.

Guidelines:

- Installation of fords is permissible only when it is not feasible to construct a bridge or install a pipe culvert, i.e. streams having no or low banks.
- Fords are prohibited on all streams in watersheds tributary to drinking water intakes or reservoirs for public and private water supplies, where ford is within 2,000 feet of such intakes or reservoir.
- Shall not be crossed when they are overtopped with water.
- Constructed on sound stable stream bottoms.



- Use geo-textile fabric or other appropriate bedding if needed to stabilize the approaches to the crossing.
- Find stream banks that are firm and level with approaches that are reasonably level for a distance of 50 feet on each side of the stream crossing.
- Place 8 - 10 inch diameter poles or cull logs side by side on the stream bed to serve as the roadbed.
- The top width of these fords should be at least 10 feet.
- Poles and logs must be removed immediately after use.
- After fords have been overtopped with water, repair and maintenance will be required.
- Poled fords should be inspected regularly to make sure the stream is not becoming turbid.
- Do not gravel or fill over poled fords.

STREAM CULVERTS

❑ **Definition:**

Corrugated pipe, well casing, dredge pipe or wooden box culvert placed under a truck haul road or major skid road to permit crossing of an intermittent or live stream.

❑ **Purpose:**

To transmit water flow of intermittent or live streams under truck haul roads and major skid trails. To carry a single lane haul road or skid trail over a stream to enable more direct routing while keeping equipment and products out of the water.

❑ **Conditions Where Practice Applies:**

Where restrictions such as topography or property lines make it necessary to cross a stream. Stream crossings are a major concern in the construction and use of truck haul roads, major skid roads, and skid trails because of the potential for large amounts of sediment to enter a stream.

Guidelines:

- Keep the number of stream crossings to a minimum.
- Culvert size selection should be based on the size of the drainage area of a forested watershed and should be able to handle the largest stream flows.
- Estimate drainage area by taking measurements on a USGS topographic map, using contour lines to define the drainage limits. The Natural Resource Conservation Service can assist you with determination of drainage area.
- Install a culvert/emergency spillway when the expected life of the stream crossing is greater than the duration of the harvesting operation.
- Construct during periods of no or low flow and in as short a period of time as possible.
- Install culvert crossing at right angle to the stream. A maximum of 15 degree skew is allowed as an exception where approach conditions are difficult.
- Align approach and exit with culvert crossing center line with as little curvature as possible.
- Road and trail grades approaching stream crossings should be broken and surface water dispersed so it will not reach the watercourse. (See Erosion Control Devices)

SIZING PIPE CULVERTS FOR STREAM CROSSINGS

Acres of Drainage		
Shallow and High Elevation Soils	Normal Forest Soils	Recommended Pipe Culvert Diameter in Inches
2	9	12
4	16	15
7	25	18
12	40	21
16	55	24
27	84	30
47	130	36
64	190	42
90	260	48
120	335	54
160	400	60
205	550	66
250	640	72

- Stream alignment should be straight at the point of crossing and of uniform profile so as not to obstruct the flow of water.
- Find stream banks that are firm and level and approaches that are reasonably level for a distance of 50 feet on each side of the stream crossing.
- Minimum acceptable culvert crossing top width is 10 feet.
- Place culverts in the natural drainage channel
- Place culverts on the same grade as the stream bed. The minimum culvert grade is 2-4%.

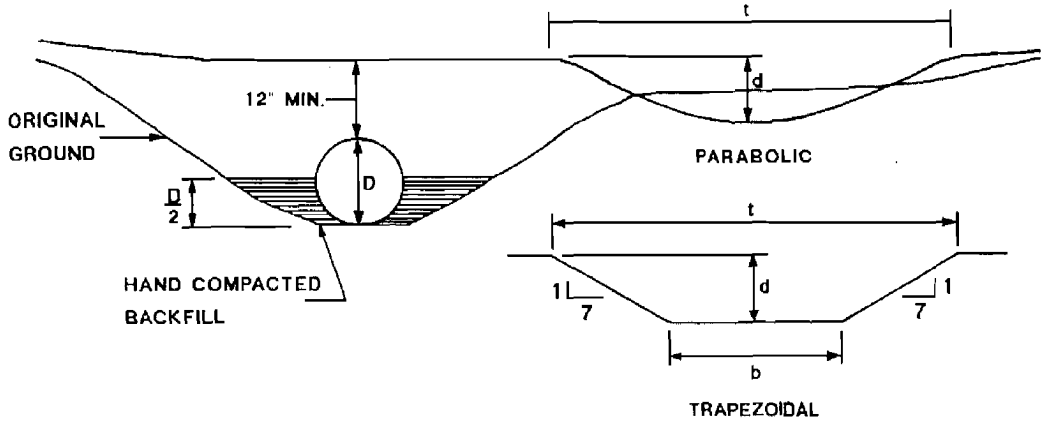
Pipe Culvert Diameter in Inches	Suggested Emergency Spillway Dimensions				
	Parabolic (ft.)		Trapezoidal (ft.)		
	d	t	d	t	b
12	0.5	12.0	0.5	11.5	4.5
15	0.5	12.0	0.5	11.5	4.5
18	0.5	17.0	0.5	15.0	8.0
21	0.75	12.0	0.75	13.5	3.0
24	0.75	22.0	0.75	19.5	9.0
30	1.0	23.0	1.0	22.5	8.5
36	1.0	33.0	1.0	29.0	15.0
42	1.0	44.0	1.0	36.0	22.0
48	1.0	55.0	1.0	44.0	30.0
54	1.5	45.0	1.5	44.0	24.0
60	1.5	52.0	1.5	48.5	27.5
66	2.0	49.0	2.0	54.0	26.0
72	2.0	55.0	2.0	58.0	30.0

