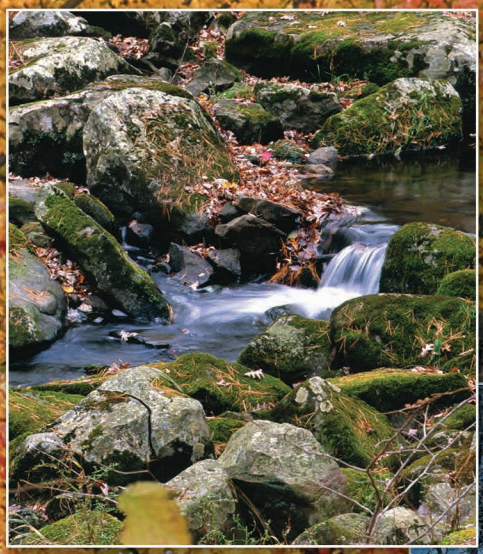
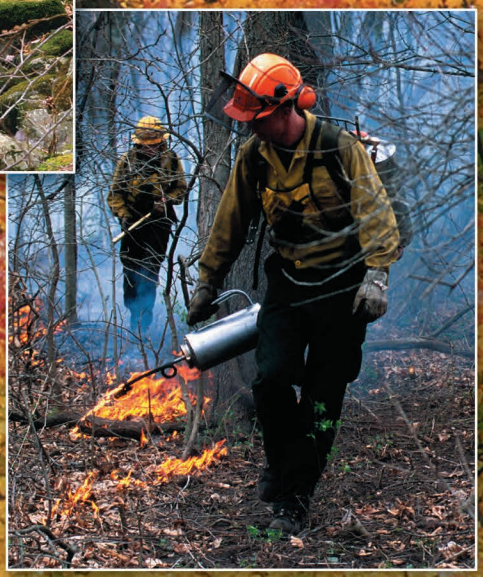
Wisconsin Forest Management Guidelines





WISCONSIN
DEPT. OF NATURAL RESOURCES

DNR PUB-FR-226 2018

Wisconsin Forest Management Guidelines

DNR PUB-FR-226 2018

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
Division of Forestry, PO Box 7921, Madison, Wisconsin 53707

For additional information, call 608-267-7494 or visit our website at dnr.wi.gov – keyword "forestry."

AUGUST, 2018

This entire document was revised and reprinted in August 2018. The document was formatted to allow for individual chapters to be revised and reprinted without having to reprint the entire document. Revision dates are printed on the bottom of each page. Check our website to determine if you have the most recent version of this publication.

This document is intended solely as guidance, and does not include any mandatory requirements except where requirements found in statute or administrative rules are referenced. This guidance does not establish or affect legal rights or obligations, and is not finally determinative of any of the issues addressed. This guidance does not create any rights enforceable by any party in litigation with the State of Wisconsin or the Department of Natural Resources. Any regulatory decisions made by the Department of Natural Resources in any manner addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

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This publication is available in alternative format upon request.

• PLEASE CALL 608-267-7494 FOR MORE INFORMATION •

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SUBJECT MATTER EXPERTS

These Wisconsin DNR subject matter experts provided their expertise in identifying recommended changes, drafting the revisions and reviewing the final product. This revision could not have been completed without their time and energy.

Jeremiah Auer
***Regeneration Specialist**, Reforestation and Afforestation*

Julie Ballweg
***Forest Economics Analyst**, Economics*

James Barnier
***Fire Suppression Specialist**, Fire Management*

Dustin Bronson
***Forest Management and Ecology Analyst**, Forest Soil Productivity*

Jerry Crow
***Tax Law Team Leader**, Timber Harvesting*

Sally Dahir
***Forest Inventory Data Analyst**, Wisconsin Forests*

Andrea Diss–Torrance
***Invasive Forest Insects Program Coordinator**, Threats to Forest Health*

Mark Dudzik
***Archeologist**, Cultural Resources*

Greg Edge
***Silviculturist/Ecologist**, Silviculture and Visual Quality*

Drew Feldkirchner
***Natural Heritage Conservation Bureau Director**, Wildlife Habitat and Biodiversity*

Ron Gropp
***Private Forestry Specialist**, Forest Management Planning*

Mike Hillstrom
***Forest Health Specialist**, Threats to Forest Health*

Mark Heyde
***Sustainable Forestry Certification Coordinator**, Forest Certification*

Brad Hutnik
***Silviculturist/Ecologist**, Silviculture and Visual Quality*

Nolan Kriegel
***BMP Forester**, Riparian Areas, Wetlands and Forest Roads*

Kassie Lang
***Attorney**, Laws and Regulations*

Todd Lanigan
***Forest Health Specialist**, Pesticide Use*

Colleen Matula
***Silviculturist/Ecologist**, Silviculture and Visual Quality*

Chuck McCullough
***Wildlife Area Supervisor**, Wildlife Habitat*

Lucas Olson
***Urban Habitat Program Coordinator**, Wildlife Habitat and Biodiversity*

Teague Prichard
***State Forest Specialist**, Forest Recreation Management*

Andy Stoltman
***Rural and Urban Forest Inventory Analyst**, Wisconsin Forests*

Jim Warren
***Section Chief Public and Private Forestry**, General Operational Guidelines*

EXTERNAL REVIEWERS

We would also like to extend our sincerest thanks to all of the external reviewers and commenters who contributed to the review effort through the public review process. Your input was extremely valuable to bringing these guidelines up the highest possible level. While not all suggestions could be incorporated within this revision, the effort was made to include all appropriate suggestions.

GRAPHIC DESIGN/LAYOUT

Jackie Bowe, *Graphic Designer*
JLB Design, LLC
jackiebowe@icloud.com

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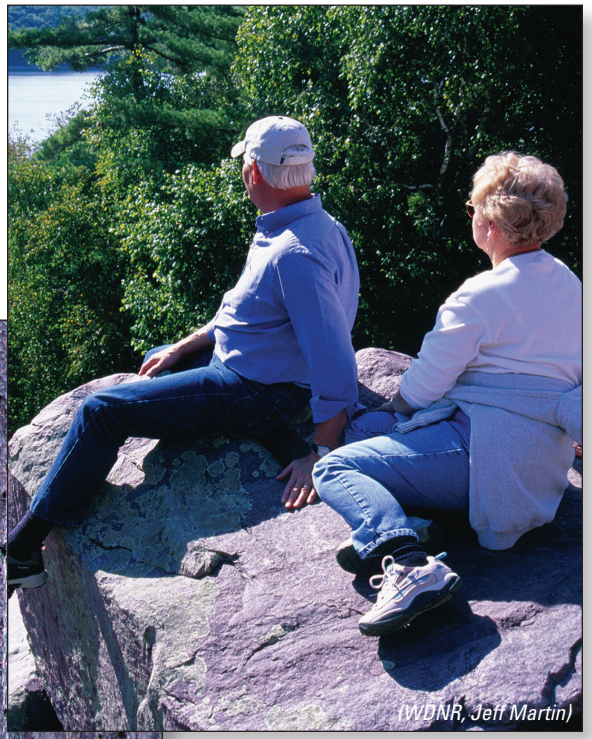
APPENDICES


(WDNR, Jeff Martin)


(WDNR, Jeff Martin)


(WDNR, Jeff Martin)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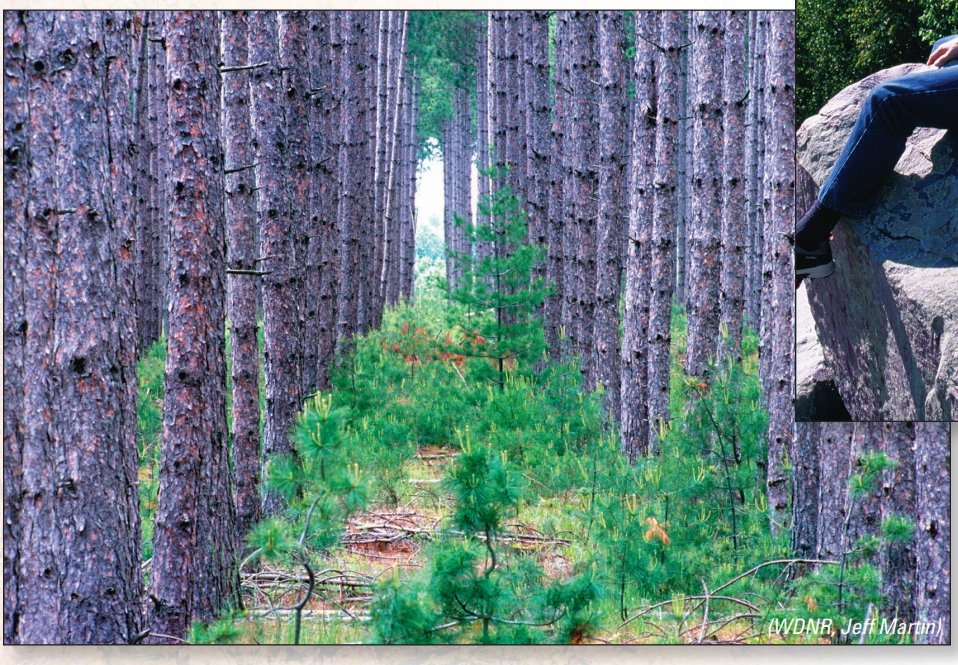
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PURPOSE

THE PURPOSE OF INTEGRATED GUIDELINES

How these Guidelines are Organized

Because these guidelines have been designed for a variety of audiences, some landowners may find it to be more technical than they need, while some resource managers may find it to be more basic than they might prefer. Some readers will be more interested in an overall understanding of "why" a particular resource (forests, wildlife, water, soils, visual quality, or cultural resources) is important relative to overall sustainability, and "why" particular strategies are employed in their management. Other readers will be more interested in "how to" implement a particular activity or practice needed to carry out a management strategy. They would like to know, for example, "how to" construct a forest road, or develop a forest management plan, or design and administer a timber harvest.

Part one of the guide – **Chapters 1 through 9** – is designed to address the "whys" of each of a number of important resource components. Why do the forests of Wisconsin look like they do – how are they changing? Why are various timber stands harvested differently? What are the key issues related to wildlife management and the protection of water resources, riparian areas, soils, and cultural resources? Why is visual quality an important resource consideration, and what trade-offs need to be considered? Why are economic considerations an important component of the forest management decision-making process?

Part two of the guide – **Chapters 10 through 18** – focuses on the "how" of specific activities that are normally carried out in the management of a forest. It begins with the development of a well-considered, ecologically-based forest management plan, and then presents integrated guidelines related to a number of "on-the-ground" activities necessary to carry out such a plan.

Obviously there is linkage between "why" and "how" a resource is managed. The management of any one resource also impacts others. The implementation of any one specific management activity must be considered from many perspectives. Readers are encouraged to explore the entire guide in order to gain a more complete understanding of any particular plan of action before proceeding.

Part three of the guide contains additional resources ranging from a glossary of terms to a list of additional resources and sources of assistance.

Figure A: Autumn in northern Wisconsin shows the diversity found in a mixed conifer and hardwood forested landscape.

• IMPORTANT NOTE •

The ***WISCONSIN'S FORESTRY BEST MANAGEMENT PRACTICES FOR WATER QUALITY (WQ-BMPs) FIELD MANUAL*** has been incorporated into and is found throughout this guide. WQ-BMPs are identified by the "💧" symbol.

The ***WISCONSIN'S FORESTRY BEST MANAGEMENT PRACTICES FOR INVASIVE SPECIES (IS-BMPs) FIELD MANUAL*** has been incorporated into and is found throughout this guide. IS-BMPs are identified by the " 🍃 " symbol.

THE CONCEPT OF INTEGRATED GUIDELINES

Figures B and C: Sustaining forest resources for future generations depends on balancing a diversity of social, economic and environmental objectives, including production of timber for wood and paper products.

Sustainability means meeting the needs of the present without compromising the ability of future generations to meet their own needs. **Sustainable forestry** is a proactive form of management that provides for the multiple uses of the forest by balancing a diversity of both present and future needs. It is a process of informed decision-making that takes into account resource needs, landowner objectives, site capabilities, existing regulations, economics, and the best information available at any given time.

Those concerned about forest management have long recognized the challenge of balancing social, economic and environmental objectives and implications. They also recognize the complex relationship between forest management practices and the long-term sustainability of our forests.

Integrated resource management approaches, comprehensive planning, and recommended practices and guidelines are not new ideas. The first edition of this publication introduced:

- The concept of one set of integrated guidelines to support the sustainability of many different resources within forest communities.
- The recognition that guidelines should be designed to accommodate a wide range of resource needs, landowner objectives, and site conditions.
- The idea of a broad-based, collaborative approach to developing user-friendly guidelines applicable to forests throughout Wisconsin.

This edition provides updates to the existing guidelines and adds newly developed guidelines such as the Wisconsin's Best Management Practices for Invasive Species.

This concept of integrated guidelines recognizes the forest as a community of related resources, rather than a collection of separate resources. Integrated guidelines reflect the forest ecosystem that they are designed to help sustain.

Who Will Use the Guidelines?

These forest management guidelines have been developed for use by forest landowners, resource managers, loggers, contractors, and equipment operators, who share a concern for balancing forest management activities and the long-term sustainability of forest resources. Although many individuals may participate in managing a particular site, final decisions regarding guideline implementation lie with the landowner.

These guidelines were designed to help landowners, resource managers, and loggers determine how to protect the functions and values of forest resources during forest management activities. They do not provide advice on whether to manage or which management activities are needed.

FACTORS THAT MAY AFFECT IMPLEMENTATION

Generally speaking, these guidelines are informational and voluntary. They are designed to help landowners and resource managers meet today's needs while also maintaining ecosystem integrity and productivity for future generations. Any federal, state and local regulations, however, whether or not referenced by these guidelines (such as endangered species laws, pesticide rules, permitting requirements, zoning ordinances, etc.), take precedence and must be observed. Landowners voluntarily participating in formal incentive programs such as Wisconsin Forest Landowner Grant Program or the Managed Forest Law are obliged to comply with the statutes and rules that apply – some of which are reflected in these guidelines.

These guidelines have special significance to anyone carrying out a forestry operation in Wisconsin. State law provides that forestry operations which are carried out in accordance with "generally accepted forestry management practices" may not be prohibited by city, village, town or county ordinances or regulations. The law further defines "generally accepted forestry management practices" to be forestry management practices that promote sound management of a forest **including practices contained in the most recent version of this publication (DNR PUB-FR-226 2018 Wisconsin Forest Management Guidelines)**.

Parts of these guidelines also have special significance to private consulting foresters, and industrial forest products companies that voluntarily participate in Wisconsin's Cooperating Forester Program. Section NR 1.213 (3)b, Wisconsin Administrative Code, provides that a cooperating forester "shall manage private lands where the cooperator provides service in a manner which maintains the long-term capacity of the land to provide forest products, uses and values desired by landowners in accordance with the silvicultural guidelines in department handbooks and directives or a written, science-based forest management commitment submitted to and approved by the department in advance." For purposes of administering the Cooperating Forester Program, compliance with the following sections of these guidelines is considered mandatory:

- **Generally Accepted Regeneration Methods by Cover Type found in Table 2-1**, Chapter 2, page 2-32, unless the Wisconsin DNR has approved an exception described in a science-based forest management commitment submitted by the cooperator. The regeneration methods designated in the table have been substantiated by forestry research, and have been found to be reliable techniques for manipulating forest vegetation with predictable results. Since our understanding of forest ecology and silvics is constantly evolving, the management commitment option allows the adoption of new techniques as they are proven.
- **Wisconsin's Forestry Best Management Practices for Water Quality (WQ-BMPs)**, designated by the symbol "💧" found throughout these guidelines. Wisconsin WQ-BMPs identify and explain guidelines for landowners, loggers and land managers to protect water quality. They were prepared in response to federal legislation. Section 208 of the 1977 Clean Water Act requires each state to develop plans and procedures to control "silviculturally related nonpoint sources of pollution ... to the extent feasible." Section 319 of the 1987 Water Quality Act requires each state to develop and implement a program to reduce nonpoint source pollution to the "maximum extent practicable." Compliance with Wisconsin WQ-BMPs will help meet our federal obligations.
- **Wisconsin's Forestry Best Management Practices for Invasive Species (IS-BMPs)**, designated by the symbol " " found throughout these guidelines. The IS-BMPs identify and explain guidelines for foresters, landowners and loggers to prevent the introduction and spread of invasive plants, insects and diseases. They were developed for the Wisconsin Council on Forestry as voluntary guidelines. Implementation may become mandatory as the language is used in contracts; however, the field guidelines are written to be flexible and recognizes the need for setting reasonable expectations and realistic goals.

Cooperating foresters must also abide by federal, state and local regulations, including those related to forest incentive programs administered by the Wisconsin DNR. Implementation of other information presented in these guidelines is encouraged, but not mandatory.

WHAT THE GUIDELINES ARE

Figure D: Harvesting timber stands can contribute to the long-term health, productivity and sustainability of valuable forest resources.

Figure E: Integrated guidelines recognize the forest as a community of related resources, rather than a collection of separate resources.

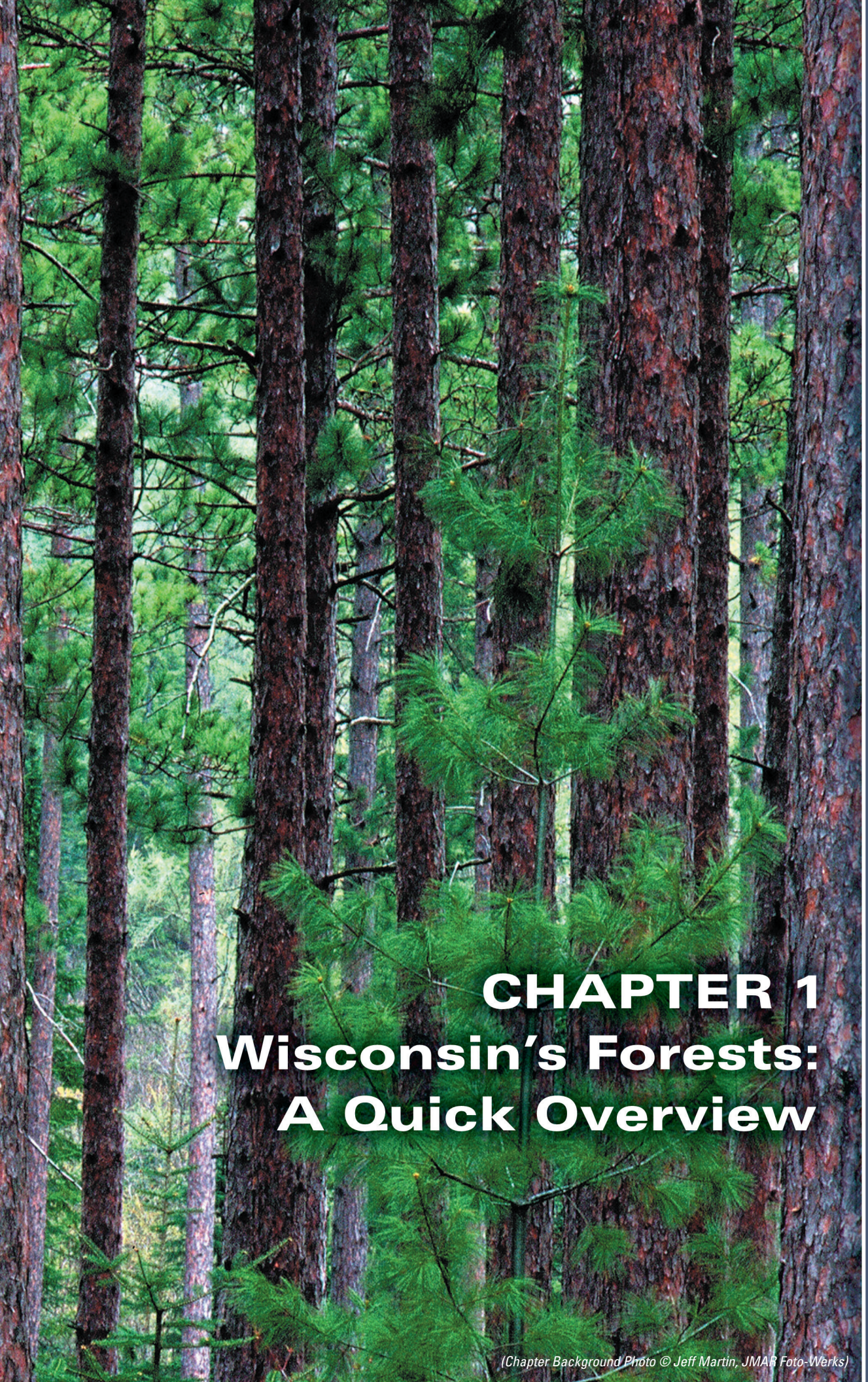
- The guidelines are designed to be flexible, recognizing that both site conditions and landowner objectives vary. Determining the most appropriate guidelines for implementation on a particular site depends on the informed judgment of the landowner, resource manager or logger responsible for that site.
- It may be possible to implement several guidelines simultaneously in some instances. For example, trees left to protect cultural resources may also satisfy mast guidelines for wildlife, as well as apparent harvest size guidelines for visual quality.
- Implementation of the guidelines is voluntary, except where noted.

- The guidelines are designed to help forest landowners, resource managers and loggers meet two goals:
  - Conduct forest management activities while addressing continued long-term sustainability of diverse forest resources.
  - Promote or enhance the functions and values of water and soil resources, riparian areas, wildlife habitat, visual quality, and cultural resources.
- The guidelines represent practical, sound and generally-accepted practices based on the best available scientific information.
- The guidelines are designed to assist with site-level forest management once the landowner has decided to manage the site for forests. They are not designed to provide broad-based landscape directions but do recognize the importance of landscape-level considerations and planning and provide references to landscape-level tools (e.g., *Ecological Landscape Handbook*, Wildlife Action Plan).

WHAT THE GUIDELINES ARE NOT

Figure F: Professional natural resource managers and educators like these are available across the state to assist landowners in the sustainable management of their forests. Contact your local Wisconsin DNR office for a copy of the Directory of Foresters, and see the Resource Directory in this guide for additional sources of information.

- The guidelines are not a substitute for a resource management plan. They are intended to support implementation of a plan once it is in place.
- The guidelines are not intended to replace any existing rules or regulations.
- The guidelines are not intended as a substitute for obtaining professional assistance as needed to achieve management objectives, or meet appropriate engineering standards. They are guidelines – not construction standards or engineering specifications.
- The guidelines are not designed to help determine whether a particular forest management activity should or should not occur. They are designed, instead, to provide guidance in how to implement a particular forest management activity.
- The guidelines are not intended to address all forest management activities and all forest resources. They address major forest management activities as they relate to selected components of a healthy forest.
- The guidelines do not address landscape scale considerations and issues. Landscape-level considerations and planning are recognized as important, but they are beyond the scope of these guidelines. References to landscape scale tools are provided for those that would like more information.



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CHAPTER 1
Wisconsin's Forests: A Quick Overview

(Chapter Background Photo © Jeff Martin, JMAR Foto-Werks)

CHAPTER 1
WISCONSIN'S FORESTS: A QUICK OVERVIEW

A STATEWIDE SNAPSHOT OF WISCONSIN'S FORESTS*

Wisconsin's Forests

Wisconsin's forests can be divided into two broad categories, the Northern Mixed Forest and the Southern Broadleaf Forest. These two forest types exist in Wisconsin because they have adapted to the different soil types and climates that have supported them over thousands of years.

These two broad categories of forests meet in an area called the Tension Zone (see Figure 1-1). The Tension Zone stretches across Wisconsin from northwest to southeast in an S-shape. The Tension Zone forms the northern boundary of many species' ranges, both plant and animal. From Polk and St. Croix counties southeast to Milwaukee, the Tension Zone divides the state into two major ecological regions. The Northern Mixed Forest is more closely related to the forests of northeastern Minnesota, northern Michigan, and southern Ontario. The Southern Broadleaf Forest is generally considered closer, ecologically, to the forests of southern Michigan, Illinois and Indiana. The Tension Zone is a diverse area, where representative plant and animal species from both the northern and southern forest types can be found, as well as a significant shift in vegetation. In addition to these two broad categories of forests, the State can be divided into 16 ecological landscapes (see Figure 1-1) which are described in the Wisconsin DNR *Ecological Landscapes of Wisconsin* found at: ***dnr.wi.gov – keyword "landscape."***

Forest Area

Of Wisconsin's more than 35 million acres of land, about 17.1 million acres are forested. Forest area in Wisconsin has been steadily increasing since 1968, mostly due to the conversion of marginal agricultural land back into forests. Currently, forest covers about 49 percent of the total land area of the state. Since 1983, forestland has increased almost 11.2 percent, or 1.7 million acres mostly in the northern area of the state. The average age of forests is increasing. The largest acreage of forests is between 61 and 100 years old.