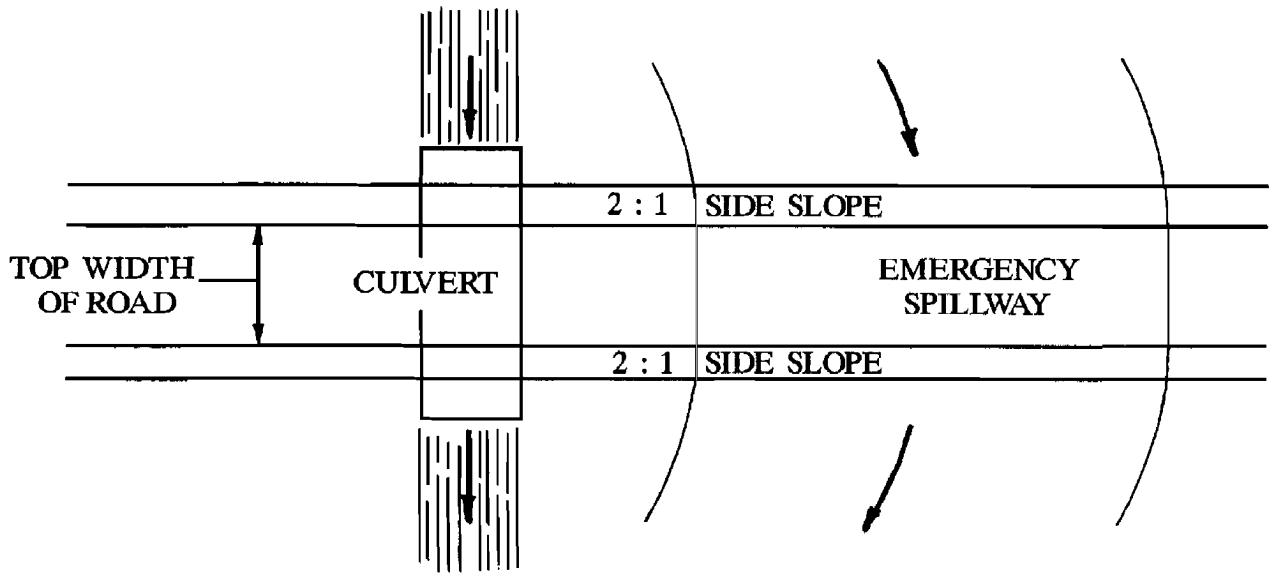
Design Assumptions:

- Entire drainage is forested
- Culverts sized for (2) year storm flow
- Emergency spillway sized for (10) year storm flow

- Inlet should be located on or below the stream bed, not above it.

- Avoid placing fill under the culvert to obtain the desired grade.





- Seat the culvert(s) and pack with clean washed stone; fill to half the diameter of the culvert and hand tamp.
- Cover culvert with a minimum of (1) foot of clean stone material or one-half the culvert diameter, whichever is greater. If adequate cover cannot be achieved, then (2) smaller culverts should be installed.
- Allow inlet and outlet ends of the culvert to extend at least (1) foot beyond the toe of the fill.
- Protect the upstream end of the fill around the culvert from erosion by placement of a rock header.
- Protect the downstream end of the fill around the culvert from erosion by seeding and mulching and providing riprap.

HAUL ROAD, SKID TRAIL, AND LOG LANDING STABILIZATION

❑ **Definition:**
Planting vegetation such as grasses and legumes on exposed mineral soil and erodible segments of truck haul roads, skid trails, or log landings.

❑ **Purpose:**
To permanently stabilize the site; to reduce damages from sediment and runoff, provide wildlife food value and habitat; enhance natural beauty; maintenance of the right-of-way is desired.

❑ **Conditions Where Practice Applies:**
Areas of exposed mineral soil that are subject to erosion and where a permanent vegetative cover is needed.

Guidelines:

- Old or new water diversion structures such as water bars, culverts, broad based dips, etc., must be operative before stabilization is initiated.

- Where feasible, prepare a seedbed by grading, removing debris, and scarifying the soil to a minimum depth of 3 inches. When the area to be seeded has been recently loosened to the extent that an adequate seedbed exists, no additional treatment is required.

- Lime and fertilizer should be thoroughly applied to the seedbed as indicated by soil test.

  1. Lime to a pH of 6.0, but in the absence of a soil test, apply a minimum of 2 ton/acre of ground agricultural limestone (high magnesium).

  2 Fertilize at the rate of 500 pounds of 10-10-10 per acre.

- Mulch, such as straw, hay, woodchips, or bark, retains soil moisture, important for seed germination, and protects the soil surface from erosion due to runoff. Mulch can be used to: (1) promote natural revegetation or (2) protect seeds that have been spread over an area. If you seed, apply mulch immediately afterward.

- Seeded areas should be closed off from all use until cover is adequately established.

- Inspect all seeded areas for failures and make necessary repairs.

- Grasses and other herbaceous cover can stabilize bare mineral soil and minimize erosion. It is a

good practice to seed disturbed areas following harvesting.

- Close off vehicle access with a gate, fence, boulders, or with a large tree felled across the road.
- Mulch seedings and anchor on slopes or where subjected to concentrated flow.
- Track in seed with a dozer whenever possible to improve germination and establishment, especially when seeding flatpea or crownvetch and on sandy, droughty sites.

Seeding Mixtures for Permanent Seedings[1]

Area/Purpose	Drainage Class	Soil pH	Shade	Appropriate Mixture[2] (lbs./Ac)	
Winter Roads Landings Wildlife	Poorly	5.0-7.5	Moderate to None	Reed Canarygrass Birdsfoot Trefoil Redtop	15 10[3] 2
Roads Trails Landings Burned Over	Excessively to Somewhat Poorly	4.5-7.5	Heavy to None	Creeping Red Fescue Tall Fescue Redtop	20 20 2
Roads Trails Landings Burned Over Brush Control	Excessively to Somewhat Poorly	5.5-7.5	Moderate to None	Flatpea Tall Fescue Redtop	20[3] 15 2
Roads Landings Wildlife	Well to Moderately Poorly	5.0-7.5	Moderate to None	Creeping Red Fescue Birdsfoot Trefoil Redtop	20 8[3] 2
Roads Landings Wildlife	Well to Moderately Well	5.5-7.5	Moderate to None	Crownvetch Tall Fescue Creeping Red Fescue Redtop	15[3] 15 10 2

[1]Seeding Dates. Seed disturbed areas as soon as possible. Seed early in the spring as soon as the ground can be worked and in the late summer - early fall based on local recommendations.

[2]Include 10-20 lbs.\ac. of winter rye when seeding after Sept. 15th. On critical areas or droughty sites, apply hay or straw mulch at the rate of 90 lbs./1000 sq. ft. Anchor mulch on steep slopes or where subjected to concentrated flow.

[3]Inoculate legumes separately with an inoculant which is specifically recommended for the legume being seeded.

Seeding Mixtures for Temporary Seedings[1]

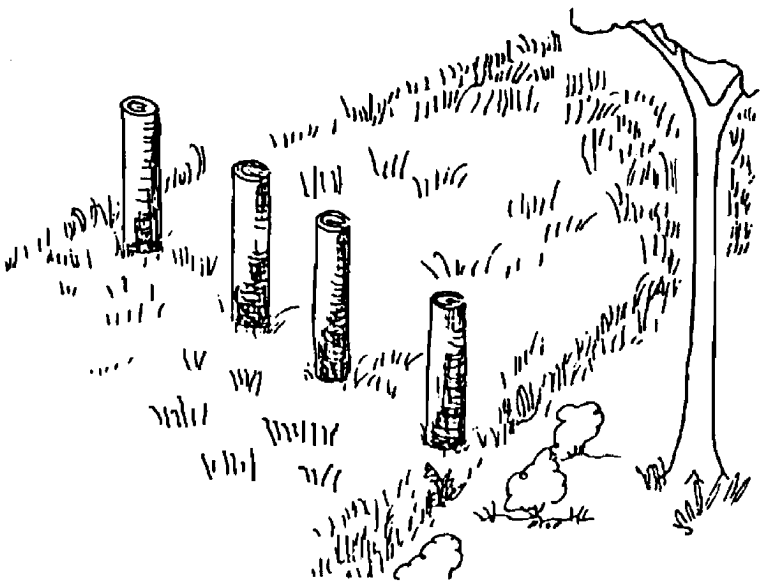
For Excessively Well to Somewhat Poorly Drained Soils

Area/Purpose	Soil pH	Shade	AppropriateMixture[2](lbs./Ac.)	
Roads Trails Landings Burned Over	4.5-7.5	Heavy to None	Creeping Red Fescue Redtop	40 2
Roads Trails Landings	5.5-7.5	Heavy to None	Annual Ryegrass	40
Roads Trails Landings Wildlife	5.5-7.5	Moderate to None	Winter Rye	112

---

[1]Seeding Dates. Seed disturbed areas as soon as possible. Seed as early in the spring as the ground can be worked and in the late summer - early fall based on local recommendations.

[2]On critical areas or droughty sites, apply hay or straw mulch at the of 90 lbs./1000 sq. ft. Anchor mulch on steep slopes or where subjected to concentrated flow.



LOGGING AND THE LAW

CHAPTER 227-J .....TIMBER HARVESTING

227-J:1 Declaration of Purpose. It is hereby recognized and declared that the public welfare of this state requires the care and protection of forest cover adjacent to certain waters of the state and along public highways, and the proper disposal of slash and mill residue resulting from forest operations in certain circumstances to help conserve the amount and quality of surface waters and groundwaters of the state; reduce the incidence and severity of forest fires; promote healthful surroundings, recreational opportunities, and scenic values; ensure future forest productivity; improve conditions for wildlife; and provide other benefits to the public as the result of perpetuating a proper forest cover, while continuing to meet the timber needs of forest industries and providing income and employment for our citizens without undue infringement on the rights of private forest landowners.

227-J:2 Duties and Authority of the Director, Division of Forests and Lands:

I. The director, or the director's authorized agents shall:

(a) Be the primary enforcement agency for this chapter.

(b) Enforce the provisions of RSA 637 insofar as they pertain to the protection and improvement of forestlands.

II. The director or the director's authorized agents may:

(a) For the purpose of performing the duties under this chapter, enter upon all lands in this state, posted or otherwise.

(b) Exercise the powers of arrest pursuant to RSA 227- G:7.

(c) Issue a written cease and desist order against any timber operation in violation of this chapter, with the exception of RSA 227-J:4. Any such violation may be enjoined by the superior court, upon application of the attorney general. A person failing to comply with the cease and desist order shall be guilty of a violation.

(d) Issue cease and desist orders to temporarily suspend logging or other operations in forest areas when the director determines that such actions have resulted in, or are likely to result in, pollution of surface water or groundwater. In such instances, the director shall immediately notify the division of water supply and pollution control, which shall investigate at once. The cease and desist order issued by the director shall remain in force until such time as the division of water supply and pollution control determines whether the action in question constitutes a threat to water supplies.

III. The director may enter into cooperative agreements or memoranda of understanding for the enforcement of the provisions of this chapter.

227-J:6 Operations in Wetlands.

I. Pursuant to RSA 482-A no person shall excavate, remove, fill, dredge or construct any structures in or on any bank, flat, marsh, or swamp in and adjacent to any waters of the state without a permit from the wetlands board. Failure to comply with these requirements may result in penalties under RSA 482-A.

II. Pursuant to RSA 482-A:3, V, persons who have complied with notice of intent to cut wood requirements under RSA 79:10, and who have filed an appropriate notification of forest management activities having minimum wetlands impact with the wetlands board and the department, shall have satisfied the permitting requirements for minimum impact activities.

III. Pursuant to the rules of the wetlands board, skid trails, truck roads and culverts, bridges, pole fords or other crossings on the skid trails or truck roads shall be constructed in accordance with procedures as currently cited in the Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire, published by the department.

227-J:7 Alteration of Terrain.

I. Pursuant to RSA 485-A:17, any person proposing to dredge, excavate, place fill, mine, transport forest products or undertake construction in or on the border of the surface waters of the state, and any person proposing to significantly alter the characteristics of the terrain, in such a manner as to impede the natural runoff or create an unnatural runoff shall comply with the provisions of RSA 485-A. Failure to comply with these requirements may result in penalties under RSA 485-A.

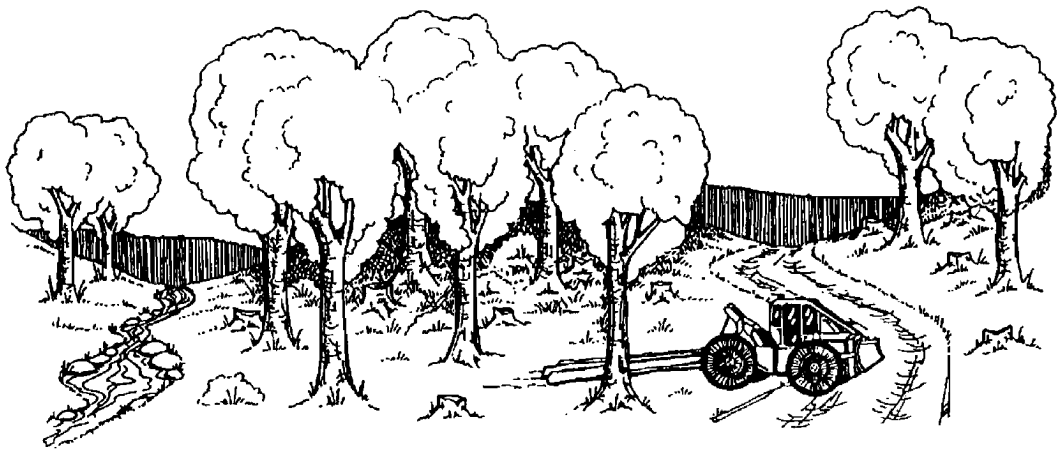
II. Permits are obtained by signing the intent to cut form as provided in RSA 485-A:17, III.

227-J:9 Cutting of Timber Near Certain Waters and Public Highways of the State; Penalty.

I. No more than 50 percent of the basal area of trees shall be cut, or otherwise felled, leaving a well distributed stand of healthy, growing trees, within 150 feet of any great pond, any other standing body of water 10 acres or more in area, fourth order stream or higher, or public highway or within 50 feet of any other stream, river or brook which normally flows throughout the year, or standing body of water less than 10 acres in size associated with a stream, river or brook which normally flows throughout the year, unless the person who pushes over, cuts, saws, or operates on or causes to be pushed, cut, sawed, or operated on said trees, obtains the prior written consent of the director or the director's agents in accordance with paragraph V.