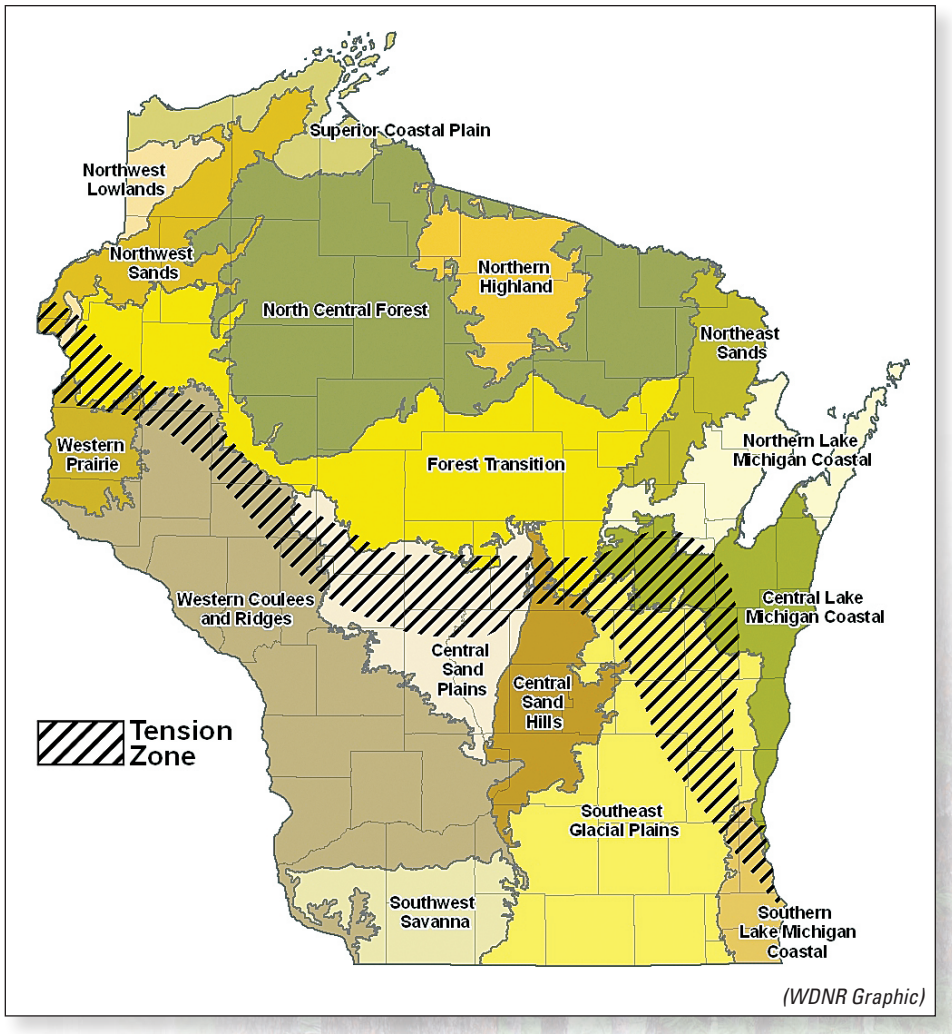


Figure 1-1: Wisconsin Tension Zone and the 16 Ecological Landscapes

* *Data and analysis in this chapter was taken from the Forest Inventory Analysis database, 2015. To read more about the current state and sustainability of Wisconsin's forest resources, see Wisconsin's Statewide Forest Assessment at:* ***dnr.wi.gov – keyword "assessment."***

Forest Types

Oak-hickory, maple-basswood, and aspen-birch are the most common forest type groups in Wisconsin. Oak-hickory accounts for 4.3 million acres followed by the maple-basswood forest type group with 3.8 million acres, and the aspen-birch forest type group with more than 2.9 million acres. While 80 percent of Wisconsin's forests are deciduous types, there are also significant coniferous types occupying large areas, especially in the north. Red pine, black spruce, eastern white pine, tamarack, northern white cedar, and jack pine are the most common coniferous types.

The area and relative proportion of various forest types have changed significantly over the last 70 years. Hardwood succession is very apparent. Since the first official statewide forest inventory in 1936, the aspen-birch forest area has steadily decreased and the area of oak-hickory, maple-basswood, soft maple-ash and conifer forests have all increased although at different rates. The oak-hickory, maple-basswood and soft maple-ash forests have increased at a rate faster than the increase in total forestland so they now occupy a larger percent of the forested land in Wisconsin. When considered as a whole, the conifer forest (pine, spruce-fir and swamp conifers) has increased at the same rate as the increase in total forestland so it still occupies the same percent of the forested land in Wisconsin. Pine forest represents the majority of this conifer increase.

Number of Trees

Predictably, along with an increase in forest area, there has been a corresponding increase in the number of trees. Between 1996 and 2015, the number of trees more than one inch in diameter increased by more than one billion individual trees. In 2015, there were 11.4 billion trees in the forests of Wisconsin.

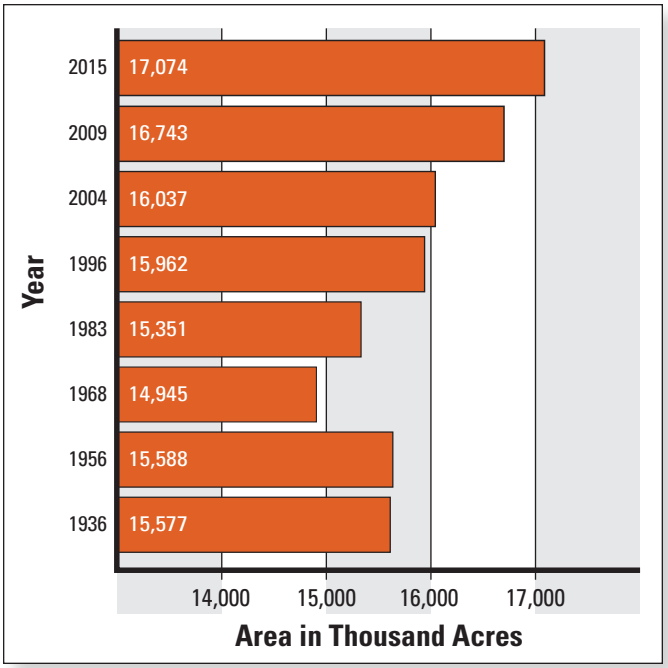


Figure 1-2: Wisconsin forest acreage over time.

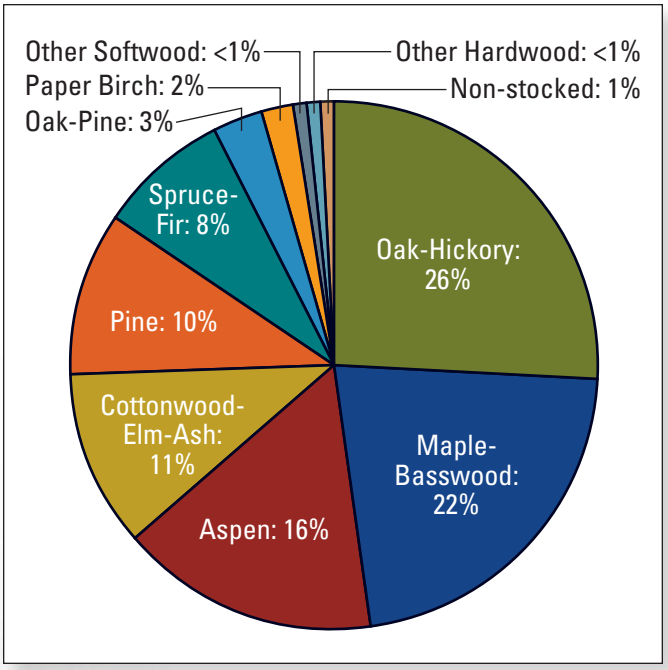
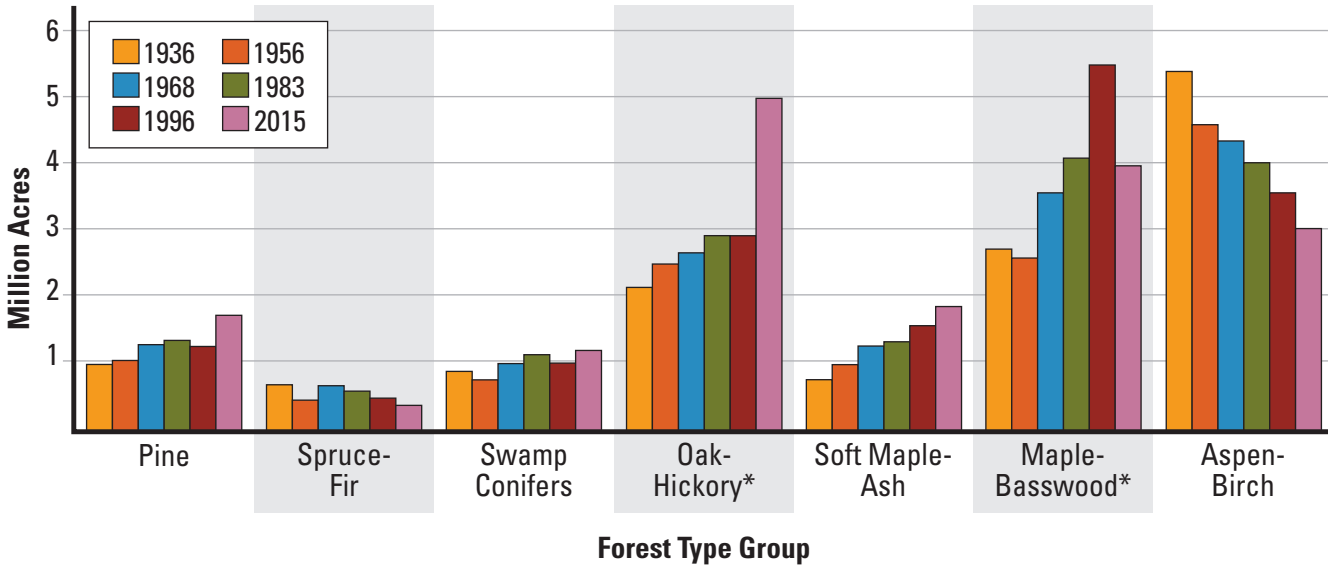


Figure 1-3: Wisconsin forest types, 2015.



** The oak-hickory and maple-basswood forest type groups are not comparable after 1996. The method for classifying forest types was changed significantly with the newest inventory. This caused much of the forest previously classified as maple-basswood to be moved into the oak-hickory forest type group.*

Figure 1-4: Wisconsin forest types over time.

Figure 1-5: The area of aspen-birch and other "pioneer types" has declined over the last 70 years. These sun-loving species require the open conditions created by a windstorm, fire or an even-aged harvest to regenerate and grow.

Timber Volume

Between the 1996 forest inventory and the 2015 forest inventory, overall growing stock volume on Wisconsin timberland* increased by more than 13 percent – more than 2.5 billion cubic feet. In 2015, there were 21.8 billion cubic feet of growing stock volume, of which 6.1 billion were conifer, and 15.4 billion were hardwood. Along with this overall increase, the state's maples, oaks, basswood, ashes, white and red pines, white and black spruces, and black walnut are some of the commercially important species whose growing stock volume increased. The volume of aspen, paper birch, jack pine, balsam fir, yellow birch, and American beech volumes decreased between inventories.

During the same period, sawtimber volume increased dramatically – by more than 30 percent or 15.7 billion board feet. Sawtimber is the largest timber size class. These trees tend to be older, more economically valuable, mature seed-producers, and are important to the forest's structure. As Wisconsin's forests age, continued growth of sawtimber volume is likely.

* ***Forestland*** *is defined as land that is at least 10 percent stocked with trees of any size, or that formerly had such tree cover and is not currently developed for a non-forest use. The minimum area for classification of forestland is one acre.* ***Timberland*** *is a subset of forestland and is defined as forestland producing or capable of producing crops of industrial wood (more than 20 cubic feet per acre per year) and not withdrawn from timber utilization.*

PLANTATIONS

About 94 percent of Wisconsin's standing forests are a result of natural regeneration. The remaining six percent of Wisconsin's forests are plantations. In this context, plantations refer to areas established through planting that are sufficiently productive to qualify as timberland. The planted species is not necessarily dominant. The majority of plantations are conifer types and located in the central and northern parts of the state.

Figure 1-6: Most of Wisconsin's plantations are pine, however, they constitute only 4.7 percent of the state's total forestland.

Growth and Removals

One indicator of sustainability is that in Wisconsin, forests are growing at a rate that significantly exceeds harvest. Between 2010 and 2015, average net annual growth of growing stock on timberland exceeded harvests and other removals by more than 274 million cubic feet. Between 2010 and 2015, average net annual growth was 578 million cubic feet and average annual removals were 304 million cubic feet, about 53 percent of average net annual growth. In 1996, average annual removals were 68 percent of average net annual growth. Average net annual growth of sawtimber also exceeded average annual removals, resulting in a net increase in sawtimber volume between 1996 and 2015. Between 2010 and 2015, net growth of sawtimber was about 2.27 billion board feet annually. About 40 percent of that growth was offset by removals – 902 million board feet each year.

Economic Importance

Wisconsin's forests provide the raw materials for homes, offices, furniture, paper, medicines, paints, plastics, and many products people may not realize come from trees. In Wisconsin, nearly 65,000 people are directly employed, and more than 110,000 others are indirectly employed by the forest products industry. Wood-using companies produce nearly 25 billion dollars of forest products every year. More information on the economic impact the forest industry has on the state as a whole or on individual counties can be found at: ***dnr.wi.gov – keywords "forest economics."***

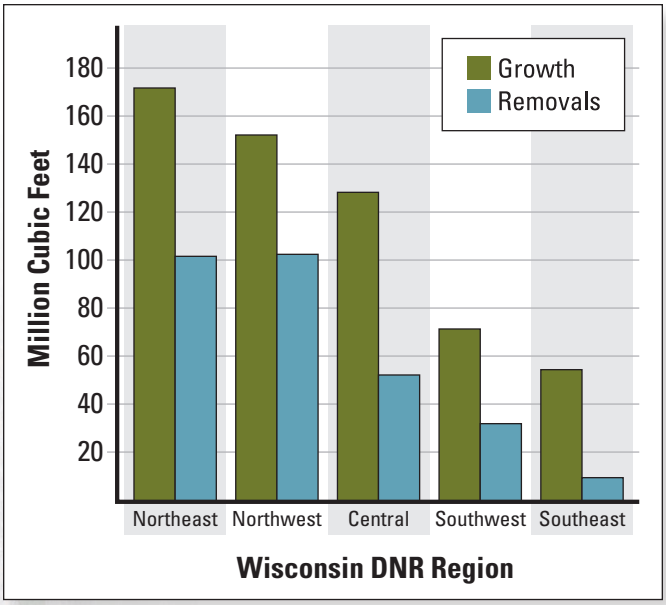


Figure 1-7: Bar graph showing growth and removal by Wisconsin DNR regions.

Carbon Storage

Forests have a role in reducing the concentration of carbon dioxide in our air. Through photosynthesis, forests remove carbon dioxide from the atmosphere and break it down into its components of carbon and oxygen. The oxygen is released back into the atmosphere and the carbon is incorporated into roots, leaves and wood of forest plants. The amount of carbon stored in a forest depends on the tree species present, growth rate and management practices. At the time of this publication, it is estimated that there is more than 1.67 billion tons of carbon stored in Wisconsin's forests.

Forest Certification

Forest certification is a market-based, non-regulatory forest conservation tool designed to recognize and promote environmentally-responsible forest management and the products that come from well-managed forests. The goal of forest certification is to ensure that on-the-ground forest management meets a set of rigorous, comprehensive measures of sustainable forest management and environmental protection.

As of 2016, more than 7.4 million acres, 47 percent of Wisconsin's private and public forestlands, have been certified by the American Tree Farm System® (ATFS) a program of the American Forest Foundation, Forest Stewardship Council® (FSC®) and the Sustainable Forestry Initiative® (SFI®). Each certification system (e.g., ATFS, FSC®, and SFI®) has developed standards that are designed to ensure that forests certified under their system are managed in a way that supports the local economy, meets consumer demand for essential goods and services, protects conservation values, and ensures the long-term sustainability of the resource. The system then uses these standards to evaluate an individual's or organization's forest management planning and practices. Forestland that is enrolled in a forest certification system must conform to the system's standards to remain certified. Conformance is evaluated by third-party auditors to ensure that planning and management practices meet the certification system's standards and to identify opportunities for improvement.

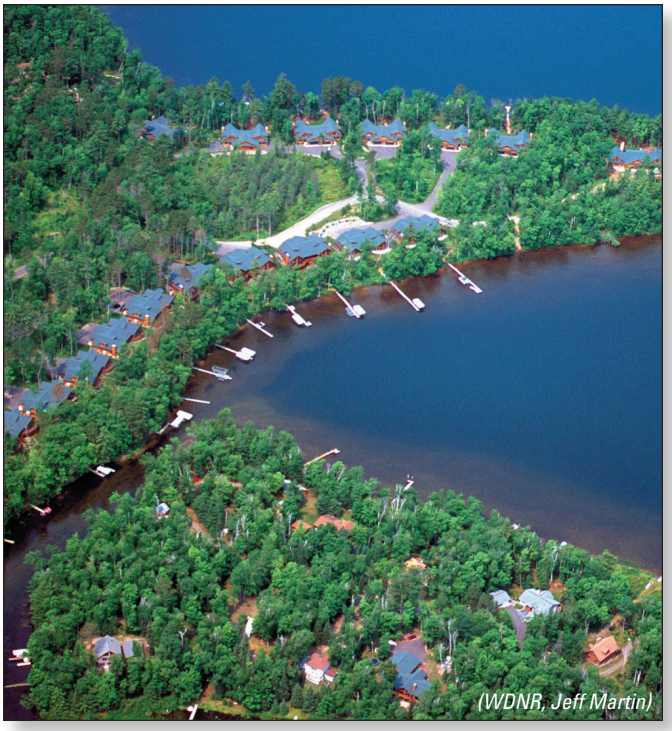


Figure 1-8: Continued lakeshore development is influencing Wisconsin forests.

Biodiversity

Wisconsin is blessed with abundant biodiversity. Located at the junction of two of North America's biotic provinces – the Eastern Broadleaf Forest in the southern half of the state, and the Laurentian Mixed Forest in the north – we have a wealth of species and natural communities. Almost 700 species of vertebrates, more than 2,000 species of native plant taxa, numerous non-vascular plant species, more than 30 lichens, and tens of thousands of invertebrates are known from the state. Although not all of these organisms use forested habitats, Wisconsin forests provide important habitat for many of them. The challenge is to manage our forests while conserving Wisconsin's heritage and preserving future management options *(Wisconsin DNR Biodiversity as a Management Issue 3)*.

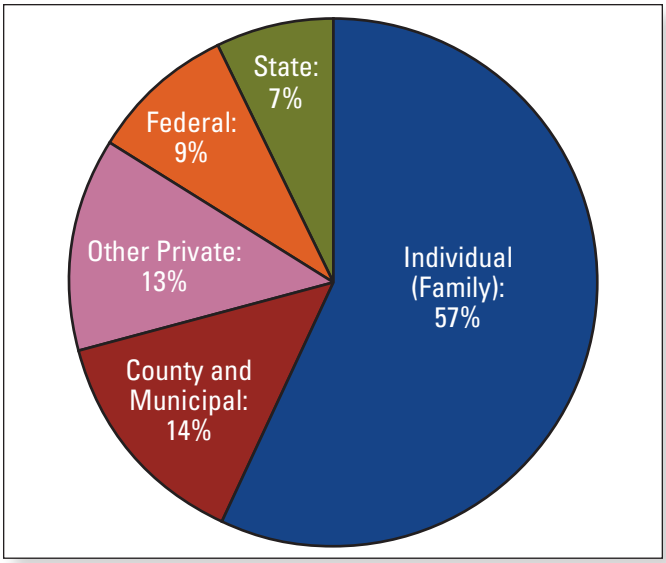


Figure 1-9: Forest acres by ownership category.

Ownership

Individual, non-industrial private landowners own the majority of Wisconsin's forests. These private woodland owners hold 57 percent of the state's forests, while other private owners (corporate, industrial, nonprofit and tribal owners) hold 13 percent. In the public sector, counties and municipalities own 14 percent of Wisconsin's forests, while the federal government owns nine percent, and the state owns just seven percent.

Due to the large impact that individual woodland owners have on the landscape, management of private woodlands has become increasingly important. However, shifting demographics of woodland owners and decreasing property size are impacting woodland owners' management decisions.

As the demographics of Wisconsin's forest landowners change, so too do landowners' values and uses for their land. More landowners are now coming from urban backgrounds and fewer from rural farming backgrounds. As non-farm owners tend to have a different relationship with the land than farmers, there has been an accompanying shift from traditional land use practices to uses more focused on amenity values such as recreation and viewing wildlife.

Along with the changing demographics, there has been an increase in the parcelization of woodlands. Each year, on average, 6,400 new parcels are carved from Wisconsin's forestlands. This has resulted in more individual private forest owners of smaller parcels. Between 2006 and 2013, the number of Wisconsin's non-industrial private owners increased 12.4 percent to 407,000.

Urban Forests

More than 70 percent of Wisconsin residents live in urban areas and are surrounded by urban trees each and every day. The trees, lawns, landscape plantings, gardens, urban wildlife, and people of the cities compose the urban forest ecosystem. Like electricity and water, an urban tree canopy is part of a community's infrastructure, providing valuable environmental, economic, health and social benefits. Based on a pilot study, Wisconsin has an estimated 42.8 million urban trees with tree canopy cover averaging 19.8 percent across the state.

The design, management and maintenance of the urban forest plays a role in the fields of arboriculture, nursery management, parks and recreation, urban planning, and landscape architecture and design – just to name a few. As urban trees complete their life cycle, the benefits may continue. Some urban wood is processed by local sawmill operators and made into a variety of end products – from flooring to artisan crafts.

Figure 1-10: A lot for sale in Wisconsin's forestland.

Figure 1-11: A home on lakeshore development.

A BRIEF HISTORY OF WISCONSIN'S FORESTS

Wisconsin's forests are reservoirs of vast ecological, economic and social wealth. Throughout Wisconsin's history, forests have played a primary role in supporting people who have lived here. The forests of Wisconsin are dynamic, living systems that change with the human demands placed on them as well as through natural occurrences such as succession, severe weather events, fire, insect infestations, and disease.

Forests Before European/ American Settlement

When the last glaciers receded from northern Wisconsin between 10,000 and 12,000 years ago, a complex array of habitats supported the colonization of plants, wildlife and humans. At the time of European/ American settlement (1825 to 1880), forests stretched over most of the area that would become the state of Wisconsin. Between 22 and 30 million acres – 63 to 86 percent of the total land area of the state – were covered with forests. Two major forest divisions became apparent – the Northern Mixed Forest and the Southern Broadleaf Forest, each representing several ecosystems.

The native vegetation of the northern region is more cold-tolerant. Pine, spruce and tamarack are more abundant. Before European settlement, sugar maple, hemlock and yellow birch dominated the mesic forests of northern Wisconsin. Various pine species were also important. Aspen and white birch were important successional species that followed natural disturbance across northern Wisconsin. Acid bogs were a significant ecosystem in the northern Wisconsin forest. Pine forests and barrens were important on the sandy soils of central and northwestern Wisconsin. In the southern part of the state, oak-hickory and maple-basswood forests were especially prevalent. The southern and western parts of the state also supported oak savannah and prairie habitats. Forested and non-forested wetlands were found throughout the state (see Figure 1-13, page 1-9).

Figure 1-12: This old growth forest of pine, hemlock and northern hardwoods west of Minocqua is typical of the native vegetation that was found in northern Wisconsin before European/American settlement.

EARLY HUMAN INFLUENCE

Native people profoundly influenced the land and ecology of Wisconsin in areas where they lived. Perhaps most significant was their use of fire. It is thought that native people used fire throughout the state in varying degrees to encourage the establishment of favored plant and animal communities. Prairies and savannahs were likely maintained by these fires.

Hunting and trapping also influenced the ecological communities of the area that later became Wisconsin. Native people hunted a broad spectrum of animals. Deer, fish and black bear were the cornerstone of the Woodland Indians' diet, but mussels, birds, fish, and more than 25 other mammal species were utilized as well. Many animal populations may have been limited by human hunting rather than by other carnivores or food supply.

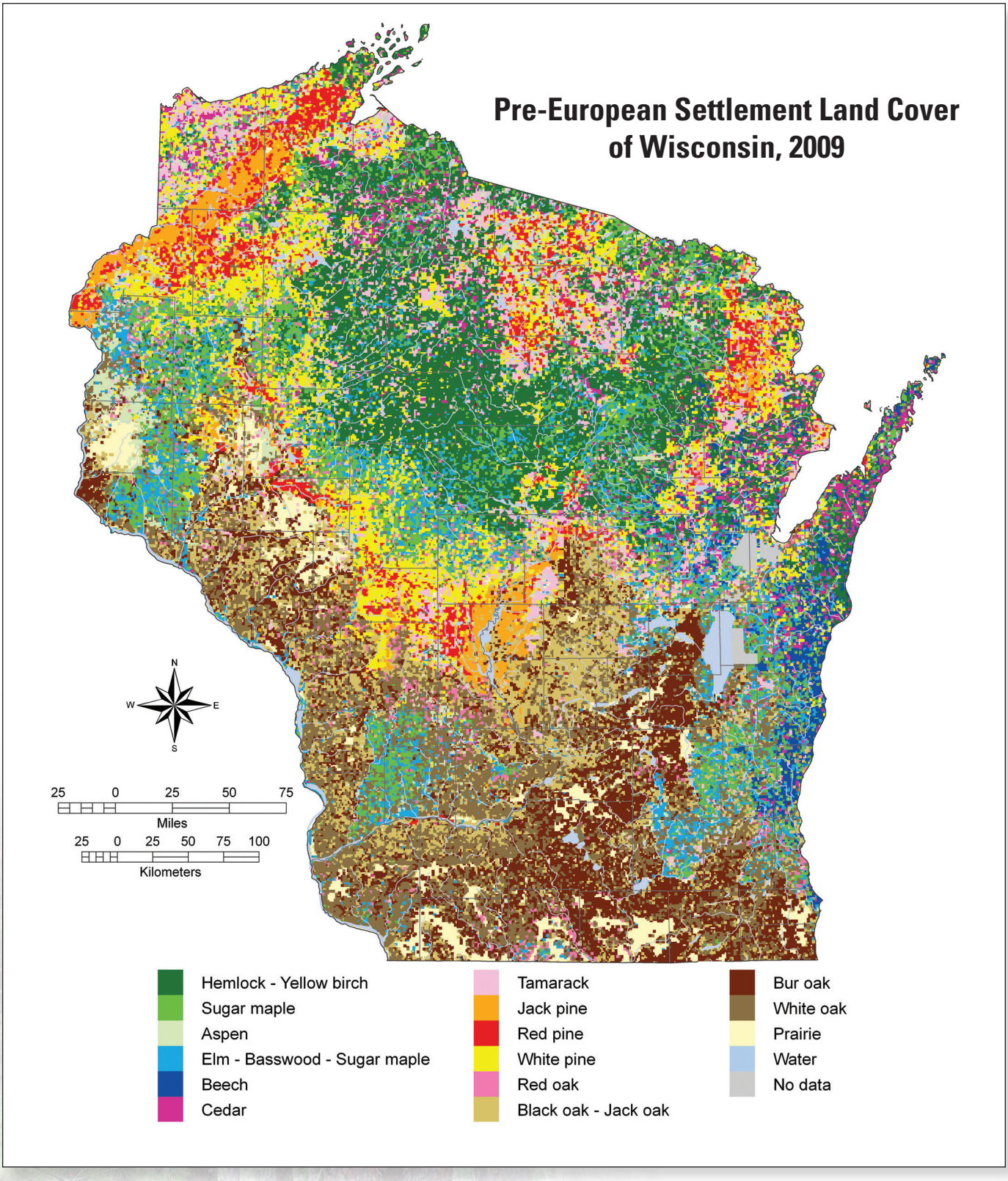


Figure 1-13: Using ecological information extracted from the U.S. General Land Office Public Land Survey records, University of Wisconsin researchers compiled a computerized, statewide tabular database of Wisconsin's 19th century vegetation. The vegetation pattern portrayed in this map is a product of the interaction among climate, soils and Native American use. Disturbances such as natural fires and windstorms were also important in shaping the forests of that time. *(Figure Credit: David J. Mladenoff, Forest Landscape Ecology Lab, University of Wisconsin-Madison, 2009)*

Figure 1-14: Prairies and savannahs were common native habitat in the southern and western parts of Wisconsin, and often maintained by the Native Americans use of fire.

Nuts and fruits were also important to native people, and there is evidence that they planted orchards to ensure a supply. There are accounts from early European explorers describing the "planted tree groves" of chestnuts, locusts, oaks, ashes, basswoods, beeches, cottonwoods, maples, pecans, medlars, mulberries, and plums. These "orchards" may have resulted in the forest islands seen on the prairies by early European explorers.

Foraging also influenced the ecology of Wisconsin. Collected plants may have become over-represented in biotic communities because of Indian dispersal. It was said of wild rice by the Menominee, "Whenever the Menomini enter a region, the wild rice spreads ahead; whenever they leave it, the wild rice passes." Mining, trails, agriculture, and placement of settlements in pre-contact times had a large impact on the landscape. Many of our major highways began as roads between native people's settlements hundreds of years ago.

When early explorers arrived in the mid-1600s, tribes living in Wisconsin included the Winnebago, Ojibwe, Menominee, Dakota, Sauk, Potawatomi, Heron, and Fox. However, some of these groups have stories of migrating from other areas to Wisconsin. For example, the Ojibwe tell of their migration from the eastern ocean in the 1400s. This era corresponds to the "Little Ice Age" – a period of significant cooling of the North American continent. Temperatures between 1450 and 1850 averaged 1.5°F cooler than today.

Forests Since European/American Settlement

Today, Wisconsin's forests are significantly different than those before European/American settlement. A variety of historical reasons can account for this.

EXPLORATION AND SETTLEMENT

In 1634, Frenchman Jean Nicolet landed on the southern shore of Green Bay to arrange a truce between the Winnebago and their enemies so that the French fur trade would be protected, a task at which he succeeded. This was the first direct European influence felt on the land that would become the state of Wisconsin. However, for two hundred years, the forests remained sparsely settled while providing for the lucrative fur trade and continuing to support native people.

Various treaties in the early 1800s, which either removed or confined native populations, opened up Wisconsin to intensive European/American settlement. With the dramatic increase in human population came increasing demands on resources. Much of the southern part of the state was converted to agriculture. The fertile soil in this area, including much that was previously forested, became the base for some of the most productive farms in the growing nation. During this process, southern forests were cut and burned to aid in clearing the land and create nutrient-rich ash to fertilize crops. Timber was not a major economic contributor until the 1870s.

THE CUTOVER

In the late 1860s following the Civil War, logging became an important component of Wisconsin's economy. By 1893, Wisconsin had reached its logging zenith and was a world leader in lumber production with more than 3.5 billion board feet produced annually. Pulpwood consumption was about 211,000 cords. Sawmills sprang up everywhere along Wisconsin's many rivers, which transported logs to the mill and finished products to burgeoning cities to the south and west.

In 1898, the federal government conducted and published a survey of Wisconsin's northern forests. By this time, a first wave of cutting was well underway, and a second wave beginning. In the survey's introduction, B. E. Fernow estimates the 1850s pine (red and white pine) volume at 130 billion board feet. By 1898, all but 17 billion had been removed, and cutting was continuing at a rate of two billion board feet per year. Fernow wrote, "In almost every town in this region, logging has been carried on, and 8,000,000 of the 17,000,000 acres of forest are 'cutover' lands, largely burned-over and waste-brush lands, and one-half of it as nearly desert as it can become in the climate of Wisconsin."

By the 1930s, most of the valuable timber in the northern area of the state had been removed or destroyed by fire. The harvest occurred in two waves; the pines were harvested first and floated down the rivers to cities to the south. When railroad shipping became available, valuable hardwoods were cut and taken by train to the south. Then the other, less economically-desirable trees were cut.

Harvest techniques varied in cutover lands. Some lands were clearcut, but most were high graded. The largest and most valuable trees were removed, often leaving species and individuals less dominant to re-seed an area. At the time of the first statewide inventory in 1936, the approximately 15.5 million acres of forestland in the state was primarily young, early succession second growth.

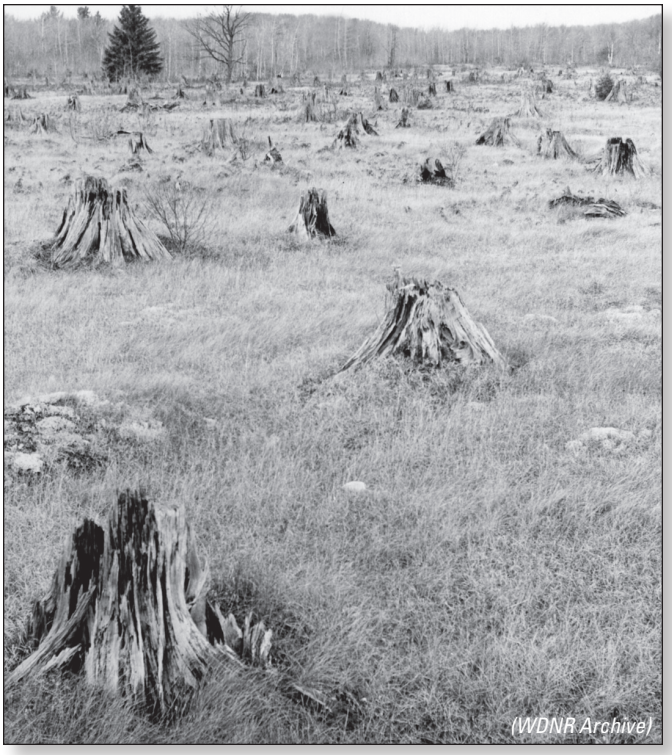


Figure 1-15: Eight million acres of forest were cut by 1898, the height of the Wisconsin Cutover.

The Cutover led to a variety of problems for contemporary and future residents. Not least among the challenges was the wave of forest fires that cinched the destruction of millions of acres of trees, and took thousands of human lives. Slash (wood residue from logging operations) burned easily and quickly. Fires spread over large areas, leaving ashes in their path.

Another result of the Cutover was the land boom of the early 1900s. In northern Wisconsin, logging companies sold sizable tracts of cutover land to speculators who then sold smaller farms to the immigrant population arriving in Wisconsin – enticed by the promise of land. Farmers diligently removed stumps left from the Cutover, sometimes disposing of them through fire, which further contributed to frequent and intense forest fires of the era.

CONSERVATION

This depletion of Wisconsin's forests did not go unnoticed. An era of forest conservation was about to begin. One of the most persistent advocates of conservation was E. M. Griffith, appointed the first state forester in 1904. With the help of people as disparate as Senator Robert LaFollette, Sr., lumber baron Frederick Weyerhaeuser, and University of Wisconsin President Charles R. Van Hise, Griffith pieced together land into state-owned forest preserves. He also oversaw construction of the first state nursery at Trout Lake near Minocqua, implemented new fire control strategies, and was influential in locating the U.S. Forest Products Laboratory in Madison.

Unfortunately, neither the public nor the Wisconsin Supreme Court was ready for such innovations. County governments were concerned about the loss of land from the tax rolls, and contended that Griffith and his cohorts were trying to turn northern Wisconsin into a "playground for the rich" at the expense of the farmers becoming established in the area.

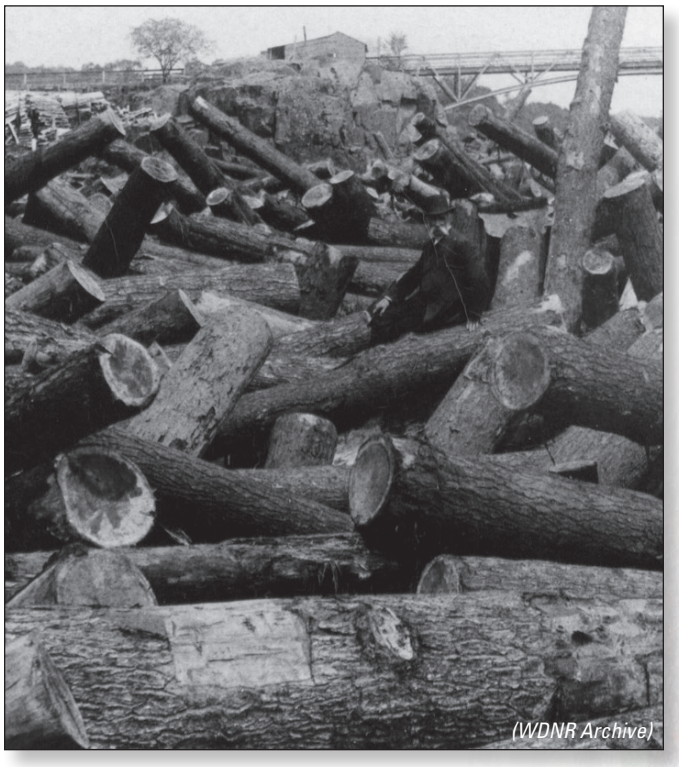


Figure 1-16: Logjam on a river. Rivers transported much of the timber cut from Wisconsin forests in the late 1800s.

The Supreme Court found that the land was purchased for the forest preserves under the authority of an improper amendment to the state constitution. Griffith resigned in 1915, and the reforms that he tried to promote were not implemented for another decade.

Finally, in the late 1920s and 1930s, some of Griffith's goals were realized. A new concern for conservation and an understanding that the forest resource is indeed finite formed new decisions regarding Wisconsin's forests. Farmers in the north realized the land and climate were not well-suited to agriculture. Many of them abandoned the land, bankrupt. This land reverted to forest.

The State Constitution was amended in 1924 to allow state funds to go to the acquisition, development and preservation of forest resources. The Northern Highland State Forest, still the largest state forest, was the first created under the new amendment. The Forest Crop Law, a precursor to the current Managed Forest Law, was passed in 1927, making it easier for private landowners and counties to conserve forest resources for future use. County forests were created from much of the tax delinquent land of failed farms. In 1928, the first national forestland was purchased in Wisconsin, creating what is now known as the Chequamegon-Nicolet National Forest.

After 50 years of pervasive forest fires, made worse because of the ready availability of fast-burning slash from the extensive harvesting, the public began to value fire control. Human life, farms, buildings, and forests were protected with new fire prevention and control measures. With the invention of Smokey Bear in 1944, the public embraced a commitment to fire prevention and forest conservation in Wisconsin.

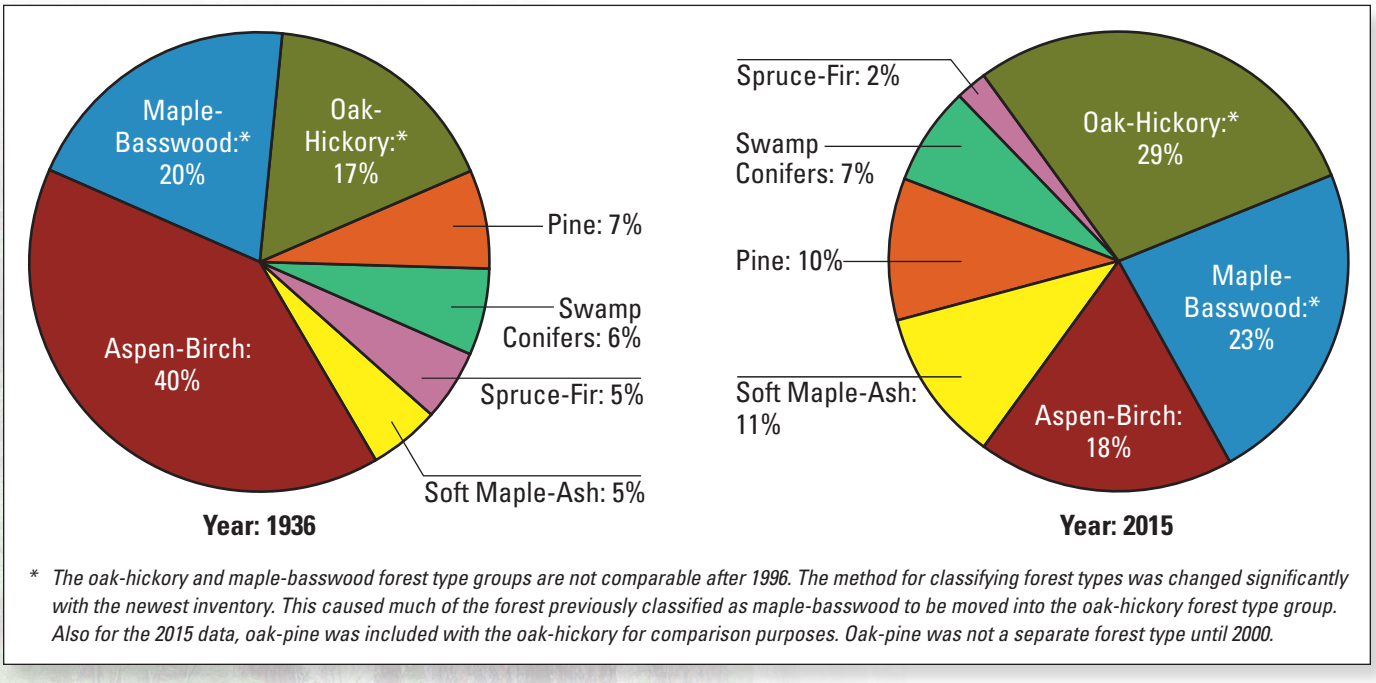
Figure 1-17: The Civilian Conservation Corps fought fires, planted trees and contributed in substantial ways to Wisconsin's growing conservation ethic.

In the 1930s and early 1940s, a notable influence on Wisconsin's forests was the Civilian Conservation Corps (CCC). As in other areas, the "CCC boys" fought fires, planted trees, built park buildings, and worked on other conservation projects. Reforestation efforts commenced across the state, with the goal to renew the forests. Many of Wisconsin's older pine plantations originated with CCC efforts.

The Cutover era dramatically changed the composition, structure and function of Wisconsin's forests. The extensive logging and large fires allowed species like quaking aspen and paper birch to become prevalent, encouraging large populations of white-tailed deer and other wildlife that thrive in early successional habitat.

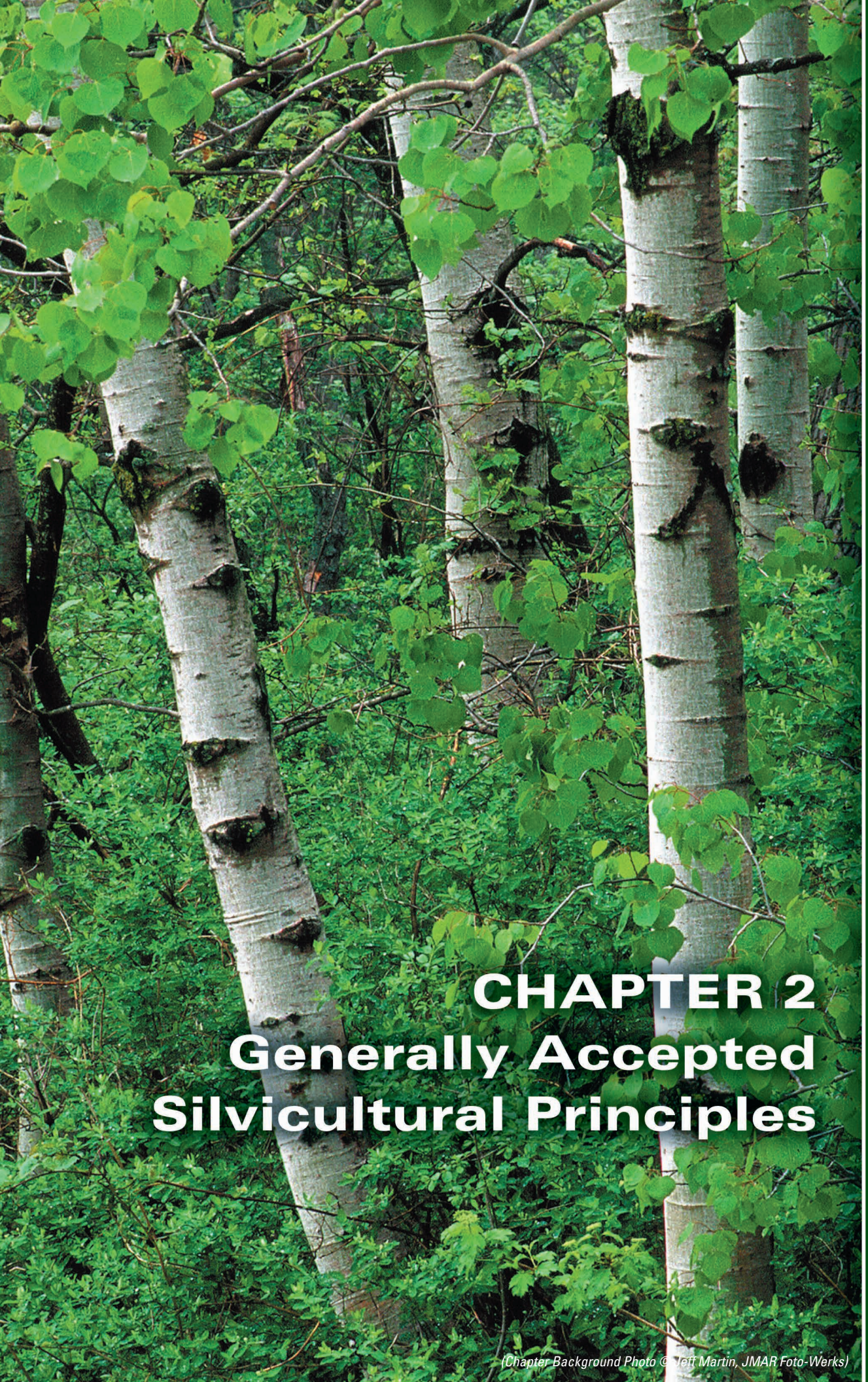
The Wisconsin Forest Inventory conducted in 1936 revealed a very young forest, with aspen-birch by far the most prevalent forest type. Many years passed before the cutover forests recovered sufficiently for harvest. Fortunately by this time, there was a better understanding of the need to conserve forest resources and employ sound forest management. In many instances, professional foresters from forest products companies and government agencies worked together to bolster the growing forests.

Today, the state supports a wide array of forest ecosystems. Ecological, economic and social benefits have grown with the growing forest. There are also challenges that face Wisconsin's forests including environmental issues, economic demands and changing expectations among people who use and own the forests.



* *The oak-hickory and maple-basswood forest type groups are not comparable after 1996. The method for classifying forest types was changed significantly with the newest inventory. This caused much of the forest previously classified as maple-basswood to be moved into the oak-hickory forest type group. Also for the 2015 data, oak-pine was included with the oak-hickory for comparison purposes. Oak-pine was not a separate forest type until 2000.*

Figure 1-18: Wisconsin forest area by type in 1936 and 2015.



2

CHAPTER 2
Generally Accepted Silvicultural Principles

(Chapter Background Photo © Jeff Martin, JMAR Foto-Werks)

CHAPTER 2
GENERALLY ACCEPTED SILVICULTURAL PRINCIPLES

Figure 2-1: Integrated guidelines recognize the forest as a community of related resources, rather than a collection of separate resources, as shown in this photo of the Baraboo Bluffs and Devil's Lake in Sauk County.

The purpose of this chapter is to focus on growing stands of trees and the generally accepted silvicultural practices used in Wisconsin.

This chapter will:

- Provide an overview on the interdependence of compatible landowner objectives, a careful evaluation of site capability, and the selection of an appropriate **silvicultural system** – the three essential elements of sustainable forestry practices.
- Expand upon each of the preceding three essential elements of sustainable forestry practices.
- Identify, define and explain various silvicultural systems and their application to the common forest cover types in Wisconsin.
- Address other types of harvesting, unsustainable cutting methods, and passive management strategies.
- Provide examples of how to distill all the sustainable forestry considerations into an effective management prescription at the stand level.

For more detailed silvicultural information related to a specific forest cover type, forest management treatment readers are referred to the Wisconsin DNR *Silviculture Handbook, 2431.5*. The handbook can be found at: ***dnr.wi.gov – keyword "silviculture."***

SUSTAINABLE FORESTRY

FOREST ECOLOGY

The science concerned with 1) the forest as a biological community dominated by trees and other woody vegetation; 2) the interrelationships between various trees and other organisms constituting the community; and 3) the interrelationships between organisms and the physical environment in which they exist.

SUSTAINABLE FORESTRY

The practice of managing dynamic forest ecosystems to provide ecological, economic, social, and cultural benefits for present and future generations (from Ch.28.04(1)e, Wisconsin Statutes).

SILVICS

The study of the life history, characteristics and ecology of forest trees. It involves understanding how trees grow, reproduce and respond to environmental variations. The silvics of a particular tree species would describe the climatic range, temperature and light requirements, moisture needs, thermoperiodicity, soil conditions and topography, life history and development, commonly associated trees and shrubs, and any environmental, insect and/or disease factors that affect its growth and survival.