II. Timber cutting for land conversion purposes, other than timber growing and forest uses, shall be exempt from this section if those persons intending to convert the use of the land have secured all required local permits including, but not limited to, building, subdivision or zoning

permits, excavation permits, or site plan approval necessary for the use to which the land will be converted, and are able to furnish proof of such permits.



III. No person shall clear land of natural vegetation on a given lot, tract or parcel proposed for subdivision pursuant to RSA 485-A:32, unless such subdivision plan has been submitted and approved in accordance with the requirements of RSA 485-A.

IV. Timber cutting for land conversion purposes, other than timber growing and forest uses, that does not require any local permits shall be exempt from this section if conversion occurs within 180 days of exceeding the provisions in paragraph I, or there has been prior written consent to extend the 180-day period from the director or the director's agents in accordance with paragraph V.

V. (a) Before the director grants a request to exceed the limits established in this section, the landowner or authorized agent shall demonstrate that it is necessary to exceed such limits and that any and all actions are consistent with the purposes of this chapter. The director shall provide a standard request form for this purpose. This form shall be submitted to the director or the director's agents at least 30 days prior to commencing the timber cutting operation.

(b) Failure of the division to act upon the request within 30 days shall serve as automatic approval.

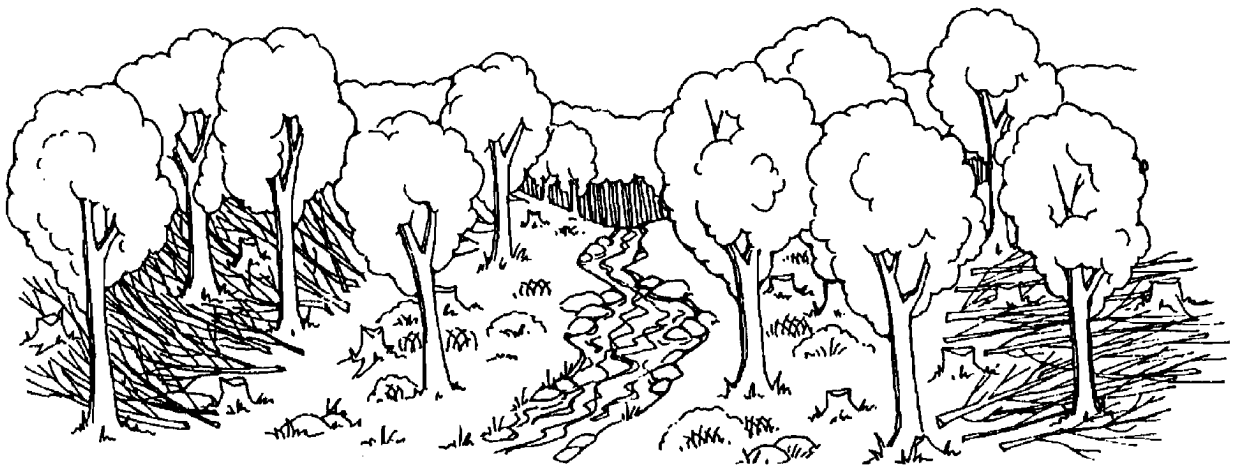
VI. (a) Any person who violates the provisions of this section shall be guilty of a misdemeanor.

(b) Each 200 linear feet or fraction thereof of frontage on the affected great pond, any standing body of water 10 acres or more in area, fourth order stream or higher, or public highway, or any other stream, river or brook which normally flows throughout the year or standing body of water less than 10 acres in size associated with a stream, river or brook which normally flows throughout the year, from which trees are cut in excess of limits prescribed in this section shall constitute a separate offense.

VII. This section shall be enforceable by the municipality in which the land is situated; provided, however, that before initiating any enforcement action, the municipality shall notify the director, who shall take action to the extent the director deems necessary to ensure uniform statewide enforcement. If, within 10 days of notification to the director, no enforcement action has been taken by the director or the director's agent, the municipality may proceed with actions necessary to ensure compliance with the law.

VIII Forest management not associated with shoreland development nor land conversion and conducted in compliance with the provisions of this section shall be exempt from the provisions of RSA 483-B.

227-J:10 Care of Slash and Mill Residue; Penalty. Whoever pushes over, cuts, saws or operates on or causes to be pushed over, cut, sawed or operated on any timber, brush, lumber, or wood shall dispose of the slash and mill residue caused by such action so that slash and mill residue shall not remain:



I. In any stream, river, or brook which normally flows throughout the year or in any other standing body of water, public highway, or active railroad bed.

II. On the property of another, or in a cemetery.

III. Within 25 feet of land of another, or fourth order stream.

IV. Within 50 feet of any great pond, any standing body of water 10 acres or more in area, public highway, or active railroad bed.

V. Within 100 feet of any occupied structure as defined in RSA 635:1, III, including all barns, sheds, and other storage buildings, except a temporary lumber camp.

VI. Disposal of slash and mill residue shall be in such manner that it is disposed of within the area between 50 feet and 150 feet of any great pond, standing body of water 10 acres or more in area, or public highway so it lies on the ground and no part of the slash or residue extends more than 4 feet above the ground.

VII. If more than one of the limitations in paragraphs I-VI on the disposal of slash and mill residue shall be applicable, the most restrictive shall control.

VIII Any person who pushes over, cuts, saws or operates on or who causes to be pushed over, cut, sawed or operated on any such timber, brush, lumber or wood, or any owner of land where cutting is done, shall be guilty of a misdemeanor for each 200 linear feet or fraction thereof of property boundaries, water frontage, public highway and railroad frontage from which the slash and mill residue is not properly removed or disposed of as provided under RSA 227-J:10, I-VII, within 30 days after such cutting unless an extension is approved by the director. If the person refuses or neglects to properly remove or dispose of the slash or mill residue within the time prescribed, the person shall be guilty of a misdemeanor as provided in this paragraph for each subsequent 30-day period of refusal or neglect to so remove or dispose of such slash or mill residue.

227-J:14 Administrative Fines.

I. The director, with the approval of the commissioner and after notice and hearing pursuant to RSA 541-A, may impose an administrative fine not to exceed $2,000 for each offense upon any person who violates any provision of this chapter. Rehearings and appeals from a decision of the commissioner under this paragraph shall be in accordance with RSA 541. Any administrative fine imposed under this section shall not preclude the imposition of further penalties under this chapter. The commissioner shall adopt rules, under RSA 541-A, relative to:

(a) A schedule of administrative fines which may be imposed under this paragraph for violation of this chapter.

(b) Procedures for notice and hearing prior to the imposition of an administrative fine.

II. The proceeds of administrative fines levied pursuant to paragraph I shall be deposited by the commissioner into the forest management and protection fund established under RSA 227-G:5, I.