SILVICULTURE

The practice of controlling forest composition, structure and growth to maintain and enhance the forest's utility for any purpose.

Sustainable forestry practices must be based on compatible landowner objectives, the capabilities of each particular site and sound silviculture. Each of these factors is equally important.

Landowners' goals and objectives might encompass a wide range of values and benefits such as commercial products, recreation, aesthetics, wildlife habitat, endangered and threatened resources, and clean water. Understanding landowners' goals and objectives is essential to ensure that prescribed forestry practices are relevant and will endure over time. Landowners' goals and objectives must also be compatible with sustainable forestry defined as the management of dynamic forest ecosystems to provide ecological, economic, social, and cultural benefits for present and future generations. The silvicultural principles discussed in this guide assume that landowners are committed to sustainable forestry.

Site capabilities help define sustainable forestry practices. Each particular growing space has its own set of environmental conditions affecting tree growth. Factors like soil type, aspect and climate influence the moisture and nutrients available to individual trees, and must be considered to ensure long-term tree health and vigor (see "Site Evaluation and Stand Delineation," page 2-5).

Silviculture is based on both forest ecology (relations between organisms) and the silvics (behavior or response) of individual tree species. Silvicultural systems are applied to stands of trees (rather than to individual trees) composed of species that commonly grow together. By definition, silviculture is the practice of controlling forest composition, structure and growth to maintain and enhance the forest's utility for any purpose. Silviculture is applied to accomplish specific landowner objectives.

The following sections of this guide will cover a number of silvicultural systems and harvest methods. The ability to adapt silvicultural systems to address multiple objectives is limited only by one's imagination and creativity, making the practice of sustainable forestry both an art and a science. Table 2-1 (see page 2-32) summarizes the array of regeneration methods generally considered acceptable for the forest cover types in Wisconsin.

LANDOWNER GOALS AND OBJECTIVES

Silviculture and forestry practices are not ends within themselves, but rather a means of achieving specific objectives in a landowner's overall goal to manage a forest on a sustainable basis. The test of a silvicultural prescription or recommended forestry practice is how well it meets the landowner's sustainable forestry goals and objectives.

As noted previously, landowner goals may be varied, reflecting a variety of forest values and benefits. Some goals may have a higher priority than others, but it is important to remember they are often interrelated, and generally depend on sound forestry practices to be realized.

Figure 2-2: Landowners and resource managers should meet on-site prior to preparing a plan or conducting operations. Such meetings can help assure common understanding of landowner objectives, forestry prescriptions and site.

Goals can be achieved by accomplishing specific objectives. For example, a goal of periodic income or maintenance of wild turkey habitat might be achieved through an objective to regenerate an oak timber type through small shelterwood harvests spread over time. Think of a silvicultural prescription as a site-specific "action plan" to accomplish objectives.

In developing goals, landowners should realize that although specific site characteristics of their land could make some objectives unsustainable, there might be other viable courses of action to choose from. It is up to the forester and other resource professionals to identify all options open to the landowner, and to use as much flexibility as possible in designing a silvicultural prescription that best addresses the full range of landowner goals (see Chapter 10: Forest Management Planning for more information).

GOAL

A concise statement that describes a future desired condition normally expressed in broad, general terms that are timeless with no specific date by which the goal is to be achieved.

OBJECTIVE

Concise, time-specific statements of measurable, planned results that relate to overall goals.

NOTE: Generally, "goals" apply to an entire property and "objectives" to individual stands.

SITE EVALUATION AND STAND DELINEATION

Site capability determines what types of forestry practices are sustainable. A **site** is defined by the sum total of environmental conditions surrounding and available to the plants. A site is also a portion of land characterized by specific physical properties that affect ecosystem functions and differ from other portions of the land (Kotar, 1997).

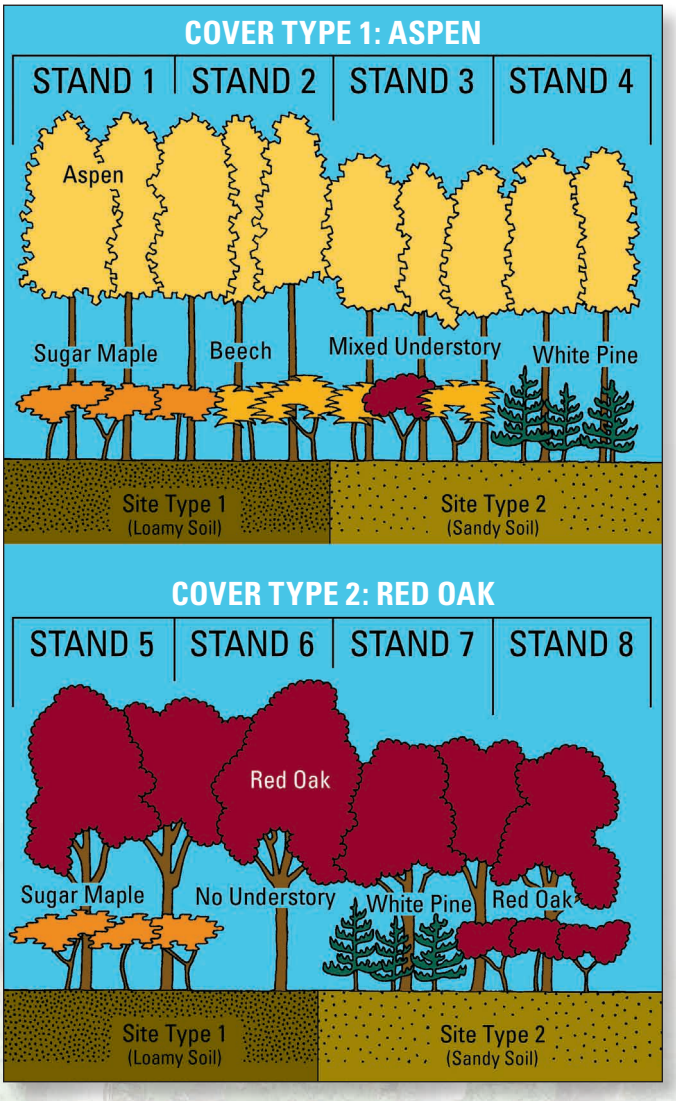


Figure 2-3: A schematic representation of two site types (loamy soil and sandy soil), two forest cover types (aspen and red oak), and eight stands. Each stand has unique composition and is defined by a specific combination of overstory and understory species. Each stand also can be considered as a unique ecological or silvicultural opportunity unit. *(Figure Credit: Kotar, page 10)*

Forestry practices are carried out on a stand basis which determines where practices will occur. A **stand** may loosely be defined as a contiguous group of trees sufficiently uniform in species composition, arrangement of age classes, and general condition to be considered a homogeneous and distinguishable unit.

A stand is usually treated as a basic silvicultural unit. Stands are normally identified by the forest cover type involved (e.g., an "aspen stand," a "northern hardwood stand," or a "jack pine stand"). Cover types are discussed in more detail later in this chapter.

Forest stands are delineated through the use of aerial photographs, forest reconnaissance, inventory, and cruising. Sites are generally delineated based on soils, topography, landforms, geology, vegetation associations, and site index.

It is important to note that forest stands and sites often overlap each other. As illustrated in Figure 2-3, a single stand may occupy more than one site and a single site may support more than one stand.

Since a stand is the basic unit of silvicultural planning, care should be taken to ensure that it represents a uniform ecological opportunity unit. In other words, each specific site and stand combination has a unique set of silvicultural opportunities and constraints, which can be used to increase the number of outcomes available to the landowner. As shown in Figure 2-4 and Figure 2-5, defining stands by cover type and site type will facilitate the determination of management objectives.

Forest **site quality** is the sum total of all factors affecting the capacity to produce forests or other vegetation. Biotic and abiotic factors impact moisture, nutrient and energy (light and heat) gradients, which determine vegetation growth and dynamics. Site quality affects tree growth, species composition and succession (plant community development). As site quality varies, so do forest management potentials and alternatives.

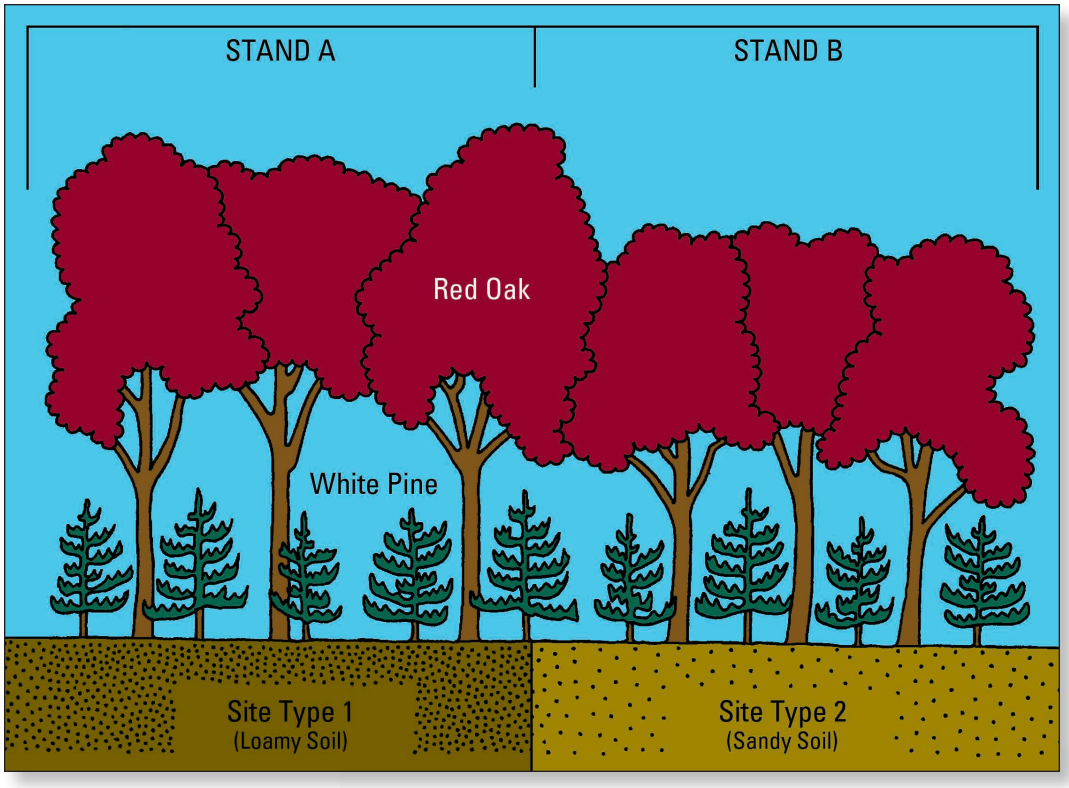


Figure 2-4: A single stand (red oak overstory with white pine regeneration) "straddles" two significantly different site types. Because ecological and silvicultural potentials differ for the two site types, the stand was split (A and B) to identify two ecological and silvicultural opportunity units. (Figure Credit: Kotar, page 12)

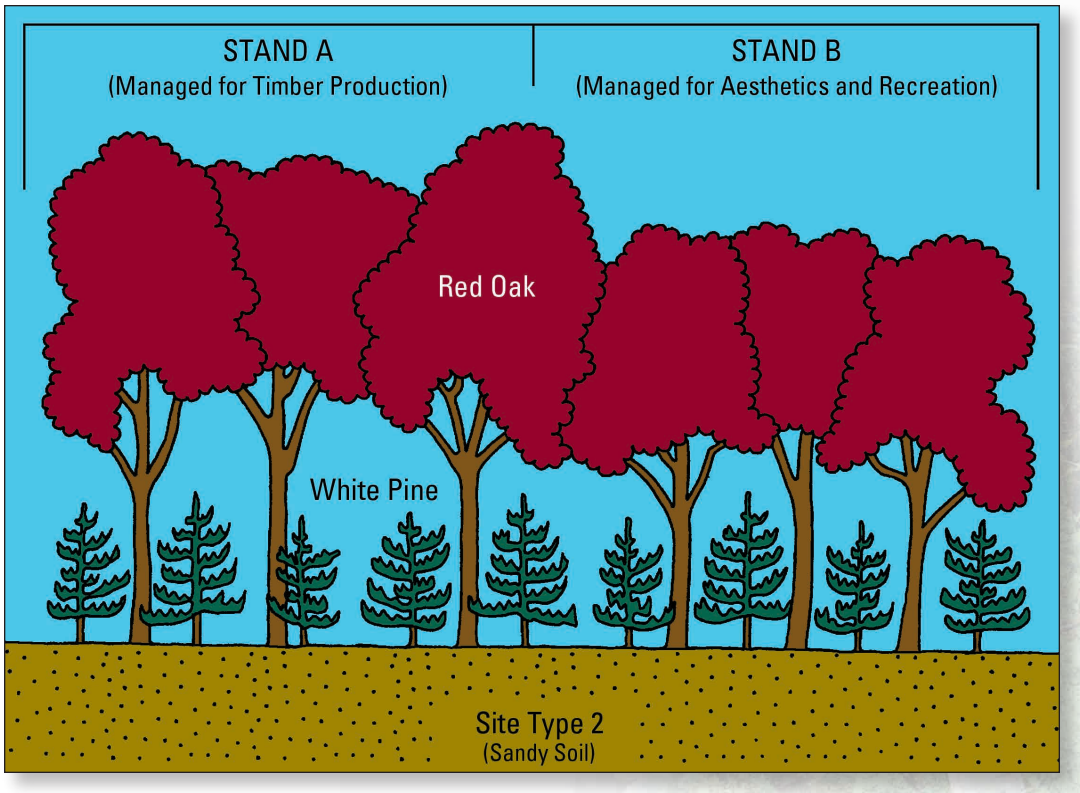


Figure 2-5: This stand is divided into two management units on the basis of different management objectives. E.g., in Stand A, oak will be harvested and white pine released to form a new crop, while in Stand B, oak overstory will be retained to provide a food source for wildlife and conditions for future old growth. (Figure Credit: Kotar, page 13)

Forest site productivity is a measure of the rate of tree growth and overall wood volumes that can be expected on a given site. Productivity for a given species will generally vary between different sites as will productivity for different species on the same site.

There are direct and indirect ways to evaluate forest site quality and productivity:

- **Direct measures** of forest productivity such as historical yields and mean annual increment. These measurements are influenced by stand characteristics and may not be available.
- **Indirect measures** that relate environmental characteristics to tree growth and productivity are more commonly used. Indirect measures can be applied individually or in combination.
  - **Site Index:** Growth rates are measured and compared to tables that predict the height a particular species will attain at a given age.
  - **Vegetation Associations:** The number and relative density of key characteristic ground plants are measured, and a vegetative habitat type is identified. A great deal of inventory and other productivity data are available for each habitat type in Wisconsin.
  - **Physical Site Characteristics:** Examples include geology, landform, aspect, topography, and soil. These characteristics can be used to differentiate among types of sites that are significantly different with respect to their capabilities to support or produce different cover types or rate of tree growth. It is important to remember, however, that different combinations of individual site factors can result in functionally similar sites.

Regional site classification systems can provide tools to understand local site variability, impacts on site quality and productivity, and potential management alternatives.

Forest Cover Types and Silvicultural Alternatives

In a forested situation, tree species tend to occur in associations known as forest cover types. They range from a single tree species to several different species that commonly grow together on a specific site. The Department of Natural Resources recognizes 18 forest cover types statewide. It is important to understand that only a subset of these cover types will naturally occur on any given site, and as a result, the range of sustainable management alternatives available are usually limited.

The forest cover type existing at a given point in time on a particular site will tend to change over time through the natural process of forest succession. Succession refers to a gradual change in plant community composition, and eventual replacement of one community of species by another. Following a major disturbance, such as fire or windstorm (or a silvicultural treatment designed to create similar conditions), an **early successional community** may invade a site. These communities (or forest cover types) are made up of sun-loving species able to rapidly establish themselves on an open, highly-disturbed site. Over time, the canopy begins to close and limit available sunlight, which results in other more shade-tolerant species eventually becoming established.

As the original early successional species are no longer able to compete, other **mid-to-late successional communities** better adapted to the changing microenvironment gradually replace them. A gradual transition to a number of different successional communities may occur as each gains a reproductive edge on the continually changing site conditions. At some point, after a long period free of disturbance, sites will transition to a potential climax community that is self-regenerating. This **climax community** will occupy the site until another disturbance creates conditions favoring re-establishment of an early successional community (a major disturbance) or a mid-to-late successional community (a lesser disturbance).

COMMON FOREST COVER TYPES FOUND IN WISCONSIN

Oak	White Birch	Northern Hardwood
Aspen	White Pine	Hemlock
Red Pine	Red Maple	Central Hardwood
Jack Pine	Black Spruce	Swamp Hardwood
Cedar	White Spruce	Bottomland Hardwood
Walnut	Balsam Fir	Tamarack

In Wisconsin, these successional trends are fairly well understood for each ecological habitat type (site type). The pathways on some sites involve only a few stages; on others there may be several. Figure 2-6 is an example of the successional stages and trends on one particular site type.

An understanding of forest succession on a particular site can provide a great deal of useful information to a landowner evaluating potential management goals and objectives, and a forester developing the silvicultural prescriptions needed to achieve those goals. Referring to Figure 2-6, for example, one might reason:

- Only seven generalized successional stages occur naturally on this site. Long-term management for quality northern hardwood or black walnut sawtimber, for example, would not be practical.
- Of the naturally occurring successional stages, some are currently more common at a landscape scale (as identified by the circles).
- Since a climax association is normally self-sustaining, maintaining an existing red maple, red oak, white pine, white spruce, and balsam fir type on this site would minimize regeneration costs.
- Based on the successional paths identified for this habitat type, the changes resulting from various levels of disturbance can be predicted. A partial removal of red pine overstory trees to release invading white pine, for example, would hasten the conversion from a red pine to a white pine timber type. On the other hand, a severe windstorm in a red oak-red maple stand might re-establish an aspen-white birch association for a period of time.
- Maintaining an early or mid-successional stage would require a disturbance, such as active management, to overcome the natural tendency to convert to the next stage. Increasing light levels by maintaining a lower canopy density is needed to allow reseeding of the more light-demanding, earlier successional stages. Marking criteria would have to focus on releasing preferred species from more shade-tolerant species to ensure survival.
- Reversing the trend and going back to a previous successional stage would generally require a significant disturbance. Even-aged management would normally be needed to create conditions favorable for re-invasion by early successional stages like aspen and white birch. Prescribed fire or mechanical scarification may be required to favor jack pine. Site preparation and planting would probably be needed to re-establish red pine. In general, the further succession is set back, the more disturbance and effort will be required.

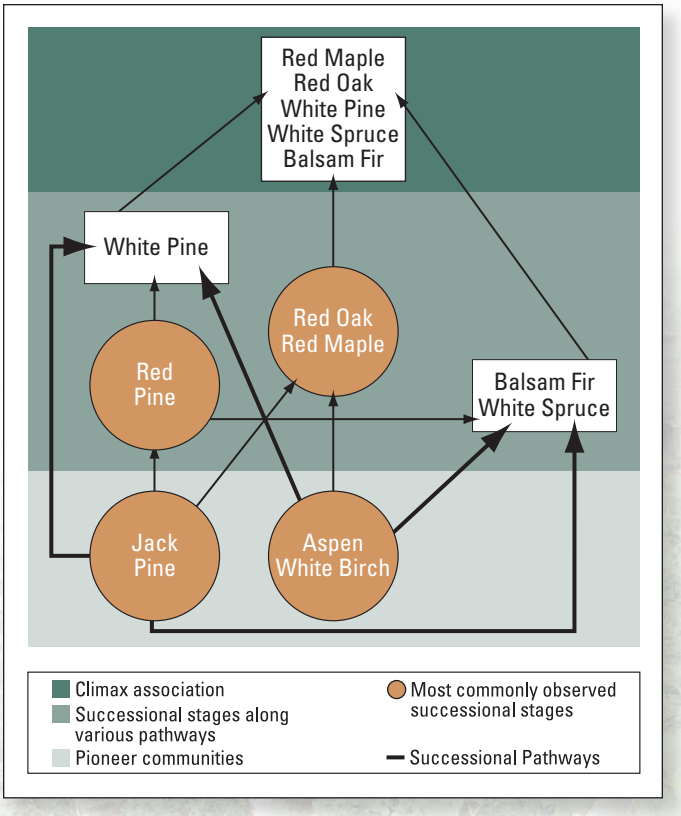


Figure 2-6: A generic example of the information available relative to the most commonly observed successional stages and probability of succession for a particular site type.

SILVICULTURAL SYSTEMS OVERVIEW

A **silvicultural system** is a planned program of vegetative manipulation carried out over the entire life of a stand. All silvicultural systems include three basic components: **harvest**, **regeneration** and **tending**. These components are designed based on understanding and partially simulating natural processes and conditions fostering healthy, vigorous stands of trees. Typically, silvicultural systems are named after the regeneration method employed to create the conditions favorable for the establishment of a new stand.

A **harvest method** differs from a simple harvest cut in that it is specifically designed to accomplish two objectives – removal of trees from the existing stand, and the creation of conditions necessary to favor regeneration and establishment of a new stand. The method selected depends on the species to be regenerated or established in the new stand. Harvest methods vary from the complete removal of a stand in a single cut or in stages over several years, to the selection of individual trees or groups of trees on a periodic basis.

A **regeneration method** is a process by which a stand is established or renewed. The various methods include: 1) removal of the old stand; 2) establishment of a new one; and 3) any supplementary treatments of vegetation, logging residue, or soil applied to create conditions favorable for the establishment of reproduction. Two general regeneration techniques are:

- **Natural regeneration systems** rely on natural seeding or root/stump sprouts and are generally carried on concurrently with the harvest process. In some cases, additional follow-up activities (e.g., scarification, understory competition control, slash treatment, or prescribed fire) may be necessary.
- **Artificial regeneration systems** depend on the planting of tree seedlings or seeds. Generally, planting occurs on non-forested land or following complete removal and harvest of a forest overstory, and results in an even-aged stand. Examples of artificial regeneration systems are:
  - **Afforestation:** Establishing a new forest on non-forested land.
  - **Reforestation and Conversion:** Forest type conversion when the desired species is not present or is inadequately represented to provide sufficient seed or vegetative reproduction.
  - **Reforestation and Re-establishment:** Forest type re-establishment when the desired species are difficult to regenerate, and it appears to be more efficient to utilize artificial regeneration than to depend on natural regeneration.

Table 2-1 (see page 2-32) shows the regeneration harvest methods described in this chapter as generally accepted for application to Wisconsin forest cover types.

Tending includes a variety of intermediate treatments that begin after regeneration is established and are implemented as prescribed throughout the rotation of a forest stand. These treatments include pruning, release, thinning/improvement, and salvage/sanitation. They are done to improve stand composition, structure, growth, quality and health, and to produce specific benefits desired by the landowner. Some tending operations are non-commercial (e.g., pruning, early release of crop trees, precommercial thinning) requiring outright investment by the landowner, and can be collectively referred to as timber stand improvement (TSI). Other tending operations, such as commercial thinning, can generate revenue for a landowner. Intermediate silvicultural treatments are discussed in detail in Chapter 16: Intermediate Silvicultural Treatments.

Several different silvicultural systems are discussed in detail in the next section of this chapter, emphasizing the particular rationale and goals of each. The systems can be adapted based on stand and site conditions, and stand management objectives. Flexibility and imagination are key in tailoring silvicultural systems to address the host of values inherent in sustainable forest management.