WETLANDS PERMITTING

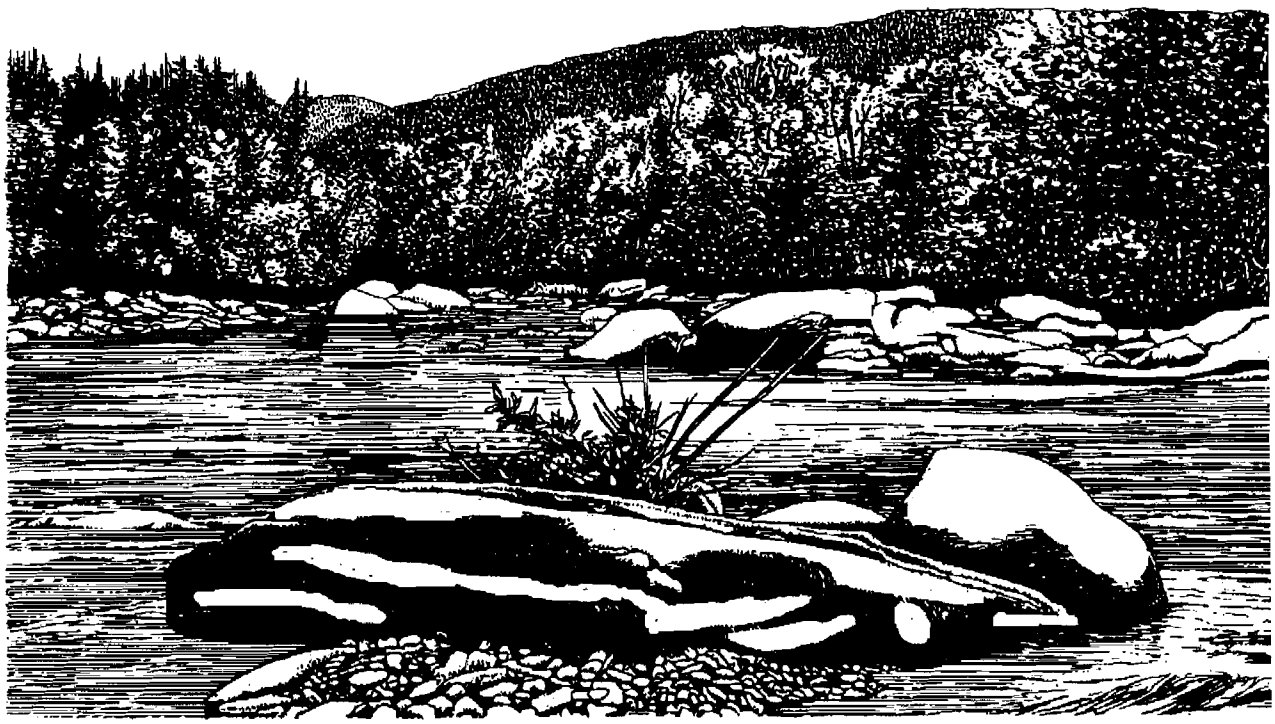
Timber harvests which involve stream or wetland crossings require a wetlands permit. The level of harvesting impacts on a wetland dictates the type of wetland permit required. There are three types of actions: minimum, minor, and major.

MINIMUM IMPACT WETLANDS PERMIT

The minimum impact wetlands permit is attached to the intent to cut form. A minimum impact wetlands permit is only allowed under the following circumstances:

- Forest management harvests only - land conversion projects require a separate dredge and fill permit;
- Wetland impacts of less than 3,000 square feet;
- Permanent culverts or rock fords which do not exceed 15 feet in width and 50 feet in length;
- Stream crossings up to 10 feet in width;
- Wetland crossings of up to 50 feet in width.

To complete the minimum impact wetlands permit, simply fill in the one page questionnaire, prepare a map of the harvest area using a USGS topographic map showing all wetland crossings and pay an additional fee of $25. Forest harvesting can begin as soon as local officials sign the intent to cut.



NOTIFICATION OF FOREST MANAGEMENT ACTIVITIES HAVING MINIMUM WETLANDS IMPACT

DIRECTIONS:

(Bold faced terms are defined on the back.)

(PLEASE CIRCLE YES OR NO, TO THE RIGHT OF QUESTIONS 1-4)

1. Will the proposed forest management activity cross any **wetlands** or **surface water.** ..... **Y / N**

   If **NO** then you do not need to file this form, or any other wetlands application. If **YES,** continue to question 2.

2. Is land being cleared in preparation for subdivision, development or other conversion to non-forestry use? .... **Y / N**

   If YES, you must file a **wetlands application** (available at the town clerk's office) and no work in wetlands or surface waters can be done until a permit is received. **If NO,** continue to question 3.

3. Does proposed activity impact **bogs, marshes,** sand dunes, tidal wetlands, undisturbed tidal buffer zones, **designated prime wetlands,** or wetland identified by the **Natural Heritage Inventory?** ..... **Y / N**

   If **YES,** you must file a **wetlands application** and no work in wetlands or surface waters can be done until a permit is received. If **NO,** continue to question 4.

4. Does any crossing ***exceed*** the following minimum impact criteria? ..... **Y / N**

If YES, (it does exceed) you must file a wetlands application and no work in wetlands or surface waters can be done until a permit is received. If NO, continue through item 12.

Examples that follow within guidelines of Forest Management:

a. Installation of a permanent culvert or rock ford, and associated fill, that meets the following criteria: 1) roadway width at the crossing does not exceed 15 feet; 2) fill width, measured at the base of the roadway slope, does not exceed 50 feet; 3) length of **wetlands** crossing, measured along the proposed access way does not exceed 50 feet; 4) length of **surface water** crossing does not exceed 10 feet, measured from base of bank to base of bank; and 5) **wetlands** does not have standing water during 10 months of the year.

b. Installation of a bridge provided that: 1) no work is done in water; and 2) abutment fill does not exceed 3000 square feet on the banks of the stream.

c. Construction of a temporary crossing, provided all work is in accordance with recommendation tin the **Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire.**

5. **PROVIDE TOWN/CITY, TAX MAP AND LOT NUMBER INFORMATION (item 1 & 2 on intent to cut).**

_____ _____ _____
TOWN/CITY TAX MAP # LOT #

6. **OWNER NAME, ADDRESS, AND TELEPHONE NUMBER (item 7 on intent to cut).**

_____ _____ (____) _____
NAME MAILING ADDRESS PHONE

7. **NAME, ADDRESS AND PHONE NUMBER OF FORESTER/LOGGER (Item 10 on intent to cut).**

_____ _____ (____) _____
NAME MAILING ADDRESS PHONE

FOR DES OFFICE USE ONLY:
FEE RECEIVED: # _____ $ _____ (____) FILE # _____
check # amount Init. date

DISTRICT FOREST RANGER # _____

8. ATTACH A COPY OF A **USGS TOPOGRAPHIC MAP** OR AN USDA SOIL CONSERVATION SERVICE **(SCS) SOILS MAP** WITH THE **TYPE AND LOCATION** OF ALL **WETLAND AND WATER CROSSING STRUCTURES** CLEARLY INDICATED.