SILVICS, THE BASIC BUILDING BLOCKS OF A SILVICULTURAL SYSTEM

Examples of Selected Silvical Characteristics for Three Common Wisconsin Tree Species

	Aspen	Northern Red Oak	Sugar Maple
Pollination	March to April	April to May	March to May
Seeds Mature	May to June	September to October of the next year	Fall
Seed Dispersal	Immediately after ripening. Wind and water long-distance dissemination.	September to December Gravity and animal dissemination.	Fall Wind dissemination up to 330 feet.
Good Seed Years	Every 4 to 5 years	Every 2 to 5 years	Every 1 to 5 years
Germination	Immediately after dissemination. No dormancy. 32ºF to 95ºF. Bare soil required.	Spring, two years after pollination. Mixed mineral/ humus soil preferred.	Spring, one year after pollination. Best at 34ºF. Bare soil not required.
Seedling Development	Six to 24" height and 8" to 10" taproot development in the first year in full sunlight.	Moderate height growth. Dieback common. Rapid taproot development.	Best growth in 30 to 90 percent full sunlight. Sensitive to moisture stress.
Vegetative Reproduction	Vigorous root suckers after fire or cutting. 4' to 6' height growth in first year.	Stumps sprout readily and can average 24" of height growth per year.	Stumps sprouting decreases with increasing tree size.
Shade Tolerance	Intolerant. Pioneer species.	Mid-tolerant. Maximum photosynthesis occurs at 70 percent shade.	Very tolerant.
Typical Rotation Age	45 to 70 years	80 to 200 years	80 to 175 years
Max. Life Expectancy	100 to 150 years	300 to 400 years	300 to 400 years

For a complete listing of all Silvical Characteristics for all Wisconsin trees, see the following website:
na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm

Another key factor to keep in mind is that all harvests are not necessarily part of a regeneration system. In some cases, a harvest is specifically designed to capture the value of trees that might otherwise be lost. An example would be a situation where past cutting practices or natural events have left many mature trees scattered over an otherwise immature stand. Waiting for the scheduled regeneration harvest of the younger stand would likely result in loss of valuable forest products. As a result, a harvest might be carried out as part of an intermediate or salvage operation specifically to remove all or a portion of the older trees. Even though such harvests are not part of the overall regeneration system being applied to the primary stand, they should be compatible with overall long-term silvicultural objectives.

Remember, too, that silvicultural systems are developed based on the characteristics of forest cover types and a consideration of site factors. Specific treatments within a system should be modified to accommodate any special requirements.

GENERAL SHADE TOLERANCE OF WISCONSIN TREE SPECIES

Shade-tolerant

Able to reproduce and grow under a dense canopy.

Balsam Fir[1], Basswood, Beech[1], Black Spruce, Boxelder, Hemlock[1], Ironwood, Musclewood, Red Maple, Sugar Maple[1], White Cedar, White Spruce

Mid-tolerant

Reproduce best under a partial canopy which admits limited sunlight.

Ashes, Black Oak, Bur Oak, Elms, Hackberry, Hickories, Red Oak, Silver Maple, Swamp White Oak, White Oak, White Pine, Yellow Birch

Shade-intolerant

Light demanding species that reproduces best in full sunlight.

Aspen[2], Balsam Poplar, Black Cherry, Black Walnut, Butternut, Eastern Cottonwood, Jack Pine[2], Northern Pin Oak, Red Pine, River Birch, Tamarack, White Birch

1 Most tolerant species *2 Least tolerant species*

Note: Tolerance levels for a given species may vary during its life cycle.

Some of the key considerations in the selection of a silvicultural system include:

- **Shade Tolerance:** The ability of a given tree species to survive and grow in low light conditions under a forest canopy is referred to as its shade tolerance. This silvicultural characteristic is one of the most important considerations in the selection of a silvicultural system. Once established, most trees will maximize vigor and growth in near full sunlight. However, the amount of sunlight required for regeneration, early survival and different growth rates varies between tree species. Some species require full sunlight for their entire life cycle while others benefit from some protection in the regeneration and early establishment phases, only requiring full sunlight later to maintain growth and vigor. Still other species are able to regenerate and develop under very shady conditions, and use that ability to effectively compete with more sun-loving species.

- **Age Distribution and Stand Structure:** The age difference between individual trees within a particular stand varies. Some cover types typically regenerate all at once following a major disturbance (e.g., fire, wind events, insect and disease activity, past cutting, etc.). Others regenerate as groups following smaller disturbances, while still others regenerate almost continuously as individual trees die and create openings. As a result, the trees in some stands are essentially all the same age, while in others age varies widely. These age differences within a stand are often reflected by differences in tree heights and diameters. Trees in an even-aged stand tend to mature at the same time, while trees in an uneven-aged stand tend to mature as groups at distinct intervals or as individual trees on a relatively continuous basis.

- **Stand Condition:** Species composition, age, structure, quality, health and vigor, and spatial distribution of the trees within a stand must be carefully considered. Silvicultural guidelines and standard management systems generally are developed for typical or average conditions.

  In some cases, however, stands may exhibit a combination of low vigor, signs of significant insect and disease problems, excessive logging damage, low stocking, inappropriate age or stand structure, low tree quality, compacted or eroded soils and/or other abnormal characteristics. These stand conditions typically result from abuse, neglect or improper management practices such as high grading or diameter limit cutting. Such **degraded stands** may require modification of a standard silvicultural system to address specific stand and site conditions. Sometimes, intermediate treatments such as a series of improvement cuttings and thinnings, can restore degraded stands to acceptable and productive conditions. Other times, when degradation is extreme, regeneration methods may be needed to initiate development of an entirely new stand. The appropriate rehabilitative treatments may not be those generally recommended for the cover type, or may be applied at unusual times or in an unusual sequence.

Figure 2-7: Pulling garlic mustard before seeds set, as demonstrated by a Wisconsin Conservation Corps crew member, is an effective method to control this nonnative invasive plant.

- **Understory Competition:** The relative competitive abilities of desired species, other species, and undesirable species (trees, shrubs, and herbs that are present or could invade) should be considered. Key species-specific considerations include regeneration strategies, shade tolerance, response to release, and growth rates across variable site and stand conditions. Different silvicultural methods and systems can be utilized to encourage or discourage a particular species.

  The presence of **nonnative invasive plants**, can limit the success of potential silvicultural systems. The aggressive competitive abilities of some plants can interfere with desired regeneration and development. Specific silvicultural methods and systems must be designed to discourage the growth and spread or ameliorate the impacts of such species.

- **Herbivory**, particularly where deer populations are overabundant, can limit the success of potential regeneration methods. Selective browsing of preferred plant species can alter competitive dynamics, reducing representation of some species and facilitating the spread of others. Browsing can retard the development of or even eliminate desired regeneration. In some cases, only certain species not generally eaten by deer can be regenerated, unless intensive protection measures are implemented (e.g., fencing the forest).

- **Seed Production, Dissemination and Predation:** If regeneration is dependent on seed from the existing stand, a harvest may have to be timed to coincide with periodic seed years. Tree selection, sale shape, and follow-up seedbed preparation treatments must enhance seed dissemination, and discourage seed predation.

- **Seedbed Characteristics, Germination Requirements and Early Survival:** Some species require a mineral seedbed for germination while others are able to penetrate the litter on the forest floor and germinate in undisturbed areas. Still other species germinate best on seedbeds composed of a combination of mineral soil and humus. The germination temperature and the sunlight requirements for early survival may also be more specific for some species than others.

- **Seedling Establishment and Competition Control:** In some cases, overstory shade is needed to protect desired seedlings from excessive heating and drying during the establishment phase and/or retard the development of competing species. In others, full sun is required to maximize growth and the ability of the desired species to outperform competing species.

- **Quality Considerations:** In stands managed for high-quality sawtimber, overstory shade levels must be carefully controlled to minimize sunscald and epicormic branching and forking, while at the same time maximizing tree form and merchantable height.

EVEN-AGED SILVICULTURAL SYSTEMS

Even-aged management systems are normally used to harvest, regenerate and tend sun-loving forest cover types that grow poorly or will not regenerate in dense shade. Generally, the cover types adapted to these systems are those accustomed to regeneration and rapid domination of a site following a catastrophic disturbance such as a fire or major windstorm. Stands normally consist of trees at or near the same age. Even-aged systems are also applied to cover types dominated by shade-tolerant species when the intent is to focus on the less-tolerant component of the stand. Portions of even-aged management systems, specifically the intermediate thinning regimes, may also be used in the early stages of young northern hardwood stands to facilitate a long-term conversion to the uneven-aged system.

Even-aged Harvest and Regeneration Methods

Light requirements, growth rates and reproductive characteristics of the species to be regenerated govern the degree of overstory removal at the time of harvest. Competing vegetation and site characteristics are additional factors. The following are the generally accepted even-aged regeneration methods used in Wisconsin.

Figure 2-9: A young poletimber stand of dense coppice origin aspen. As this stand continues to develop, there will be periods of natural thinning caused by competition induced mortality.

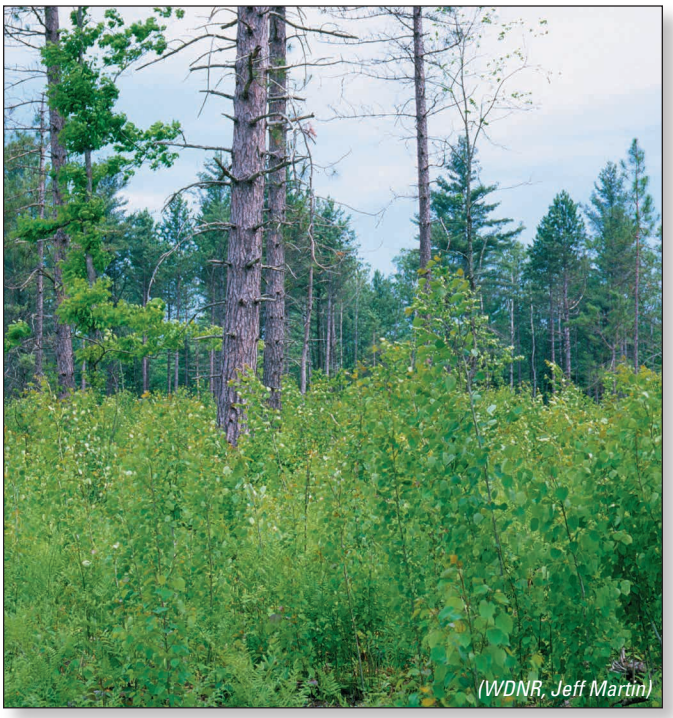


Figure 2-8: This aspen stand was harvested one year ago using the coppice regeneration method. Red pine "standards" were retained to enhance ecological and visual diversity. Abundant aspen from vegetative reproduction is now established.

EVEN-AGED REGENERATION METHODS USED TO PARTIALLY SIMULATE THE DEGREE OF STAND MORTALITY THAT WOULD NORMALLY FOLLOW A SEVERE NATURAL DISTURBANCE SUCH AS A FIRE OR MAJOR WINDSTORM

These methods are primarily used with intolerant species such as aspen, red pine or jack pine that require full sunlight to ensure complete regeneration and optimum development.

- **Coppice:** (Figures 2-8 through 2-10) A method designed to naturally regenerate a stand using vegetative reproduction. The overstory is (nearly) completely removed. Generally, there is no residual stand left, other than a limited number of reserve trees or standards, as excessive residual can interfere with the regeneration, and is not necessary to shelter the regenerated stand. This method differs from the other even-aged regeneration systems (clearcut, seed-tree and shelterwood) in that the regenerated stand is derived from sprouting rather than a seed source.

Figure 2-10: A 50-year-old aspen stand. This mature aspen stand will be regenerated using the coppice method.

- **Clearcut:** (Figure 2-11) A method used to regenerate a stand by the removal of most or all woody vegetation during the harvest creating a mostly or completely open area leading to the establishment of an even-aged stand. Regeneration can be from natural seed produced by adjacent stands or trees cut in the harvesting operation. Clearcuts are also used prior to direct seeding or replanting for artificial regeneration systems.

  This method differs from the seed-tree and shelterwood methods in that no trees are left in the cut area for seeding purposes. Rather, the seed source is from outside the cut area or from felled tops of harvested trees.

Figure 2-11: This central Wisconsin stand of mixed jack pine and "scrub" oak was clearcut within the past year.

- **Seed-tree:** (Figures 2-12 and 2-13) A method designed to bring about natural reproduction on clearcut harvest areas by leaving enough trees singly or in groups to naturally seed the area with adequate stocking of desired species in a reasonable period of time before the site is captured by undesirable vegetation. In this method, only a few trees (typically three to 10 per acre) are left and the residual stocking is not enough to sufficiently protect, modify or shelter the site in any significant way. Seed-trees may be removed after establishment or left indefinitely. This method differs from the coppice method in that regeneration comes primarily from seed rather than sprouts. It differs from a clearcut in that the seed source for regeneration is from residual trees within the harvest area rather than outside the cut area, or relying on seed existing on or in the ground. It differs from a shelterwood in that the residual stocking is too sparse to modify the understory environment for seedling protection.

Figure 2-12 (Seed-tree A): A mature forest of mostly white pines mixed with smaller amounts of northern red oak and red maple. Seed-tree harvesting is one method used with even-aged species that require full sunlight for regeneration. All trees in such stands are generally ready for harvest at the same time, but sufficient advanced regeneration is not usually present. (Figure Credit: Computer-generated simulation by Andy Stoltman)

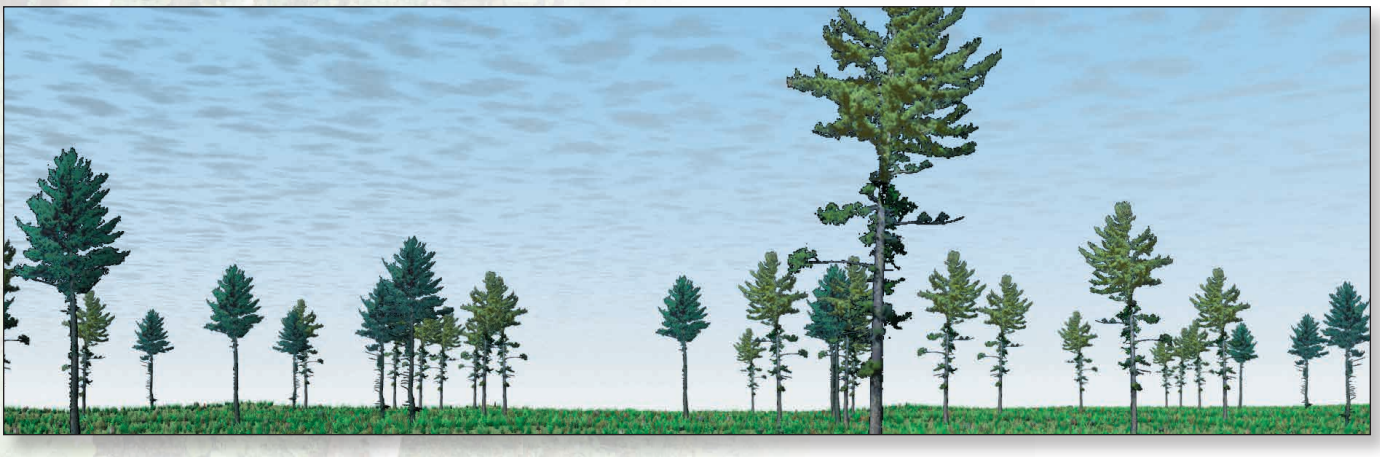


Figure 2-13 (Seed-tree B): White pine residual following a seed-tree regeneration harvest leaving about three to 10 trees per acre as a seed source to renew the stand. (Figure Credit: Computer-generated simulation by Andy Stoltman)

EVEN-AGED REGENERATION METHODS USED TO PARTIALLY SIMULATE NATURAL DETERIORATION OF THE OVERSTORY OVER TIME

These methods are tailored to more tolerant species that require partial shade and/or an abundant seed source for optimum regeneration, but once established need full sunlight for survival and full development (such as white pine and oak).

- **Shelterwood:** (Figures 2-14 through 2-19) A method used to regenerate a stand by manipulating the overstory and understory to create conditions favorable for the establishment and survival of desirable tree species. This method normally involves gradual removal (usually in two or three cuts) of the overstory. The overstory serves to modify understory conditions to create a favorable environment for reproduction and provide a seed source. A secondary function of the overstory is to allow further development of quality overstory stems during seedling establishment. The most vigorous trees are normally retained as the overstory, and the less vigorous trees removed.

A successful shelterwood harvest often requires the removal of intermediate or suppressed saplings and poles (often of less desirable species such as elm, ironwood or red maple) because the smaller understory trees will suppress development of vigorous seedlings of the preferred species.

Initial shelterwood cuttings resemble heavy thinnings. Natural reproduction starts under the protection of the older stand, and is finally released when it becomes desirable to give the new stand full use of the growing space. At that point, the remaining overstory is completely removed.

This method differs from clearcutting and coppice methods in that the next stand is established on the site before overstory removal. It differs from a seed-tree cutting in that the overstory serves to protect the understory as well as distribute seed. Finally, an even-aged shelterwood harvest differs from uneven-aged selection methods in that it promotes an even-aged stand structure.

Figure 2-14: May apples and other ground vegetation have begun to resprout following the first shelterwood cut (seed cut) in this red oak stand. Logging slash was removed and the ground scarified to provide improved conditions for light-demanding oak acorns to germinate.

Figure 2-15 (Shelterwood A): A dense stand of mature oak sawtimber and associated hardwoods before harvest. Notice the uniformity in size and age in the overstory, and the lack of regeneration.

(Figure Credit: Computer-generated simulation by Andy Stoltman)

Figure 2-16 (Shelterwood B): An oak forest soon after the first stage of a shelterwood harvest. The overstory has been opened up to allow sufficient light penetration for seed germination. Enough shade has been retained to prevent excessive drying of the seedbed and enhance early survival and establishment of the new seedlings. (Note: In some situations, post-harvest treatment of the understory with herbicides or mechanical scarification may be needed to control competition or prepare the seedbed.)

(Figure Credit: Computer-generated simulation by Andy Stoltman)

Figure 2-17 (Shelterwood C): The same stand after five years. Notice the regeneration developing as a result of the increased light penetration.

(Figure Credit: Computer-generated simulation by Andy Stoltman)

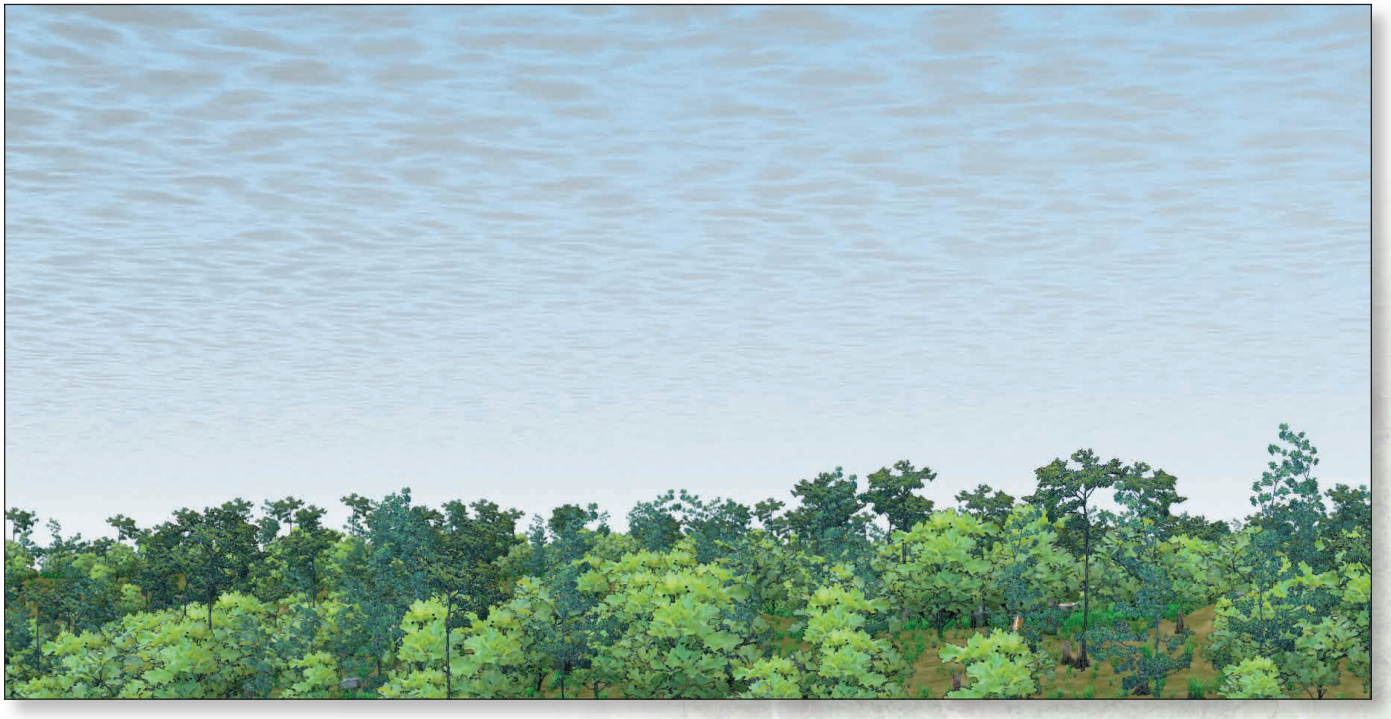


Figure 2-18 (Shelterwood D): An oak stand after the second stage (overstory removal) of a shelterwood harvest. After approximately 10 years, adequate regeneration is fully established, and the overstory has been removed to provide the added sunlight needed to maximize growth and development.

(Figure Credit: Computer-generated simulation by Andy Stoltman)

Figure 2-19: Natural regeneration after a shelterwood harvest has developed into an excellent stand of red oak poletimber, 30 years later, on the Hardies Creek Stewardship Forest in Trempealeau County.

- **Overstory Removal:** A method used to mimic the natural deterioration of the overstory but at an accelerated rate in situations where adequate regeneration is already established. The entire stand overstory is removed in one cut to provide the release of established seedlings and saplings. This method has been referred to as a natural shelterwood or a one-cut shelterwood.

  Overstory removal results in an even-aged stand structure as opposed to uneven-aged structure. It differs from the clearcut and the coppice regeneration methods in that seedling and sapling regeneration is established prior to the overstory removal. It differs from the shelterwood and seed-tree methods in that no manipulation of the overstory is needed to establish regeneration.

  Overstory removal can be applied to all forest stands being managed on an even-aged basis if desirable advance regeneration is well-established. General considerations in the application of the overstory removal method are:
  - Overstory health, condition and composition
  - Potential risk of raising the water table on wet sites
  - Adequate stocking, distribution, vigor and desirability of established, advanced regeneration
  - Site capability
  - Existing and potential competition, including exotic species

In most cases, the objective of an even-aged silvicultural system is to naturally regenerate a species already present in the stand. Depending on the species involved, additional activities may be required to ensure that its germination and growth requirements are met. These may involve the use of prescribed fire, disking and other forms of scarification to expose a mineral soil seedbed to enhance seed germination and survival. Where natural regeneration is insufficient or in cases where the desired species is not present in the harvested stand, artificial regeneration by tree planting or direct seeding may be required.

The basic description of all the even-aged methods includes harvesting the stand through complete overstory removal and initiation of a new stand. However, these systems can incorporate the retention of reserve trees to provide continuity between stands and a variety of potential ecological and social benefits. Depending on the species being regenerated, reserve tree retention can be designed to provide minimal interference with the growth and timber productivity of the new stand. Reserve tree retention during even-aged rotations is a generally recommended sustainable forestry management practice (see Appendix A).

Even-aged Tending Methods

Tending operations implemented in young stands usually are non-commercial. **Timber stand improvement (TSI)** generally includes the **intermediate treatments** of pruning and release. **Pruning** is usually applied to improve timber quality and value, although it can also be utilized to control disease, improve aesthetics, or improve stand accessibility. **Release** treatments are designed to free young trees from undesirable competing vegetation to improve stand composition, growth and quality.

Thinning and improvement are intermediate treatments implemented in older stands with larger trees that often offer commercial opportunities. **Thinning** entails the removal of trees to temporarily reduce stocking and concentrate growth on the more desirable trees. Thinnings are applied primarily to improve diameter growth, manipulate structure, enhance forest health, recover potential mortality, and increase economic yields. **Improvement cutting** is the removal of less desirable trees of any species primarily to improve composition and quality. Typically, improvement is applied coincidentally with thinning.

Specific applications of intermediate treatments depend on landowner goals and objectives, economic constraints and opportunities, site capability, stand development, and the silvics/ecology of the desired species and their competitors. Intermediate silvicultural treatments are discussed in detail in Chapter 16: Intermediate Silvicultural Treatments.

In most even-aged stands, intermediate treatments are generally applied relatively consistently across the stand. These thinning practices can be modified (spatially) and temporarily applied in even-aged stands where the long-term management objective is conversion to uneven-aged management. For example, in even-aged small sawtimber-sized northern hardwood stands, even-aged thinning guides can be applied to most of the stand, however, some regeneration gaps can be created to initiate the development of an uneven-aged structure. Following one or more of these modified even-aged thinnings with canopy gaps, later operations are then based on uneven-aged selection management guidelines (simultaneous thinning, harvest and regeneration).

Figure 2-20 and 2-21: The importance of tending an even-aged stand is illustrated by comparing these two plots in the famous Star Lake thinning experiment started by Fred Wilson with red pine planted in 1913. Figure 2-20 (left) shows the poor growth and mortality in the plot that was never thinned. The adjoining plot, Figure 2-21 (right), shows the impact that periodic thinnings (every five to 10 years starting in 1943) can have on red pine.