9. ATTACH A SKETCH PLAN FOR ALL WETLAND OR SURFACE WATER CROSSINGS (copies of plans from the **Best Management Practices for Erosion Control of Timber Harvest Operations in New Hampshire)** may be used, if they accurately depict proposed structure.

10. Attach a check for **$25.00** payable to the New Hampshire Wetlands Board.

11. **LANDOWNER'S SIGNATURE CERTIFIES THAT:** 1) items 1 through 9 are correctly answered; and 2) all logging contractors have been directed to conform with the **Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire,** and have been instructed to install crossings only as indicated on the attached map and sketches.

SIGNATURE _____ **DATE** _____

12. Mail this form, with attached map(s), sketches, and check, to the New Hampshire Wetlands Board, PO Box 2008, Concord, NH 03302-2008. If any of ITEMS 1-11 are missing, this notification will be considered **INCOMPLETE** and all work in wetlands or surface waters **SHOULD NOT PROCEED.** Conducting work WITHOUT FILING A COMPLETE NOTIFICATION may be cause for enforcement action to be taken. Work may proceed upon proper filing of a COMPLETE notification.

Wetlands - an area that is inundated or saturated by surface or ground water at frequency and duration sufficient to support, and that under normal conditions does support, a prevalence of vegetation (more than 50%) typically adapted for life in saturated soil conditions (hydric soils). Wetlands include, but are not limited to swamps, bogs, marshes and similar areas.

Swamp - a wetland that is dominated by trees and/or shrubs. Typical trees are red maple, hemlock, black ash, black willow, black spruce, tamarack and white pine.

Bog - a wetland distinguished by stunted evergreen trees and shrubs, peat deposits, and/or highly acidic soil and water conditions.

Marsh - a wetland distinguished by : 1) absence of trees and shrubs; 2) dominance of soft stemmed herbaceous plants such as grasses, reeds, and sedges; and 3) water table is at or above the surface throughout the year, but can fluctuate seasonally.

Surface water - those portions of waters of the state, as defined by RSA 482-A:4, which have standing or flowing water at or on the surface of the ground. This includes, but is not limited to rivers, streams, (perennial and seasonal), lakes, ponds and tidal waters.

Designated Prime Wetland - A wetland designated by a municipality as requiring special protection. Check with town office for location of these wetlands.

Natural Heritage Inventory - A listing maintained by the Department of Resources and Economic Development. Call 603-271-3623 for information.

Best Management Practices for Erosion Control on Timber Harvest Operations in New Hampshire - A manual developed by the Department of Resources and Economic Development (DRED). Copies are available from DRED, 172 Pemboke Road, Concord, NH 03301 (603-271-2214); or UNH Extension, Durham, NH (603-862-1028). There is no charge.

Wetlands Application - Forms for applying for permits to work in wetlands or surface waters when criteria of sections 2 or 3 are not met. These forms can be obtained from the town clerk, or by calling the Wetlands Bureau at 603-271-2147. For projects not qualifying for minimum impact for forestry notification, no work in wetland or surface water may commence without a posting permit.

EXCAVATING AND DREDGING PERMIT

If the timber harvest has minimum impacts but the land is being converted to other than non-forest uses, or if a logging operation will result in wetland impacts greater than those described above, a dredge and fill permit from the New Hampshire Wetlands Bureau will be required. Applications for these permits are available at town and county conservation district offices. Permit applications, a detailed plan, proof of notification of abutters and fees based on the square footage of impacted wetlands are required. When the application and accompanying materials are submitted to the Bureau, four copies of each must also be provided to the town clerk. The town clerk keeps one and sends the other copies to the selectmen, planning board, and conservation commission. Town clerks may charge an administrative fee of up to $10.

RSA 482-A:3 Excavating And Dredging Permit; Certain Exemptions

I. No person shall excavate, remove, fill, dredge or construct any structures in or on any bank, flat, marsh, or swamp in and adjacent to any waters of the state without a permit from the wetlands board. The permit application together with a detailed plan and a map showing the exact location of the proposed project, along with 4 copies of the permit application, plan and map, shall be submitted to the town or city clerk, accompanied by a filing fee in the form of a check made out by the applicant to the New Hampshire wetlands board. The permit application fee shall be $50 for minimum impact projects. Fees for minor and major projects shall be assessed based on the area of dredge or fill proposed and the number of boat slips requested. The rates shall be $100 per boat slip and $0.025 per square foot. At the time the permit application is submitted to the city or town clerk, the applicant shall provide postal receipts or copies, verifying that abutters, as defined in the rules of the wetlands board, and except as further provided in said rules, have been notified by certified mail. The postal receipts or copies shall be retained by the municipality. The town or city clerk shall immediately sign the application and forward by certified mail, the application, plan, map and filing fee to the wetlands board. The town or city clerk shall then immediately send a copy of the permit application, plan and map to the local governing body, the municipal planning board, if any, and the municipal conservation commission, if any, and may require an administrative fee not to exceed $10 plus the cost of postage by certified mail. One copy shall remain with the city or town clerk, and shall be made reasonably accessible to the public. The foregoing procedure notwithstanding, applications and fees for projects by agencies of the state may be filed directly with the wetlands board, with 4 copies of the application, plan and map filed at the same time with the town or city clerk to be distributed as set forth above.

MINIMUM SHORELAND PROTECTION STANDARDS

RSA 483-B:9

V. The following minimum standards shall apply to the protected shoreland provided that forestry, involving water supply reservoir watershed management or agriculture conducted in accordance with best management practices, shall be exempted from the provisions of this chapter:

(a) Natural Woodland Buffer

(1) Where existing, a natural woodland buffer shall be maintained within 150 feet of the reference line. The purpose of this buffer shall be to protect the quality of public waters by minimizing erosion, preventing siltation and turbidity, stabilizing soils, preventing excess nutrients and chemical pollution, maintaining natural water temperatures, maintaining a healthy tree canopy and understory, preserving fish and wildlife habitat, and respecting the overall natural condition of the protected shoreland.

(2) Within the natural woodland buffer of the protected shoreland under conditions defined in RSA 483-B:9,V the following prohibitions and limitations shall apply:

(A) Not more than a maximum of 50 percent of the basal area of trees, and a maximum of 50 percent of the total number of saplings shall be removed for any purpose in a 20-year period. A healthy, well-distributed stand of trees, saplings, shrubs and ground covers and their living, undamaged root systems shall be left in place.

(B) [REPEALED 1992, 235:28, I.]

(C) Trees, saplings, shrubs and ground covers which are removed to clear an opening for building construction, accessory structures, septic systems, roadways, pathways, and parking areas shall be excluded when computing the percentage limitations under subparagraph (a)(2)(A).

(D) Dead, diseased, unsafe, noxious or fallen trees, saplings, shrubs, or ground cover may be removed. Their removal shall not be used in computing the percentage limitations under subparagraph (a)(2)(A).

(E) Stumps and their root systems which are located within 50 feet of the reference line shall be left intact in the ground.

(F) Dead and living trees that provide dens and nesting places for wildlife are encouraged to be preserved.

(G) Planting efforts that are beneficial to wildlife are encouraged to be undertaken.

ALTERATION OF TERRAIN

An alteration of terrain permit application must be filed if the harvest is being done to clear and stump land for non-forest uses. The permit is required if and more than 100,000 square feet (a little more than 2 acres) or 50,000 square feet in the shoreland protection zone (RSA 483-B:9, V) of land are affected. Alteration of Terrain permits are available at county conservation district offices and the Water Supply and Pollution Control Division of the New Hampshire Department of Environmental Services (DES).

485-A:17 Terrain Alteration

I. Any person proposing to dredge, excavate, place fill, mine, transport forest products or undertake construction in or on the border of the surface waters of the state, and any person proposing to significantly alter the characteristics of the terrain, in such a manner as to impede the natural runoff or create an unnatural runoff, shall be directly responsible to submit to the division detailed plans concerning such proposal and any additional relevant information requested by the division, at least 30 days prior to undertaking any such activity. The operations shall not be undertaken unless and until the applicant receives a permit from the division. The division shall have full authority to establish the terms and conditions under which any permit issued may be exercised, giving due consideration to the circumstances involved and the purposes of this chapter, and to adopt such rules as are reasonably related to the efficient administration of this section, and the purposes of this chapter, Nothing contained in this paragraph shall be construed to modify or limit the duties and authority conferred upon the division of water resources under RSA 482 and RSA 482-A.

II. The division shall charge a fee for each review of plans, including project inspections, required under this section. The fee shall be based on the extent of contiguous area to be disturbed. Except for RSA 483-B:9, the fee for plans encompassing an area of at least 100,000 square feet but less than 200,000 square feet shall be $100. For the purposes of RSA 483-B:9, the fee for plans encompassing an area of at least 50,000 square feet but less than 200,000 square feet shall be $100. An additional fee of $100 shall be assessed for each additional area of up to 100,000 square feet to be disturbed. No permit shall be issued by the division until the fee required by this paragraph is paid. All fees required under this paragraph shall be paid when plans are submitted for review and shall be deposited in the treasury as unrestricted funds.

III. Normal agricultural operations shall be exempt from the provisions of this section. The division may exempt other state agencies from the permit and fee provisions of this section provided that each such agency has incorporated appropriate protective practices in its projects which are substantially equivalent to the requirements established by the division under this chapter. Timber harvesting operations shall be exempt from the provisions of this section. Permits shall be granted for timber harvesting operations provided that the department of revenue administration's intent to cut form is completed.

485-A:32 Prior Approval; Permits

III. No person required to submit subdivision plans pursuant to paragraph I shall commence the construction of roads within the lot, tract or parcel proposed to be subdivided, by clearing the land thereof of natural vegetation, placing any artificial fill thereon, or otherwise altering the land, nor shall he do any other act or acts which will alter the natural state of the land or environment, unless the subdivision plan relating thereto has been submitted and approved in accordance with the requirements of this chapter. Nothing in this paragraph shall be construed to prevent the taking of test borings, the digging of test pits, or any other preliminary testing and inspection necessary to comply with the requirements of the division of water supply and pollution control relative to information necessary for review and approval of the subdivision plans.

AVAILABLE ASSISTANCE

Division of Forests and Lands

Department of Resources and Economic Development
Post Office Box 1856
Concord, New Hampshire 03302-1856
(603) 271-2214

North Country Resource Center
RFD #2 - Box 241 - Route 3
Lancaster, New Hampshire 03584
788-4157

South Region Headquarters - Fox Forest
PO Box 1175 - School Street
Hillsborough, New Hampshire 03244
464-3453

Central Region Hdqtrs. - Forest Nursery
405 Daniel Webster Highway
Boscawen, New Hampshire 03303
796-2323

Urban Forestry Center
45 Elwyn Road
Portsmouth, New Hampshire 03801
431-6774

Department of Environmental Services

Health and Human Service Building
6 Hazen Drive - PO Box 95
Concord, New Hampshire 03302-0095
(603) 271-3503

Water Supply & Pollution Control Division
Health and Human Service Building
6 Hazen Drive - PO Box 95
Concord, New Hampshire 03302-0095
271-3504

Water Resources Division
64 North Main Street
Concord, New Hampshire 03301-4913
271-3406

Wetlands Bureau
Health and Human Service Building
6 Hazen Drive - PO Box 95
Concord, New Hampshire 03302-0095
271-2147

University of New Hampshire - Cooperative Extension

Cooperative Forestry Programs
Pettee Hall
Durham, New Hampshire 03824
862-1028

Belknap County

Beacon Street East
Box 368
Laconia, New Hampshire 03246
524-1737

Carroll County

34 Main Street
P.O. Box 367
Conway, New Hampshire 03818
447-5922

Cheshire County

33 West Street
Keene, New Hampshire 03431
352-4550

Coos County

North Country Resource Center
RFD#2, Route 3
Lancaster, New Hampshire 03584
788-4961

Grafton County

Grafton County Courthouse
RR 1, Box 65F
North Haverhill, New Hampshire 03774
787-6944

Hillsborough County

Chappell Prof. Center
468 Route 13 South
Milford, New Hampshire 03055
673-2510

Merrimack County

327 D.W. Highway
Boscawen, New Hampshire 03303
796-2151 or 225-5505

Rockingham County

113 North Road
Brentwood, New Hampshire 03833
679-5616

Strafford County

259 County Farm Road, Unit 5
Dover, New Hampshire 03820
749-4445

Sullivan County

24 Main Street
Newport, New Hampshire 03743
863-9200

Natural Resources Conservation Service

Federal Building - Madbury Road
Durham, NH 03824
868-7581

Claremont Field Office

25 Mulberry Street
Claremont, New Hampshire 03743-2539
542-6681

Concord Field Office

The Concord Center
10 Ferry Street, Box 312
Concord, New Hampshire 03301-5081
225-6401

Conway Field Office

44 Main Street
PO Box 533
Conway, New Hampshire 03818-0533
447-2771

Dover Field Office

USDA Agriculture Service Center
259 County Farm Road, Unit #3
Dover, NewHampshire 03820-6015
749-3037

Epping Field Office

243 Calef Highway
Telly's Plaza
Epping, New Hampshire 03042
679-1587

Keene Field Office

U.S. Postal Service Building
196 Main Street
Keene, New Hampshire 03431-3765
352-3602

Lancaster Field Office

RR2, Box 235
Lancaster, New Hampshire 03584-9612
788-4651

Milford Field Office

Chapell Professional Center
#468, Route 13, South
Milford, New Hampshire 03055-3442
673-2409