Even-aged Harvest Considerations

Under even-aged silvicultural systems, entire stands are harvested all at once or over a relatively short period when they reach a given age. The term rotation is used for the period of years required to grow timber stands to a specified condition of maturity. The age of the stand at the end of the rotation period when it is normally harvested is called the **rotation age**.

Traditional rotation ages are set at a period in time when average annual volume growth reaches its maximum. For a given stand, there is usually a period of time when harvests will maximize the timber produced per year over the rotation. This age range can vary, depending on factors such as species, site characteristics, management regime, and products produced. This traditional timber rotation age range is normally established for each individual forest cover type reflecting prevailing regional or local conditions. For example, red pine in Wisconsin maximizes annual volume growth at 60 to 120 years old.

Sometimes, stands are rotated at younger ages, reducing maximum timber production in order to increase economic returns to the landowner. Sometimes, stands are rotated at older ages, reducing maximum timber production in order to increase other social and ecological benefits for the landowner; examples of potential benefits include desired aesthetics, diverse wildlife habitat, increased biodiversity, and additional protection of soil, water, or cultural resources. Other reasons to alter rotations may include property level and landscape-level considerations (e.g., rotation ages may be shortened or lengthened in order to increase age class diversity on the property).

Eventually, the trees in an even-aged stand will reach old age. Old trees grow slowly, and eventually timber volume losses from decay and death will outstrip growth. As tree mortality progresses within the stand, a once even-aged stand will slowly develop an uneven-aged stand structure.

The actual rotation length for a specific stand can vary depending on a number of factors:

- **The average growth rate and life span of the species involved.** A typical rotation age for a stand of aspen, for example, is 45 to 60 years. A typical rotation age for an oak stand may be two to three times as long.
- **Site productivity.** More productive sites support increased growth rates for a longer period of time. As a result, the period of positive mean annual growth is also extended, increasing the optimum rotation age. Different rotation lengths are typically employed across the range of site productivity.

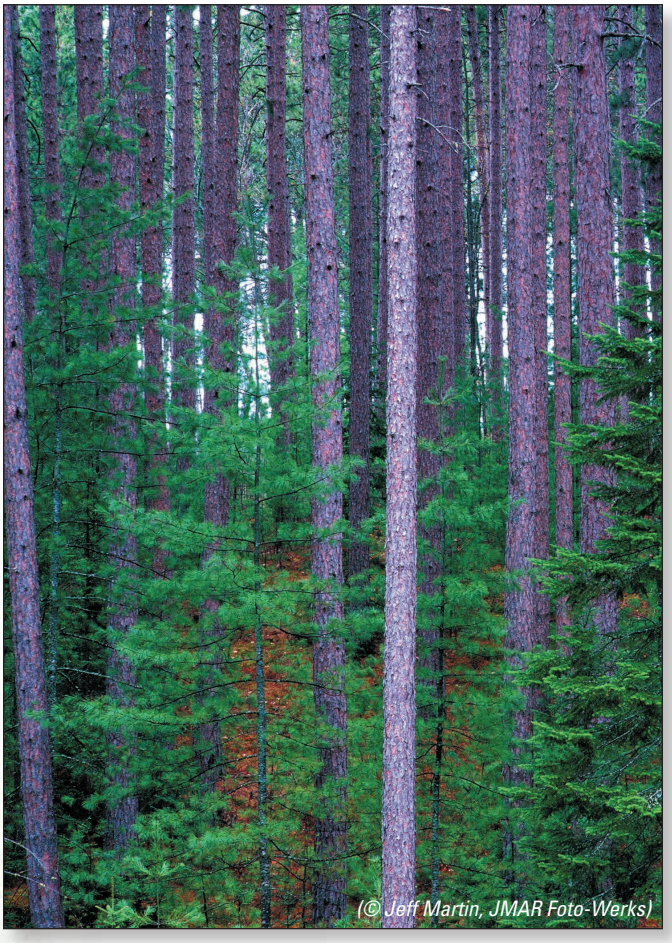


Figure 2-22: Red pine is a good example of a species amenable to modification of rotation age to reflect site productivity, product goals, and landowner non-timber objectives.

- **Silvicultural practices** can influence the pattern of growth and the age when growth is maximized. For example, manipulating the number of trees per acre, from planting through final thinning, influences tree vigor and the distribution of growth. Dense, unthinned stands managed for small diameter products maximize growth while relatively young. Fully stocked stands that are regularly thinned to maintain crop tree vigor to produce sawtimber maximize growth when older. Regular thinning shortens the period of time to reach a specified diameter, but also maintains vigor and high growth rates for a longer period of time.
- **Insect and disease concerns.** The level of mortality and decay caused by insects and disease is a prime factor in net growth. Insect and disease outbreaks can significantly reduce stand growth, and in extreme cases, cause such extensive mortality that they determine rotations.
- **Landowner goals.**
  - **The type and quality of timber products desired.** Pulpwood takes a shorter time to produce than sawlogs, which must be larger in diameter. High quality sawlogs and veneer logs require even more time, since they are typically grown to still larger diameters and at higher density levels to control stem form and limit defects.
  - **Economic considerations.** Changes in supply and demand in general, market values, specific customer requirements, and internal infrastructure demands can all result in modified rotation ages.
  - **Management for other (non-timber) forest resources.** Forest management goals may emphasize non-timber resources such as aesthetics, recreation, wildlife habitat, biodiversity, and protection of soil, water, and cultural resources. Timber rotations could be altered to maintain, protect or enhance non-timber resources.

Figure 2-23: White pine stand that has reached rotation age for the site it is on. The first cut (seed cut) of the shelterwood regeneration method has been applied.

UNEVEN-AGED SILVICULTURAL SYSTEMS

Uneven-aged management systems are normally used to harvest, regenerate and tend forest cover types that will regenerate and grow under partial shade. Stands managed under uneven-aged systems are normally comprised of three or more age classes. These cover types are adapted to regenerate under partial canopies following minor disturbances like individual tree mortality, or a moderate disturbance such as a wind storm that would damage up to one-third of the stand, felling trees as individuals, groups and in small patches. Uneven-aged systems are designed to partially emulate such disturbances.

Even shade-tolerant species grow most vigorously in relatively free-to-grow conditions with near full sunlight, assuming other growth requirements, like soil moisture, are met. As a result, regeneration and most vigorous growth typically occur in small- to medium-sized canopy openings. The number and size of openings created through uneven-aged management are dependent on species composition, size class or acreage regulation, and tree rotation age or size. Normally, these systems are used to manage stands containing mixed trees of all ages, from seedlings to mature trees. They are also used to convert even-aged stands into an uneven-aged structure.

Uneven-aged Harvest and Regeneration Methods

Stand regeneration is achieved by periodically manipulating the overstory and understory to create conditions favorable for the establishment and survival of desirable tree species. Canopy openings for regeneration are created by removing individual trees with large crowns, groups of trees, and small patches of trees. Smaller openings favor shade-tolerant species, whereas the larger patches generally favor mid-tolerant species.

In general, stands managed under uneven-aged systems regenerate as a result of manipulation of light levels during the harvest process. In some cases, non-commercial removal of additional cull trees or poorly formed saplings may be needed to further enhance regeneration in specific areas which are not opened up through the normal selection process.

Thinning, regeneration and harvesting usually occur simultaneously (time), but may vary across the stand (space). The harvested trees are essentially replaced by growth on the younger trees left in the stand. These silvicultural systems are designed to maintain an uneven-aged stand condition by periodically regenerating new age classes (cohorts), while manipulating the multi-aged and multi-sized structure of the overstory to facilitate continual development of quality growing stock. For more information, see the Wisconsin DNR *Silviculture Handbook, 2431.5*. The handbook can be found at: ***dnr.wi.gov – keyword "silviculture."***

With the uneven-aged silvicultural systems, the tree selection decision (to retain or cut) considers a number of factors, including those illustrated in Figures 2-24 through 2-26.

Figure 2-24: Species Desirability

Figure 2-25: Tree Quality

Figure 2-26: Desired Age and Size Class Distribution

The following are generally accepted uneven-aged silvicultural systems used in Wisconsin:

- **Single-tree Selection:** (Figures 2-27 and 2-29) Individual trees of various size and age classes are periodically removed to provide space for regeneration, and promote the growth of remaining trees. To recruit and release regeneration, trees are removed singly and in small groups, creating canopy gaps less than 0.1 acres in size. Each regeneration opening (canopy gap) covers an area equivalent to the crown spread of one to several large trees. The spacing of canopy gaps is irregular, based on the location of large harvested trees and small groups of undesirable trees. The overstory provides a seed source, and modifies understory conditions to create a favorable environment for the reproduction, competition and growth of certain species. This system favors the regeneration and maintenance of shade-tolerant species.

  Residual stand stocking is regulated by size or age class and generally maintained at a specified level to promote development of high-quality timber and fully utilize the site. Trees are selected for removal from all size classes (to achieve desired residual density levels) following recognized order of removal that considers tree risk, crop tree release, tree vigor, tree quality, species composition, and spacing. The goal, particularly in the northern hardwood cover type, is to achieve an optimum distribution of size and age classes so each contains a sufficient number of quality trees to replace those harvested in the next larger size class.

Figure 2-27: Single-tree selection. This 25-year-old canopy opening is being captured by young yellow birch trees.

Figure 2-28 (Single-tree Selection A): An uneven-aged northern hardwood stand which has not been harvested in 15 years. The basal area is approximately 120 square feet per acre.

(Figure Credit: Computer-generated simulation by Andy Stoltman)

Figure 2-29 (Single-tree Selection B): The same stand following a single-tree selection harvest. Trees have been removed from across the range of age and size classes to maintain an uneven-aged structure. The residual basal area is about 84 square feet per acre.

(Figure Credit: Computer-generated simulation by Andy Stoltman)

Figure 2-30: One-third acre group selection harvest in a central hardwood stand shortly after the harvest was completed.

- **Group Selection:** Trees are periodically removed in groups to create conditions favorable for the regeneration and establishment of new age classes (cohorts). Canopy openings to recruit or release regeneration may range in size from 0.1 to 0.5 acres. The smallest canopy openings are one-tenth acre, equivalent to a 75 foot diameter circular opening; this size can be large enough to recruit some mid-tolerant species, as well as stimulate vigorous shrub and herb competition. The largest canopy openings are one-half acre, equivalent to a 167 foot diameter circular opening; this is approximately two-times tree height. The overstory provides a seed source, and modifies understory conditions to create a favorable environment for the reproduction, competition and growth of certain species. This system favors regeneration and maintenance of shade-tolerant and mid-tolerant species; shading effects will vary across the canopy opening. The distribution of regeneration openings may be regular, or irregular depending on variations in stand condition, such as the age, size, vigor, quality, composition, and health of groups of trees.

  Acreage regulation determines the number of canopy openings. Groups of trees are harvested at rotation age creating new canopy openings. In addition, regeneration recruited by past cutting may require release, and the remainder of the stand is thinned. Many small cohorts of trees must be tracked to evaluate rotation, site preparation and regeneration, release, and thinning of different aged groups. Regeneration cuts, release, thinning, and harvesting usually occur simultaneously (time), but are variable across the stand (space).

  In general, northern hardwood stands dominated by large crowned tolerant species (e.g., sugar maple and beech) do not require the creation of large group openings to provide sunlight for regeneration, and individual trees are harvested as they mature using the single-tree selection method. However, some of the less-tolerant species commonly associated with sugar maple (e.g., basswood, yellow birch and ash) can benefit from the group selection method to enhance recruitment and growth of new seedlings if appropriate steps are taken to control competition.

Figure 2-31: One acre patch selection harvest in a central hardwood stand shortly after the harvest was completed.

- **Patch Selection:** Trees are periodically removed in patches to create conditions favorable for the regeneration and establishment of new age classes (cohorts). Canopy openings to recruit or release regeneration are greater than 0.5 acres in size, and typically less than two acres in size. The smallest canopy openings are larger than one-half acre, which is equivalent to a 167 foot diameter circular opening (approximately two-times tree height). The overstory provides a seed source and partially modifies understory conditions. This system generally favors regeneration and maintenance of shade mid-tolerant species; however, relatively intolerant or tolerant species can be encouraged. Shading effects will vary across the canopy opening ranging from completely open at the center to shaded at the edge. The distribution of canopy openings may be regular or irregular depending on variations in stand condition such as the age, size, vigor, quality, composition, and health of patches of trees.

  Acreage regulation determines the number of canopy openings. Patches of trees are harvested at rotation age creating new canopy openings. In addition, regeneration recruited by past cutting may require release, and the remainder of the stand is thinned. Many cohorts of trees must be tracked to evaluate rotation, site preparation and regeneration, release, and thinning of different aged patches. Regeneration cuts, release, thinning, and harvesting usually occur simultaneously (time), but are variable across the stand (space).

  Patch selection is a system to manage uneven-aged stands essentially composed of many small even-aged patches. Both even-aged and uneven-aged silvicultural techniques are employed. Relatively large regeneration openings may be fairly exposed and plant competition can be fierce. Site preparation and follow-up release may be needed to establish desired regeneration.

Uneven-Aged Tending Methods

In uneven-aged silvicultural systems, tending operations are not as clearly distinguished from rotation harvest and regeneration operations as in even-aged systems. Harvest and regeneration are perpetual operations, rather than occurring once during a stand's rotation, so tending must also be integrated and not temporally separated. In addition, uneven-aged stands typically have a spatially patchy age structure that may require patchy applications or variations of intermediate treatments.

Release treatments are designed to free young trees from undesirable competing vegetation to improve stand composition, growth and quality. These treatments can be applied to regeneration openings created by any selection system, although costs associated with the location and treatment of scattered regeneration patches may be prohibitive. They are generally most needed and feasible where the objective is to facilitate the survival, growth and development of seedlings and saplings of mid-tolerant species growing in larger openings created through application of the group and patch selection systems. In addition, as canopy crowns expand over time, previously created canopy openings may need to be re-opened or expanded to maintain the vigorous growth of young trees. This release operation can be conducted concurrently with other periodic cutting operations.

Thinning is an intermediate treatment that entails the removal of trees to temporarily reduce stocking to concentrate growth on the more desirable trees. Thinnings are applied primarily to improve diameter growth, manipulate structure, enhance stand vigor, recover potential mortality, and increase economic yields. **Under the uneven-aged silvicultural system, thinnings are implemented concurrently with periodic harvest and regeneration operations.** Stands are normally re-entered on an eight- to 20-year cutting cycle depending on landowner objectives, economic constraints and opportunities, site quality, tree growth rates, stand development, and the silvics of the desired species. Specific target stand stocking levels (density management) by size or age class are very important to tree growth and quality development. Often, small groups or patches of essentially even-aged trees can be recognized and treated. Tree selection is based on a recognized order of removal that considers tree risk, crop tree release, tree vigor, tree quality (timber), species composition, and spacing. Additional criteria can also be employed to enhance wildlife habitat, biodiversity, water quality, and aesthetic values. Temporary **improvement cutting** may be needed to improve composition or quality in stands that have been previously unmanaged, neglected or poorly managed.

Figure 2-32: When the uneven-aged system is used, an optimum maximum tree diameter class is determined for each stand.

Uneven-aged Harvest Considerations

Harvests in uneven-aged stands occur regularly. The normal cutting cycles range from eight to 20 years. The interval is based on site quality, species, growth rates, removable volumes, and landowner goals relative to each stand.

In the patch and group selection systems, once stands are regulated, even-aged harvest considerations apply to the rotation of groups and small patches. Usually, trees are also harvested throughout the majority of the stand during thinning operations following crop tree release and order of removal concepts. However, these methods do allow for stand level variations in regeneration, composition, structure, and silvicultural practices over space and time.

In the single-tree selection system, individual trees are removed from each size (or age) class as needed to achieve the desired level of stocking. When selecting which trees to remove within each diameter class, the primary factors considered are risk, crop tree release, vigor, quality, species, and spacing. In addition, an optimum maximum diameter class is determined for each stand based on the following considerations:

- **Site Productivity:** Higher quality sites can support increased growth rates. Trees can reach a given diameter faster, but increased vigor may also allow trees to be carried to a larger diameter before growth rates decline significantly and before degrade/decay becomes a major factor in tree value.
- **Average Growth Rates and Life Spans of the Species Involved:** Stands managed by single-tree selection may contain a variety of different species, each potentially having a different optimum maximum diameter class.
- **Landowner Goals:** Maximum diameter classes can be increased or decreased depending on specific landowner goals.
  - **Type and Quality of Products Desired:** A decision to focus on sawtimber, veneer or both may influence the selection of an optimum maximum diameter class.
  - **Log Grade:** As a particular high-quality crop tree gets larger, it becomes more economically valuable. The value increase is due to more than just the additional volume accumulated as the tree grows. As a tree passes though a number of threshold diameters, it increases in grade and value dramatically. The values of sawlogs depend more on grade than volume. Larger diameters are required for the higher grades, which can bring two to three times the value of lower grade logs. Attaining veneer size can result in another major increase in tree value (see Figure 9-6, page 9-7).
  - **Economic Considerations:** Changes in supply and demand in general, market values, specific customer requirements, and internal infrastructure demands can all result in modified rotation ages (maximum diameter class).
  - **Management for Other (Non-timber) Resources:** Forest management goals may emphasize non-timber resources such as aesthetics, recreation, wildlife habitat, biodiversity, and protection of soil, water, and cultural resources. The optimum maximum diameter class can be altered to maintain, protect or enhance these non-timber resources.

The Wisconsin DNR *Silviculture Handbook, 2431.5* provides three stocking guides for northern hardwood stands managed by single-tree selection. The traditional guide is based on a maximum diameter class of 24 inches (or trees 20 inches diameter and larger) and attempts to optimize the production of sawtimber quantity and quality. An alternative guide is based on a maximum diameter class of 18 inches (or trees 15 inches diameter and larger) and may facilitate increased economic returns (under certain economic scenarios). Another alternative guide is based on a maximum diameter class of 30 inches (or trees 25 inches diameter and larger) and can facilitate increased production of specific non-timber resources. Both alternatives may sacrifice optimal sawtimber productivity (quantity and quality) in order to increase other benefits.

Reaching the optimum maximum diameter class is not a primary criterion for tree selection. Other marking criteria (risk, vigor, quality, species, spacing, and basal area stocking levels) guide the selection of trees to retain and remove. Vigorous, low risk, high-quality trees may be retained well beyond the top diameter, for example, if stocking in the maximum diameter class is too low or other higher risk, lower vigor, or poorer quality trees are removed instead.

Flexibility exists in the selection of an optimum maximum diameter class. The diameter class chosen, however, is a key factor in the determination of the optimum number of trees needed in each of the other various diameter classes – from the smallest to the largest – to ensure that quality trees are available to replace those harvested.

PASSIVE OR NON-MANAGEMENT OPTIONS

Figure 2-33: Passive management is the most appropriate approach with fragile plant communities such as this relic white pine stand on cliffs in a stream-side riparian zone.

Some landowners and resource managers choose to "let nature take its course" on some forestland. In such cases, they make a conscious management decision to not actively manipulate the vegetation. This passive management is not considered a silvicultural system since it does not involve manipulation of vegetation.

Landowners and managers have different reasons for choosing to not actively manipulate vegetation. They may wish to protect and preserve fragile or special sites or communities (e.g., cliff communities, springs, groves of large old trees, and cultural sites). They may wish to develop habitat for specific wildlife that prefers relatively undisturbed forests. They may enjoy the appearance (aesthetics) and the recreational opportunities. Philosophical reasons may include the desire to allow nature to develop free of human impacts. Wilderness areas and some research control sites may be passively managed.

The concepts of "preservation" and "natural dynamics free of human impacts" are relative. Forests are dynamic communities that are continuously changing and adapting to external inputs and internal disturbances. Natural processes like forest succession, plant competition, structural development, wildlife and insect activity, tree aging and decay, windstorms, and fires will cause changes in forest composition, structure and function over time. Forests cannot be maintained in a static, unchanging condition. Also, there are no forest ecosystems undisturbed by human activities. Human disturbance has occurred through atmospheric composition and inputs, fire control, management of wildlife populations (intentional and unintentional), introduction of nonnative invasive species, recreational use, other human uses, etc. Passively managed forests will continue to change and will be subjected to human impacts, however, these changes and impacts often will be different than in actively managed forests.

Passive management does require monitoring, and certain events may necessitate the implementation of some short-term active practices. Examples include control of nonnative invasive plants, fire management, disease and insect management, wildlife management, recreation management, removal of diseased or weakened trees that pose safety hazards, and loss of attributes desired by the landowner. Passive management requires an understanding of the effects of natural processes and the impacts of other human activities (internal and external to the forest) on the development of the forest. This knowledge will facilitate the achievement of landowner objectives, and minimize the chances of counterproductive results or unintended consequences. In some situations, a blend of passive management and active silvicultural treatment may most effectively achieve landowner goals.

SILVICULTURAL SYSTEMS SUMMARY

As discussed in previous sections of this chapter, each of the silvicultural systems and regeneration methods has a number of variations that can be employed to tailor them to the specific species and sites involved. The choices can be confusing, but hopefully this summary will help sort things out.

EVEN-AGED SILVICULTURAL SYSTEMS

(Normally Used for More Sun-loving Species)

CLEARCUT

A complete overstory removal designed to facilitate regeneration by natural seeding, direct seeding or planting.

COPPICE

A complete overstory removal (clearcut) designed to promote regeneration through sprouts and suckers.

OVERSTORY REMOVAL

A complete removal of the overstory in a single harvest (clearcut), applied to any even-aged cover type if adequate regeneration is already established (used to release a new stand).

SEED-TREE

All overstory trees, except for about three to 10 seed trees per acre, are removed to facilitate regeneration by natural seeding.

SHELTERWOOD

A complete overstory removal in two to three harvests spaced over a period of years. The residual trees from the first cut serve to modify understory conditions to create a more favorable environment for reproduction and provide a seed source. They are removed when the regeneration is established.

NOTE: Reserve tree retention during even-aged rotations is a generally recommended sustainable forestry management practice (see Appendix A).

UNEVEN-AGED SILVICULTURAL SYSTEMS

(Normally Used for More Shade-tolerant Species)

SINGLE-TREE SELECTION

Individual trees are harvested from all size classes on a recurring cycle. Regeneration occurs naturally in the canopy gaps, less than 0.1 acres in size, created by harvesting one to several trees.

GROUP SELECTION

Trees are removed (rotated) in groups, 0.1 to 0.5 acres in size, on a recurring cycle. Regeneration occurs naturally in the openings created.

PATCH SELECTION

Trees are removed (rotated) in small patches, greater than 0.5 acres in size, on a recurring cycle. Regeneration occurs naturally in the openings created.

SIGNIFICANCE OF TABLE 2-1 TO THE WISCONSIN COOPERATING FORESTER PROGRAM

Table 2-1 summarizes the regeneration methods and silvicultural systems that are generally recognized as acceptable and widely applied in Wisconsin. The designations are substantiated in forestry research literature and further elaborated in the Wisconsin DNR *Silviculture Handbook, 2431.5*. Under the framework established by NR 1.213(3) b, Wisconsin Administrative Code, all forest management and timber harvesting assistance provided by the Wisconsin DNR and Cooperating Foresters must be consistent with the sideboards established in Table 2-1. Exceptions will be granted only if a science-based management commitment describing an alternative method is submitted to and approved by the Wisconsin DNR in advance. Additional information on conditionally recommended and alternative regeneration methods by cover type is also presented in the *Silviculture Handbook*. Procedures regarding management commitments can be found in Chapter 21 of the Wisconsin DNR *Private Forestry Handbook, 24705.21*.

FOREST COVER TYPES[1]	NATURAL REGENERATION METHODS							
	Coppice	Clearcut	Seed Tree	Overstory Removal	Shelterwood	Patch Selection (0.5 to 2.0)	Group Selection (0.1 to 0.5)	Single-tree Selection (less than 0.1 acre)
Jack Pine		GAP	GAP	GAP	X			
Red Pine			X	GAP	X			
White Pine			GAP	GAP	GAP	X	X	
Aspen	GAP	X		GAP				
White Birch	X	GAP[2]	X	GAP	GAP	X		
Oak	GAP	X		GAP	GAP	X		
Black Walnut			X	GAP	X	X	X	
Red Maple	GAP		X	GAP	GAP	GAP	GAP	X
Central Hardwood		X		GAP	GAP	GAP	GAP	
Northern Hardwood				GAP	GAP		GAP	GAP
Hemlock				GAP	GAP			GAP
White Spruce		GAP[2]	X	GAP	GAP	X	X	
Balsam Fir		GAP[2]	X	GAP	GAP	X	X	X
Black Spruce		GAP[2]	X	GAP	GAP	X	X	X
Tamarack		GAP[2]	X	GAP	X	X		
Cedar		GAP[2]	X	GAP	GAP	X	X	X
Swamp Hardwood	X	GAP[2]		GAP	GAP	X	GAP	GAP
Bottomland Hardwood	GAP	GAP[2]		GAP	GAP	X	GAP	

GAP.....(Generally Accepted Practice) Method generally accepted in Wisconsin and supported by literature. Applicability may vary depending on site quality, stand age and condition, ability to control competition, and other factors (e.g., herbivory). Refer to appropriate cover type chapters for application details. The generally accepted methods may not be reflected in some cover type chapters that have not been updated recently.

X.....Method may have potential for application.

1.....Natural regeneration methods apply to the cover type to be regenerated, not necessarily the currently existing cover type.

2.....Strip clearcutting generally recommended.

Table 2-1: Natural Regeneration Methods by Forest Cover Type for Wisconsin

SALVAGE HARVESTS

Figure 2-34: Forest management plans are often modified by natural disturbances like this major wind storm in a northern Wisconsin hemlock stand.

In addition to regeneration harvests employed as part of a silvicultural system, salvage harvests may be carried out as part of an overall forest management program. Unlike regeneration harvests, which are also designed to facilitate regeneration of the new stand, salvage harvests are geared only to the recovery and use of dead or dying trees that would otherwise go unharvested. Wind events, fire, flooding, insect and disease activity, and weather extremes can all wreak havoc on the best of forest management plans. High-quality trees can have significant economic value and often justify a salvage effort. Removal of infected trees is sometimes necessary to prevent additional mortality.

It should also be remembered, however, that dead and dying trees are part of the overall forest system, and provide a number of benefits to wildlife and other ecological processes. Decisions to conduct or not conduct a particular salvage operation are often a balance between potential economic return, impact on stand silviculture, risk of wildfire, cost of salvage, and the ecological value of leaving the trees in place. When mortality is significant, a regeneration strategy should be developed to facilitate regeneration, based on current conditions and landowner goals.

UNSUSTAINABLE HARVEST METHODS

A silvicultural system is a planned program of treatments over the life of a stand. Other cutting methods exist primarily to maximize short-term economic gain, and are not part of a long-term plan to ensure regeneration of a healthy, vigorous stand on a sustainable basis.

The following examples of unsustainable cutting methods are not an all-inclusive list. These methods may result in a new stand of trees, but due to the lack of consideration of specific species requirements, they often lead to stand degradation and are not considered generally accepted silvicultural practices that result in sustainable forestry.

- **Economic clearcutting**, where any tree of economic value is cut with no consideration for site, silvics of the species involved or regeneration needs. This practice differs from a clearcut in the even-aged silvicultural system where all trees are harvested, regardless of value, in order to ensure residual shade and competition does not hamper the regeneration and development of a new stand.
- **Diameter limit cutting** is cutting all trees above a set diameter regardless of the impact on stand structure, stand quality, tree quality, species composition, or regeneration needs. At times referred to as a "selective cut," the only consideration is diameter as opposed to specific criteria employed in a true single-tree selection harvest under the uneven-aged silvicultural system.
- **High grading** (Figures 2-35 and 2-36), also referred to as "selective logging," is the practice of cutting only the largest, most valuable trees in a stand and leaving low value and poor quality trees to dominate. This practice is NOT the same as a single-tree selection regeneration harvest described in the silvicultural systems section (see page 2-24). High grading is not designed to enhance the quality and reproductive potential of the residual stand, but does attempt to maximize immediate revenue. The term "selective logging" is sometimes used intentionally by unscrupulous loggers to create false expectations on the part of landowners.

It is emphasized that economic gain and sustainability ARE compatible. Using creativity and imagination in the application of sound silviculture will best achieve both goals in the long-run.

Figure 2-35: Before

Figure 2-36: After

Figures 2-35 and 2-36: The figures above depict the results of a typical "high grade." All the larger trees with the greatest economic value have been removed leaving only poor quality trees behind. No consideration was given to size and age distribution, residual stocking levels or regeneration needs.

(Figure Credits: Computer-generated simulation by Andy Stoltman)

MANAGEMENT PRESCRIPTIONS

As the previous sections of this chapter describe, the basic question of "what to grow and how to grow it" is not as simple as it may first appear. Indeed, the answer can involve the collection and evaluation of a great deal of information, and the consideration of a number of alternative strategies. **In the end, the question – "what to grow and how to grow it" – must be answered clearly, logically and completely.** This final step in the decision-making process can be compared to the last phase of designing a new home – the development of a blueprint which spells out in detail exactly how your vision transfers to clear, specific action. The silvicultural counterpart to that blueprint is a management prescription.

A **management prescription** or recommendation is a detailed description of a specific treatment or cutting scheme designed to implement a specific stand management objective. Prescriptions describe the individual activities necessary to implement the overall silvicultural system in a given stand.

A **forest management plan** is written for entire properties and identifies general landowner goals as well as other property and landscape information. The more detailed plans also identify specific stand management objectives, and the series of management prescriptions describing specific actions needed for all stands for an entire operational period (see Chapter 10: Forest Management Planning).

It is important that a management prescription reflect all relevant factors and be written in a clear, logical fashion. Less complex prescriptions are normally written in a narrative format. More complex prescriptions involving a number of interdependent activities with the outcomes of each leading to different pathways may include a decision tree or diagram (see Figure 2-37).

The development of a detailed management prescription for a given stand is a complex process. It requires a thorough understanding of the landowner's goals and objectives, silviculture, silvics, capabilities and limitations of the resource, and collection and evaluation of considerable vegetative and site data. Since each stand is unique, a forester and possibly other resource professionals should be involved to provide technical assistance.

MANAGEMENT PRESCRIPTIONS: FACTORS TO CONSIDER

1. Landowner's Objective

- Is it sustainable?
- Were all opportunities considered?

2. Assess Biological Characteristics

- Site capabilities
- Past disturbances
- Current vegetative condition and potentials (species composition and succession; stand structure, quality, and growth)
- Stand vigor
- Presence and severity of invasive plants, insects, and diseases

3. Consider Relevant Environmental, Cultural, Social, and Economic Factors Such As:

- Aesthetics
- Recreation
- Wildlife
- Biodiversity and presence of endangered species
- Water and soil quality
- Landscape scale issues (critical habitat, percentage of land in a cover type, etc.)
- Regulations (statutes, rules or local ordinances)
- Traditions (possibly related to ethnic heritage) and cultural resources
- Markets
- Community viability

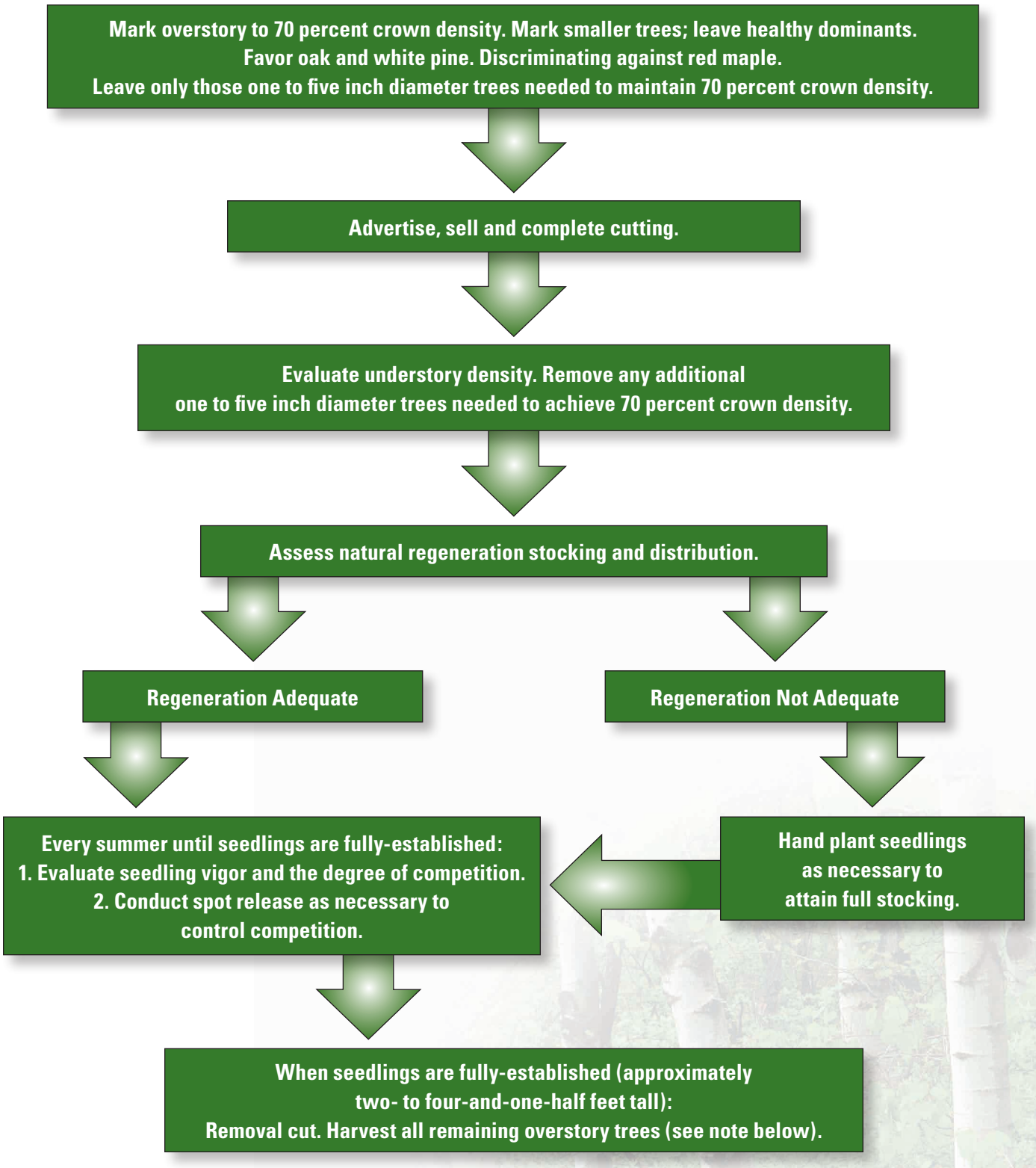


Figure 2-37: An example of a management prescription designed to implement a shelterwood regeneration harvest in a mature red oak stand. (NOTE: This particular management prescription has a strong timber management focus. To enhance sustainable forestry goals, a portion of the residual overstory (five to 15 percent) could be retained as reserve trees during the final removal cut to provide for a continuous supply of mast and increased habitat diversity.) There is a significant amount of flexibility available to tailor a silvicultural system to meet various needs as long as the primary objective to regenerate the stand is not compromised.

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

APPROACHES TO ECOLOGICALLY BASED FOREST MANAGEMENT ON PRIVATE LANDS

Approaches to Ecologically Based Forest Management on Private Lands. Kotar, J., University of Minnesota Extension Service, Publication NR-604, 1997.
www.na.fs.fed.us/spfo/pubs/misc/ecoforest/toc.htm

THE DICTIONARY OF FORESTRY

The Dictionary of Forestry. Helms, J. A. (Editor), Society of American Foresters, 1998.

FOREST DYNAMICS AND DISTURBANCE REGIMES: STUDIES FROM TEMPERATE EVERGREEN – DECIDUOUS FORESTS

Forest Dynamics and Disturbance Regimes: Studies from Temperate Evergreen – Deciduous Forests. Frelich, L. E., Cambridge University Press, Cambridge, UK, 2002.

NATURAL DISTURBANCE AND STAND DEVELOPMENT PRINCIPLES FOR ECOLOGICAL FORESTRY

Natural Disturbance and Stand Development Principles for Ecological Forestry. Franklin, J. F., R. J. Mitchell, and B. J. Palik, U.S. Department of Agriculture Forest Service, Northern Research Station, GTR NRS-19, 2007.
nrs.fs.fed.us/pubs/3293

THE PRACTICE OF SILVICULTURE: APPLIED FOREST ECOLOGY (9TH EDITION)

The Practice of Silviculture: Applied Forest Ecology (9th Edition). Smith, D. M., B. C. Larson, M. J. Kelty, and P. M. S. Ashton, New York: Wiley, 1996.

SILVICS OF NORTH AMERICA: 1. CONIFERS 2. HARDWOODS AGRICULTURE HANDBOOK

Silvics of North America: 1. Conifers 2. Hardwoods Agriculture Handbook 654. Burns, R. M. and B. H. Honkala (technical coordinators), U.S. Department of Agriculture Forest Service, Washington D. C., 1990.
na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm

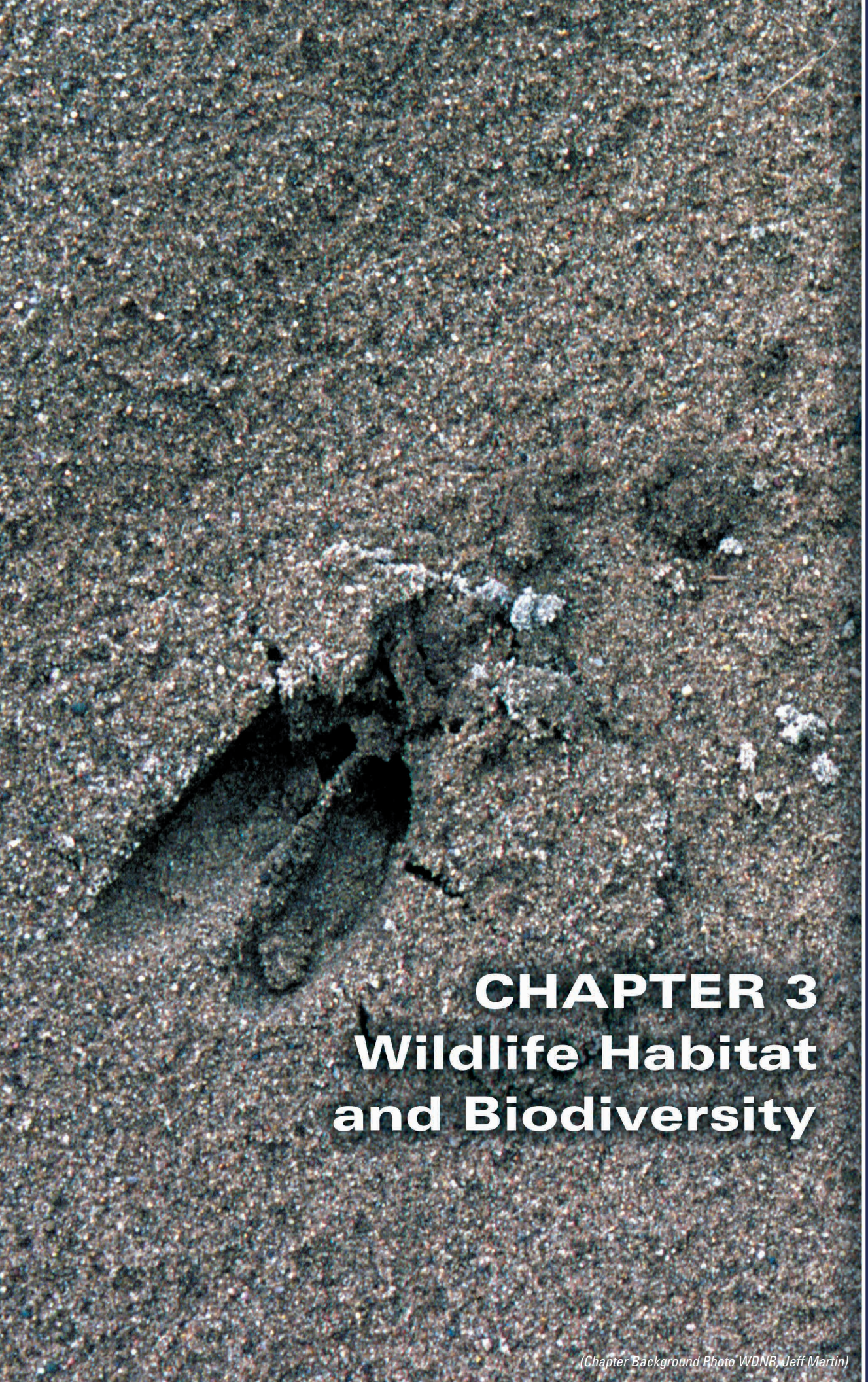
SILVICULTURE: CONCEPTS AND APPLICATIONS

Silviculture: Concepts and Applications. Nyland, R. D., New York: McGraw-Hill, 1996.

SILVICULTURE HANDBOOK

Silviculture Handbook. Wisconsin DNR, Publication Number 2431.5, Madison: Wisconsin DNR, 2010.
dnr.wi.gov – keyword "silviculture"

NOTE: Figures 2-12, 2-13, 2-15, 2-16, 2-17, 2-18, 2-28, 2-29, 2-35 and 2-36 use computer-generated simulations to depict various harvest methods listed in Table 2-1 (see page 2-32). The images were produced by Andrew Stoltman as part of the Forest Visualization at Multiple Scales for Management project at the University of Wisconsin-Madison, Department of Forest Ecology and Management.



3

CHAPTER 3
Wildlife Habitat and Biodiversity

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 3
WILDLIFE HABITAT AND BIODIVERSITY

Wisconsin supports a diverse natural heritage with almost 700 species of vertebrates, more than 2,000 native plant taxa, tens of thousands of invertebrates, more than 730 lichens, and numerous non-vascular plant species. Although not all of these organisms use forested habitats, Wisconsin forests provide important habitat for many of them.

Wisconsin is at the junction of two of North America's ecological provinces and provides a number of different forest types, habitats and niches for species to occupy. Each forest type occurs along a gradient of moisture, temperature, soil type, and climate creating the different habitats and niches for species. Each species associated with a forested habitat or niche contributes to ecosystem functioning and, in turn, larger ecosystem processes. For example, studies have shown that insect-eating birds reduce overall levels of foliage loss from insect populations. As a result, bird populations can affect larger ecosystem processes such as carbon storage or primary productivity. Therefore, loss of organisms or groups of organisms from an ecosystem can have much larger consequences on forest health and larger ecological processes. The challenge is to conserve all the working parts within a particular ecosystem in order to maintain ecosystem resilience when disturbances occur. Simplified forest ecosystems suffer more damage from forest pests and are more likely to have problems regenerating effectively. Some forest systems actually depend on disturbance. The challenge in these systems is to provide disturbances that mimic natural processes. For example, mimicking natural processes through silvicultural practices can set back succession, allowing forest stands to regenerate and renew.

The primary focus of this chapter is on forest-dependent terrestrial and amphibious forms of wildlife. The intent is to provide practical, science-based guidelines to address a number of specific issues and projected impacts relating to forestry and wildlife. The resource directory contains Wisconsin DNR and non-Wisconsin DNR contacts that can provide additional information on management of all wildlife species.

Certainly, more can be done to enhance wildlife habitat or individual species than the steps recommended in these guidelines. Furthermore, each management

Figure 3-1: A deer trail meanders through a frost-covered opening. The retention of openings, created during forest operations, can help provide a mix of habitat conditions for many wildlife species. Other species, including some that are rare, rely mostly on unbroken, contiguous forest.

practice, including the option to do nothing, will favor some species and hinder other species. As a result, it is not practical to provide a complete set of guidelines covering all possibilities for improving habitat in Wisconsin forests. Instead, these guidelines cover the essentials for addressing site-level issues related to forestry practices. Those interested in pursuing objectives that focus on wildlife habitats or natural communities are encouraged to consult a professional wildlife manager and/or ecologist for more information.

Remember that it is difficult to separate site-level and landscape-level issues. For wildlife, more than for other forest resources, what occurs on a site influences the surrounding landscape and vice versa. While the guidelines focus on the site-level as much as possible, some of the more important "landscape implications" will also be discussed. Landscape-level wildlife needs can best be addressed through professional planning for individual properties and cooperation among landowners and agencies within a landscape.

Finally, many wildlife habitat guidelines can be applied simultaneously. For example, leave tree clumps in clearcuts might also serve as rare species buffers, provide mast production, and enhance vertical structure. These overlapping benefits may extend to other forest resources as well, such as for cultural resource protection and visual quality. In other cases, retention of various structural habitat components may create issues like the reduction of visual quality or increase the potential for pest damage. Other chapters of this guide will address some of the trade-offs that should be considered.

SPECIFIC WILDLIFE HABITAT GUIDELINES

Leave Trees and Snags

Leave trees are individual trees or groups of trees left unharvested within a stand for reasons other than the purpose of regeneration. Snags are standing dead trees.

PURPOSE

The purpose of this habitat aspect is to provide for wildlife requiring perches, tree cavities, and bark-foraging sites through retention of suitable leave trees and snags on a site during forest harvesting and timber stand improvement. This guideline will also contribute to the continued presence of coarse woody debris on a site. For a more complete discussion of tree retention guidelines see Appendix A: Tree Marking and Retention Guidelines.

RATIONALE, BACKGROUND AND BENEFITS

In Wisconsin, up to 30 breeding birds, nearly 30 mammals, and several reptiles and amphibians use snags as breeding sites. Different species have adapted to different ecological conditions. Saw-whet owls utilize cavities in and around lowland conifer swamps, while red-headed woodpeckers nest in cavities in open or semi-forested conditions. The major issue for timber harvesting and cavity-dependent wildlife is whether suitable trees and nest cavities remain for these species following logging or timber stand improvement.

Retention of leave trees and snags during timber harvesting provides habitat for wildlife that require perches, tree cavities or bark-foraging sites as the surrounding forest regenerates. Leave trees can be left scattered throughout a harvest area or in clumps as illustrated in Figure 3-10 (see page 3-17). The distribution and density of leave trees and snags will affect which wildlife species benefit from the practice. Leave trees can also impact regeneration after harvest. Snags and leave trees may also provide unique niches and microsites for a variety of plants, especially within retained clumps. Leave trees or snags that fall over and decay will also benefit soil conditions as well as wildlife that utilize coarse woody debris.

The fundamental idea is to retain some structure for snag- and cavity-dependent species on a site, or maintain the potential to produce such structure as a stand grows and develops (see Chapter 13: Timber Harvesting, for specific recommendations on leave tree and snag selection and distribution).

Cavity and snag trees are important statewide and are lacking in many stands. Wildlife species that use cavities range in size from small mammals such as bats and mice, up to black bears. A range of tree sizes and species is necessary on a landscape scale to provide for the full use of this habitat feature.

Openland or brushland management may require felling of all stems to reproduce open conditions needed in these habitats. However, some openland wildlife species require cavities. For example, eastern bluebirds will nest in single, scattered snags in an open landscape. Generally, dead standing stems do not detract from the establishment or maintenance of openland/brushland habitat. However, they may provide structure for some undesirable wildlife species in some situations. In addition, if managing for openland species that are under severe predation pressure from raptors, consider removing all standing stems. If managing a site for oak savanna or pine/oak barrens habitats, some level of tree retention is needed to maintain the community type.

Figure 3-2: Snags provide ideal conditions for wildlife requiring perches, tree cavities and bark-foraging sites.

Figure 3-3: This strip of uncut pine provides a wildlife travel corridor through a clearcut area.

Cavity/snag trees are equally important in forested stands. There are a number of cavity-dependent species that require a larger forested acreage with sufficient canopy cover. Small mammals, bats and breeding birds that live in heavily forested areas also nest in cavities and use snags for foraging sites. Black-capped chickadees and tufted titmice are only two of a number of charismatic forest bird species that nest in cavities. When conducting an uneven-aged harvest or even-aged thinning it is recommended to retain snag and cavity trees (see Appendix A: Tree Marking and Retention Guidelines). Barred owls and pileated woodpeckers utilize large cavities and snag trees, while downy woodpeckers and chickadees utilize smaller trees. In addition to serving as nesting and foraging sites, these trees will also eventually topple and contribute to coarse woody debris on the forest floor, providing cover, food and growing sites for many species.

LANDSCAPE IMPLICATIONS

Although these guidelines address site-level recommendations for snags and leave trees, the contribution of an individual site should be considered in the context of the surrounding landscape. Many cavity-dependent species have home ranges larger than the typical harvest unit, so planning for their needs requires a broader look, both spatially and temporally, at the larger forest community. Many other species have smaller home ranges than the typical harvest unit.

Coarse Woody Debris and Fine Woody Debris

PURPOSE

The purpose of coarse woody debris and fine woody debris is to provide cover, food or growing sites for a diverse group of organisms through the retention or creation of woody debris during forest management. Coarse woody debris and fine woody debris include existing down pieces of trees and branches, as well as the tops and slash of harvested trees. Snags and leave trees retained for other wildlife benefits become coarse woody debris as they deteriorate and fall. For a more complete discussion of tree retention guidelines, see Appendix A: Tree Marking and Retention Guidelines.