Woodsville Field Office

Swiftwater Road
RR 2, Box 148-B
Woodsville, New Hampshire 03785-0229
747-2001

New Hampshire Farm Service Agency

22 Bridge Street - PO Box 1388
Concord, New Hampshire 03302
(603) 224-7941

Cheshire County

NH Farm Service Agency
196 Main Street, Room 218
PO Box 464
Keene, New Hampshire 03431
352-2322

Coos / Carroll County

NH Farm Service Agency
RR #2, Box 235, Kidder Building
Lancaster, New Hampshire 03584
788-4602

Grafton County

NH Farm Service Agency
Swiftwater Road, RR 2, Box 148C
Woodsville, New Hampshire 03785
747-3751

Hillsborough County

NH Farm Service Agency
Chappell Professional Building
468State, Route 13 South
Milford, New Hampshire 03055
673-1222

Merrimack / Belknap County

NH Farm Service Agency
10 Ferry Street, Box 22, Suite 212
Concord, New Hampshire 03301
225-5931

Rockingham / Strafford County

NH Farm Service Agency
243 Calef Highway
Route 125, Telly's Plaza
Epping, New Hampshire 03042
722-4384

Sullivan County

NH Farm Service Agency
25 Mulberry Street
Claremont, New Hampshire 03743
542-4281

REFERENCES

Barto, J. and Babcock, E.J., *Forest Laws of New Hampshire*, 1984, Society for the Protection of New Hampshire Forests, Concord, New Hampshire.

Brown, Darlene B., *Best Management Practices for Silvicultural Activities in Pennsylvania's Forest Wetlands*, 1993, Pennsylvania State University and Pennsylvania Hardwood Development Council, State College, Pennsylvania.

Clinch, B. and Logan, B., *Montana Forestry Best Management Practices*, 1991, Montana Department of State Lands, Missuola, Montana.

Finlay, J.C. Brandt, R.C., Clifton, W., and Piper, R., *Controlling Erosion and Sedimentation from Timber Harvesting Operations*, 1986, Pennsylvania State University, Cooperative Extension Service, University Park, Pennsylvania and The Commonwealth of Pennsylvania, Department of Environmental Resources, Harrisburg, Pennsylvania.

Goodhue, S., *Twelve Ways to Reduce Soil Erosion and Stream Pollution on Logging Jobs*, 1975, New Hampshire Division of Forests and Lands, Department of Resources and Economic Development, Concord, New Hampshire.

Goodhue, S., Kinder, R., and Stuart, G., *Timber Harvesting Practices for Controlling Erosion*, 1979, New Hampshire Water Supply and Pollution Control Commission, Concord, New Hampshire.

Hartung, R.E., and Kress, J.M., *Woodlands of the Northeast - Erosion and Sediment Control Guides*, 1977, USDA Soil Conservation Service, NETSC, Broomall, Pennsylvania and USFS State and Private Forestry, Upper Darby, Pennsylvania.

Haussman, R.F., and Pruett, E.W., *Permanent Logging Roads for Better Woodlot Management*, 1978, USDA Forest Service, State and Private Forestry, Broomall, Pennsylvania.

Holaday, Steve, *Wisconsin's Forestry Best Management Practices for Water Quality - Field Manual*, 1995, Wisconsin Department of Natural Resources, Bureau of Forestry, Madison, Wisconsin.

Kent, B., Nelson, K., Todd, F., *The Land Use Handbook - Section 6, Erosion Control on Logging Jobs*, 1981, Land Use Regulation Commission, Department of Conservation, Augusta, Maine.

Kittredge, David B., Jr., and Parker, Michael L., *Massachusetts Best Management Practices Timber Harvesting Water Quality Handbook*, 1989, University of Massachusetts Cooperative Extension, Amherst, Massachusetts.

Kochenderfer, J.N., Wendel, G.W. and Kidd, W.E. Jr., *Woodlot Management: Building Roads*, 1987, West Virginia University, Extension Service, Parsons, West Virginia.

Lants, R.L., *Guidelines for Stream Protection in Logging Operations*, 1971, Oregon State Game Commission, Portland, Oregon.

Magee, Dennis W., *Freshwater Wetlands - A Guide to Common Indicator Plants of the Northeast*,

1981,The University of Massachusetts Press, Amherst, Massachusetts.

Mississippi Forestry Association, *Mississippi's Best management Practices Handbook*, 1989, Jackson, Mississippi.

McEvoy, T., *Proceeding - Forest Water Qaulity and Erosion Control in Vermont*, 1986, School of Natural Resources, UVM, Burlington, Vermont.

Murphy, A. and Connick, J., *Forest Transportation Systems - Roads and Structures Manual*, 1985, Seven Islands Land Company, Bangor, Maine.

Paff, W.D., *Lean Streams Handbook for Loggers*, 1982, West Virginia Department of Natural Resources, Charleston, West Virginia.

State of Florida, *Silviculture - Best Management Practices*, 1993, Florida Department of Agriculture and Consumer Services, Tallahassee, Florida.

State of Maryland, *Forest Harvest Access Practices*, 1988, Department of Natural Resources, Forest Park and Wildlife Service, Annapolis, Maryland, Maryland Forest Association, Salisbury, Maryland, Maryland Lumbermen's Association, Baltimore, Maryland.

State of Maryland, *Maryland's Guide to Forest Harvest Operations and Best Management Practices*, 1992, Department of Natural Resources, Resource Conservation Service, Annapolis, Maryland.

State of Maryland, *Soil Erosion and Sediment Control Guidelines for Forest Harvest Operations in Maryland*, 1993, Department of Natural Resources, Annapolis, Maryland.

State of Minnesota, *Water Quality in Forest Management - "Best Management Practices in Minnesota"*, 1989, Minnesota Department of Natural Resources, Division of Forestry.

State of Minnesota, *Protecting Water Quality and Wetlands in Forest Management: Best Mangement Practices in Minnesota*, 1995, Minnesota Department of Natural Resources, Division of Forestry.

State of New Hampshire, *Information on Timber Harvesting Laws in New Hampshire*, 1986, New Hampshire Division of Forests and Lands, Department of Resources and Economic Development, Concord, New Hampshire.

State of Texas, *Texas Best Management Practices for Silviculture*, 1993, Texas Forestry Association, Lufkin, Texas.

State of Texas, *Forestry Best Management Practices for Water Quality - Circular 286*, 1993, Texas Forest Service, College Station, Texas.

State of Vermont, *Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont*, 1987, Department of Forests, Parks, and Recreation, Waterbury, Vermont.

Tiner, Ralph W. Jr., *Field Guide to Nontidal Wetland Identification*, 1988, Institute For Wetland and Environmental Education and Research, Sherborn, Massachusetts.

U.S. Fish and Wildlife Service, *List of Plant Species That Occur in Wetlands: Northeast (Region 1)*, Biological Report 88(26.1), 1988 - 1995 Supplement, Hadley, Massachusetts.

Van Ryn, Tammara, *A Guide to the Forest Laws of New Hampshire*, 1995, Society for the Protection of New Hampshire Forests, Concord, New Hampshire.