RATIONALE, BACKGROUND AND BENEFITS

A wide variety of organisms benefit directly or indirectly from presence of woody debris. Small mammals dependent on downed logs and branches, in turn, provide food for mammalian carnivores and forest raptors (such as the pine marten and the broad-winged hawk). Amphibians such as wood frogs, four-toed salamanders, and red-backed salamanders utilize the cool, moist microsites created by woody debris as nesting/feeding areas.

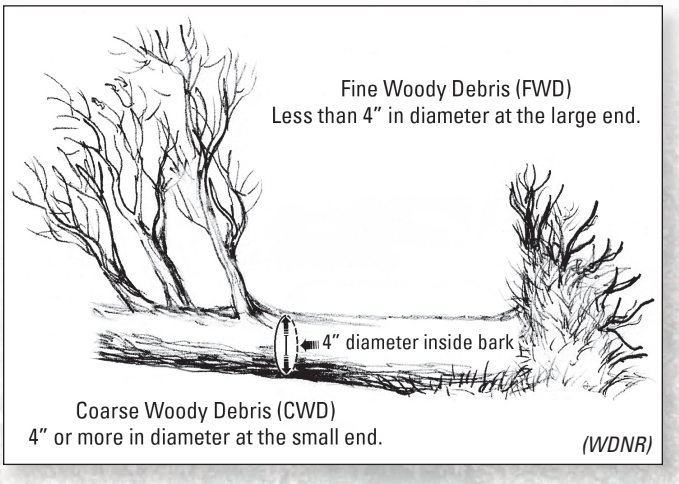


Figure 3-4: Generalized illustration of coarse and fine woody debris.

Figure 3-5: Coarse woody debris provides cover, food, habitat structure, and growing sites for many different animals and plants.

Woody detritus, like branches, twigs and leaves, reduces erosion and affects soil development, stores nutrients and water, is a major source of energy and nutrients, serves as a seedbed for plants, and is a major habitat for microbes, invertebrates and vertebrates. For example, yellow birch, white cedar and eastern hemlock regeneration is enhanced by woody debris. These tree species are important components of a diverse northern forest, and provide habitat for an untold number of vertebrate and invertebrate species. Bird researchers in northern Wisconsin found that hemlock dominated natural areas contained higher species diversity and richness than the even-aged managed hardwood sites that dominate much of the north.

The fundamental idea is to retain or enhance the amount of woody debris in a stand in order to benefit organisms associated with woody debris and to support nutrient cycles that benefit healthy forests (see Chapter 13: Timber Harvesting and *Wisconsin's Forestland Woody Biomass Harvesting Guidelines, Field Manual for Loggers, Landowners, and Land Managers*, for specific recommendations on woody debris).

Woody debris is important to forests and forest organisms statewide and is lacking in many stands. There are a number of species that utilize slash and coarse woody debris across the state. In northern Wisconsin, birds such as winter wrens and ruffed grouse utilize downed logs for nesting/feeding sites and for territorial displays. Blue-spotted and northern red-backed salamanders enjoy the moist, cool microsites provided by rotting logs on the forest floor. In southern Wisconsin, birds such as hooded warblers or Kentucky warblers may be taking advantage of the arthropods that live in and around coarse woody debris. Regardless of the location, coarse woody debris and slash is an important component of the forest ecosystem.

LANDSCAPE IMPLICATIONS

Although these guidelines address site-level recommendations for woody debris, the contribution of an individual site should be considered in the context of the surrounding landscape. Coarse woody debris left on a specific site may benefit reptiles and amphibians living there but breeding elsewhere. Thus, coarse woody debris placement might be influenced by off-site factors. For example, when managing a pine plantation, coarse woody debris may be important as a salamander migratory corridor between an adjacent hardwood forest and a wetland breeding site. However, if the pine plantation is bordered by other dry or arid cover types, and lacks wetlands of any type, coarse woody debris may not be important to salamanders at this site.

The size and position of intensive timber management may also determine the importance of coarse woody debris to associated organisms. For example, if a clearcut takes place surrounding a temporary wetland, coarse woody debris left in the clearcut and in the wetland would be essential habitat for breeding salamanders. Increased sunlight in the pond and harvested stand makes desiccation a problem for salamanders. Downed logs would provide cool, moist microsites enabling salamanders to avoid the desiccating effects of direct sunlight during the heat of the day. In addition, leaving downed logs would also provide drumming sites for ruffed grouse. However, if the clearcut was smaller and the wetland was bordered by older forest, coarse woody debris left in the clearcut may not be as important for salamanders, although, it still may perform other ecological functions important to the forested stand.

Conifer Retention and Regeneration

PURPOSE

The purpose of this aspect of habitat is to ensure diversity of wildlife habitat through the retention and regeneration of conifers for food, nesting and cover in mixed deciduous/coniferous stands. Conifers should continue to be a significant structural component in appropriate habitats and landscapes.

RATIONALE, BACKGROUND AND BENEFITS

Many wildlife species benefit from a mixture of conifer and deciduous trees and shrubs. Retaining young conifers, including isolated trees and scattered clumps, can provide habitat and food for many wildlife species, as well as a future seed source to promote conifer regeneration in harvested areas.

Various animal species including the great gray owl, bald eagle, pine warbler, white-tailed deer, elk, pine marten, snowshoe hare, and red-backed vole depend on coniferous stands for structural attributes. Others including spruce grouse, red-breasted nuthatch, red squirrel, porcupine, and elk – depend on food that coniferous stands provide. Deer and elk will often winter in conifer forests due to the reduced snow depths and thermal cover that these stands provide. Many species associated with the boreal forests of Canada reach the southern limits of their range in the coniferous and mixed coniferous forests of northern Wisconsin. Examples of these include American marten, fisher, Cape May warbler, Boreal chickadee, great gray owl, gray jay, and palm warbler.

Historically, conifers often existed as scattered trees or clumps within most of northern Wisconsin's hardwood stands, although parts of the state had more extensive conifer-dominated areas. Many of these conifers have been lost due to poor regeneration following early logging. A number of species are adapted to scattered overstory conifers or patches of conifer within a hardwood stand. Pine warblers are often heard singing from scattered overstory white pines that persisted or regenerated within an oak or maple forest. Bald eagles or osprey often use scattered supercanopy trees as nesting or roosting sites. Often aspen/birch stands in northern Wisconsin contain patches of regenerating or mature white spruce or balsam fir. Birds such as Cape May warbler, magnolia warbler and Canada warbler will locate territories in and around these coniferous patches. These dense areas of conifer also provide thermal cover for grouse, deer and other northern species during cold winters and warm summers.

Retaining conifers in clumps is preferable to scattered trees. Clumps are more windfirm, provide better cover, are better potential seed sources due to improved pollination, and can withstand snow and ice loads more successfully (see Table 3-1, page 3-7).

These guidelines are most applicable to the northern part of the state. Certain portions of west-central and central Wisconsin contain areas dominated or co-dominated by white and jack pine and may also benefit from these recommendations.

It is important to consider existing site conditions and silvicultural objectives when planning conifer retention and regeneration. Consult the Wisconsin DNR *Silviculture Handbook, 2431.5* or Wisconsin DNR staff for distributions of different conifer species within different ecological landscapes. Conifer regeneration and retention will work best if done in appropriate conditions and site locations. For example, retention and regeneration of pine, fir and spruce in aspen/birch stands would be most appropriate on the Superior Coastal Plain and other areas of northern Wisconsin that historically supported a mixed aspen/spruce forest type often referred to as Boreal Forest. Retention and regeneration of white or red pines might be most effective in places like the Northern Highland or Central Sands Ecological landscapes, where white and red pines once dominated forest canopies.

CONIFER SPECIES	EXAMPLES OF USES BY WILDLIFE
RED PINE	Mature red pine trees may be used by raptors for perches or nest trees. Its seeds are an important food source for winter songbirds and red squirrels. Larger stands of mature trees provide breeding habitat for red crossbills, pine warblers, Blackburnian warblers, and pine siskins. Mature stands with dense deciduous or coniferous understories can contain diverse breeding bird assemblages including some rare species.
WHITE PINE	White pine, when young, provides a good escape and severe winter cover for many species. It can also provide high calorie, large seeds often eaten by many small mammals and winter songbirds. Mature trees are important for cavity-dependent wildlife, preferred bald eagle nest trees, and escape cover for bear cubs. White pine can also serve as roosting trees for wild turkeys where present in central and southern Wisconsin.
JACK PINE	Young, well stocked stands of jack pine can provide great cover for a number of species. It is used as browse mostly by spruce grouse, but seeds are also eaten by red squirrels and red crossbills. Its persistent cones provide a year-round food source. Mature stands in northwestern Wisconsin are home to rare Connecticut warblers. The federally endangered Kirtland's warbler uses young stands and has recently been found nesting in Wisconsin, with individuals documented in at least five counties.
BALSAM FIR	Balsam fir is an important winter and summer cover for deer, elk and many species of birds. Birds eat its seeds and use them for nesting. When balsam fir is allowed to persist in hardwood understory, it is important nesting cover for black-throated blue warblers and other bird species and also provides good thermal cover for grouse and owls.
BLACK SPRUCE	Black spruce provides important escape and severe winter cover for wildlife. Birds such as white-winged crossbills eat its seeds and use individuals for nesting. Its buds and needles are important spruce grouse food. Stands of it often have diverse and abundant small mammal populations, which are important food sources for owls and other forest raptors. Black spruce wetlands contain many uncommon vertebrate and invertebrate species. Dead or dying trees often provide insects and snags for black-backed woodpeckers.
TAMARACK	Mature stands of tamarack provide excellent habitat for owls and other birds as snags are used as hunting and singing perches. Its seeds are eaten by small mammals, pine siskins and crossbills.
WHITE CEDAR	White cedar mast is an important food source for winter songbirds. It provides very important cover and browse for deer especially during severe winters. It can provide cover and a cooling effect near water.
WHITE SPRUCE	White spruce is an important seed source for winter finches. It provides summer nest cover for rare songbirds such as Cape May warbler and evening grosbeaks. It also provides thermal cover for owls and grouse.
EASTERN RED CEDAR	Eastern red cedar is important winter cover in southern Wisconsin. Its fleshy berry-like cones are used by birds for food.
HEMLOCK	Hemlock-dominated forests or mixed stands contain distinct breeding bird assemblages not found in hardwood forests. Mature trees provide important owl roosting sites. Hemlock mast is important to red squirrels and winter finches. It also provides important thermal cover for deer.

Table 3-1: Conifer Species and Examples of Use by Wildlife

LANDSCAPE IMPLICATIONS

Although these guidelines address site-level recommendations for conifer retention and regeneration, the contribution of an individual site should be considered in the context of the surrounding landscape. When discussing conifer retention and its importance to wildlife, landscape scale management can be very important. Many species that utilize coniferous or mixed/coniferous woods have much larger home ranges than the particular stand being considered for management; therefore, it is important to take into account neighboring properties. In other situations, scattered leave trees or clumps of conifer regeneration will provide wildlife benefits, even when isolated from similar conditions.

If the stand being considered for management is bordered by coniferous forest, or if the region contains a large percentage of coniferous/mixed coniferous forest, then conifer retention or regeneration will have a greater likelihood of benefiting those species with larger home range needs or area requirements. Species such as Blackburnian warblers, Connecticut warblers or Cape May warblers will use conifers retained in managed areas if these landscape conditions are met. Often, small songbirds such as these will nest in loose colonies where extra-pair matings are an important part of the breeding strategy. Larger patches of habitat will increase chances that this mating system will work.

If the stand being considered for management is isolated from appropriate coniferous or mixed coniferous habitat, it will be of lesser value to those species needing large areas of this habitat. However, as discussed previously, other species may utilize smaller patches of coniferous regeneration. For example, small patches of thick fir or spruce may harbor wintering ruffed grouse or saw-whet owls. Scattered white pine canopy trees can be important nesting areas for pine warblers or bald eagles.

Mast

PURPOSE

The purpose of this habitat aspect is to provide food for wildlife that utilizes mast, or fruit and seed, production from trees and shrubs.

RATIONALE, BACKGROUND AND BENEFITS

Many species of trees and shrubs have developed a seed dispersal system that benefits many species of wildlife. Producing mast in the form of nuts or berries encourages mammals such as squirrels or birds to eat or transport the seeds to other areas. Oaks may produce thousands of acorns in the hope that a blue jay or wild turkey will accidentally scratch one into the forest soil. Dogwoods and juneberries produce fruit attractive to migrating birds, which will pass the seeds to neighboring areas during migration. This complex reproductive strategy is essential to the inner workings of many ecological systems in Wisconsin.

High levels of fat, protein and carbohydrates in mast contribute to energy stores critical for migration or hibernation, and for survival of newly-independent young. Many birds that eat insects on breeding grounds will consume berries during fall migration. Yearly variations in mast production may impact subsequent reproductive success of many species. Often, plentiful mast production will lead to abundant small mammal populations, which in turn benefits forest carnivores that prey on small mammals. During winter, some sources of mast remain available to forest wildlife on trees and shrubs, under snow or stored in caches (see Table 3-2, page 3-9).

Mast production is generally favored by increased crown exposure to light, crown size, maturity of trees or shrubs, increased soil nutrients, tempered microclimates (especially during flowering), and adequate soil moisture. Production on a site tends to vary considerably from year to year.

Other considerations with respect to mast include:

- Mast-producing species often depend on animals for their dispersal and reproduction.
- Riparian edges often contain a higher concentration and richness of mast-producing species.
- Most shrub species will regenerate well and produce mast after cutting, burning or soil disturbance.

MAST SPECIES	EXAMPLES OF USES BY WILDLIFE
Oaks (acorns), beech and hazel nuts	Deer, bear, wild turkey, woodpeckers, blue jay, wood duck, squirrels, small mammals
Maple and ash seeds	Small mammals, evening and pine grosbeaks
Aspen, birch and hazel buds	Ruffed grouse
Yellow and white birch seeds	Common redpoll, pine siskin, American goldfinch
Conifer cones and seeds (such as white cedar, balsam fir, black spruce, white pine, common juniper, red cedar, Canada yew)	Red squirrels, white-winged and red crossbills, pine siskins, red-breasted nuthatch, pine grosbeak
Late summer soft mast (such as juneberries, blueberries, cherries, dogwoods, and elderberries)	Important to numerous birds and mammals as they prepare for migration and winter
Soft mast retained in fall and through winter (such as mountain ash, cranberry and nannyberry, winterberry)	Waxwings, pine grosbeaks, robin, and other bird and mammal species
Vines (such as wild grape)	Numerous bird and mammal species; bluebird, robin, cardinal, fox, raccoon, squirrels

Table 3-2: Examples of Mast-producing Plants that Will Benefit Wildlife in Wisconsin

Although certain dominant tree species (e.g., oak) are important for game species (e.g., deer or gray squirrels), other mast species also provide important benefits.

Retention of mast and other key food-producing tree types should be prioritized in accordance with the local abundance of each tree species. In areas of least abundance, greatest attention should be applied to retention. Planning silvicultural treatments to increase mast-producing trees should be performed in accordance with silvicultural guidelines laid out in the Wisconsin DNR *Silviculture Handbook, 2431.5* and Appendix A: Tree Marking and Retention Guidelines.

LANDSCAPE IMPLICATIONS

Although these guidelines address site-level recommendations for mast production, the contribution of an individual site should be considered in the context of the surrounding landscape. Land managers in regions with low mast availability have opportunities to enhance wildlife habitat characteristics by careful management of mast species on their land. Some wildlife species may travel significant distances to obtain mast. The black bear, for example, may travel 10 miles to obtain mast. Breeding birds will often relocate family groups to wetland edges or areas with increased levels of berries during late summer before migration.

Harvesting Patterns

PURPOSE

The purpose of this habitat aspect is to provide site- and landscape-level wildlife habitat requirements by using a variety of sizes and shapes of harvest areas. Understanding the impact from site-level management on the larger forested area will help land managers make better wildlife decisions.

RATIONALE, BACKGROUND AND BENEFITS

This management objective involves making silvicultural decisions on a landscape basis. Ideally, the management regime should range from the very fine-scale management represented by selection cutting to the coarse-scale management affected by sizable clearcuts. The size of clearcuts and other treatments should be determined by considering issues such as size of the management unit, the home range requirements of large animals, aesthetics, and natural disturbance regimes.

Although ownership considerations may preclude this, size and shape of both cut and uncut areas should mimic natural disturbance regimes such as wind, fire or disease that historically impacted the forest type to be managed. This will benefit the native species of plants and animals adapted to this forest type and

disturbance regime. Larger patch sizes historically occurred under natural disturbance regimes on even-aged, fire-dependent types such as jack pine forests and associated barrens habitats. Large clearcuts in such types can function for a short time as habitat for some area sensitive openland species such as sharp-tailed grouse and upland sandpipers.

These managed areas will be of even greater benefit to openland species if they are placed adjacent to more permanent open barrens. Colonization of new openland habitat created by forest management is more likely to occur if it is adjacent to existing populations of openland species. As the managed area ages, it will become less attractive to openland species, but other early successional species such as eastern towhees and brown thrashers will colonize the site.

Smaller patches are appropriate in more heterogeneous forest types such as deciduous forests on moraines. For example, northern mesic forests dominated by sugar maple, hemlock or beech were much more likely to undergo disturbance from wind than from large fires. Most wind events created smaller patchy canopy gaps within a larger forested matrix. Species like black-throated blue warblers nest within the thick regeneration generated by these disturbance events and could benefit from a silvicultural treatment that mimics this process in large forest blocks.

The shape and size of the cutting area determines the total amount of edge habitat created through management. An **edge** is defined as the transition area between two different forest types or successional stages. This transition zone can be "hard" (between a forested habitat and a field) or "soft" (between two age classes of forest habitat). "Hard" edges tend to be permanent, and may have more impact on wildlife than "soft" edges. "Soft" edges can also form as forest expands into open habitats. These "soft" edges differ from the regeneration found in canopy gaps by virtue of the amount and distribution of the regenerating age class. The amount and type of edge in a landscape will create conditions favorable for some species and detrimental to others. Many game species such as white-tailed deer and ruffed grouse, along with indigo buntings and chestnut-sided warblers, prefer the wide

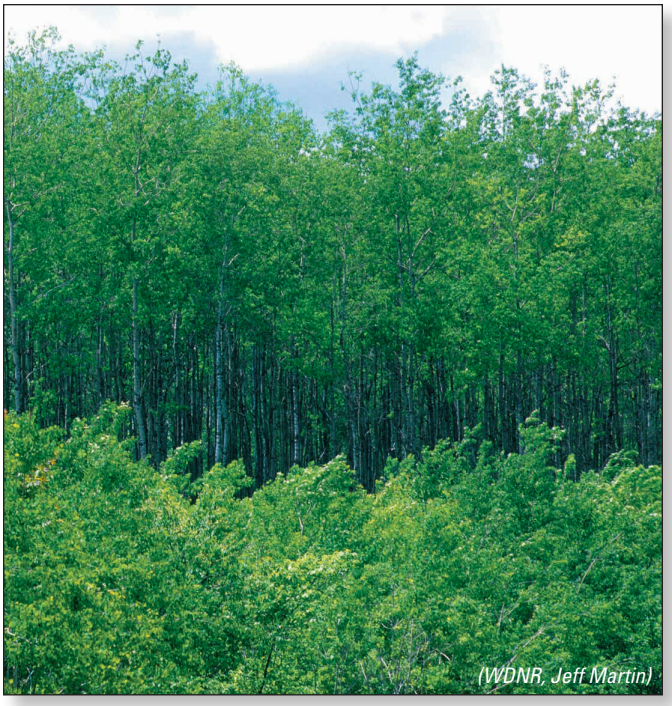


Figure 3-6: Two age classes of aspen, managed for grouse by clearcutting, illustrate the "edge" where two stands meet.

variety of cover and food resources found along forest edges and tend to be very good competitors for those resources. Landscapes with high amounts of natural or man-made edges tend to favor these edge species. However, many species of birds, some mammals and herps prefer the interior of larger (greater than 100 acres) blocks of forest. Cerulean warblers, Acadian flycatchers, hooded warblers, black-throated blue warblers, wood thrushes, and many other interior species are listed as endangered, threatened or special concern by the Bureau of Natural Heritage Conservation due to loss of appropriate habitat. A large increase in the amount of edge, through forest management activities or a natural disturbance in large blocks of forest, will increase edge species which will replace many interior species.

The soils, climate and geology of different locations across the state favor different types of forests. Each forest type and its associated wildlife are adapted to a particular disturbance regime. Ideally, forest management activities should take these disturbance regimes into account.

In general, more diverse and larger patch sizes are possible in northern Wisconsin than in the forest fragments of southernmost Wisconsin. Although there are notable areas with larger patches in the south such as parts of the Driftless Area and the Kettle Moraine, many of Wisconsin's southern forests have been converted to other uses, so special consideration should be given to conserving large patch sizes of existing forests in southern Wisconsin.

LANDSCAPE IMPLICATIONS

When employing large clearcuts, consider harvesting in segments over several years. This will provide both early successional diversity and, over the long-term, a large mature forest stand. Coordinate with adjacent landowners when natural stand boundaries cross property lines.

Endangered, Threatened and Special Concern (ETS) Species

PURPOSE

The purpose of this section is to increase awareness of ETS species and the need to maintain or enhance populations of these species. This section will also help to increase awareness of statewide forest policies to consider endangered, threatened and special concern species in the forest management decision-making process.

RATIONALE, BACKGROUND AND BENEFITS

By definition, ETS species are rare. The Wisconsin DNR tracks 978 species of animals, vascular plants, and non-vascular plants on the Natural Heritage Inventory Working List. Of these, 233 are listed as Endangered or Threatened and protected by the state's Endangered Species Law; the others are designated as Special Concern. Most of the animals on the Working List are also considered Species of Greatest Conservation Need from the Wisconsin Wildlife Action Plan.

Sustainable forestry includes consideration for rare (ETS) species and their habitats using the best information available. All species found in a natural forest play important roles in ecosystem health and function, and the Wisconsin DNR mission reflects the importance of maintaining biodiversity. Below are some of the reasons for considering the full suite of species in an area during planning and management activities:

- Conservation of species for their innate values.
- Conservation of rare species that play a critical role in ecosystem function.
- Conservation of nutrient recycling and soil enhancing animals and fungi.
- Conservation of natural disturbance regimes.
- Deter invasion by aggressive, nonnative invasive species.
- Conservation of genetic strains that are adapted to local climate and site conditions.
- Conservation of aesthetic and recreational values.
- Conservation of species that may produce economically-valuable products or provide eco-tourism benefits.
- Scientific and educational benefits.

PROTECTION AND MANAGEMENT

The presence of ETS species does not prevent most forest management activities. Often timber sales can accommodate rare species through modifications such as the timing of harvests, buffering nest locations, strategically locating gaps and residuals, locations of landings and roads, and careful planning of post-harvest treatments. The guidelines outlined throughout this chapter cover important forest characteristics that should contribute to many rare species habitats. As with other planning activities, considering both 1) a site's relationship to the surrounding landscape and 2) whether the site provides unique contributions to that landscape is important for biodiversity. Maintaining reserve areas in the state is critical, but how working lands are managed is just as important to Wisconsin's biodiversity as a whole.

Figure 3-7: Cavity trees enhance the quality of wildlife habitat.

Figure 3-8: Eagle nest in the top of a white pine tree. Leaving trees like this provide ideal sites for nesting.

Many forest endangered, threatened and special concern (ETS) species can be found in specialized habitats, some of which are easy to accommodate. Seeps, ephemeral ponds (vernal pools), cliffs, extensive bogs and other wetlands, older forests, and large blocks of southern Wisconsin dry-mesic and floodplain forests harbor many forested ETS species. Many species are localized in their distribution and may be known from only certain landscapes or sites within the state.

Existing research and monitoring provide some forest management guidance for rare vertebrates, although many questions remain unanswered, and treatments must be considered within the context of the surrounding landscape. Comparatively little is known about the impacts of timber harvest on rare plants, and many invertebrates lack even the most basic life history information, making management decisions challenging. Long-lived and slow-dispersing understory plants and invertebrates, especially those that have their optimum habitat in late-successional or older forest, may be particularly sensitive to timber harvests, so it is important to adequately monitor the effects of management wherever possible.

Forestry projects are subject to ETS species laws, and screening for ETS species can help projects comply with laws and conserve biodiversity. All projects that the Wisconsin DNR conducts, funds, or approves are screened (e.g., management plans and timber sales on Managed Forest Law [MFL] lands). Department foresters routinely use Natural Heritage Inventory data and other information to screen for potential impacts when writing management plans and setting up timber sales to comply with laws, Forest Certification requirements and department policy.

LEGAL PROTECTION

Endangered and threatened species are protected in Wisconsin by one or more of the following laws: the Federal Endangered Species Act of 1973 (Public Law 100-478), Lacey Act, Migratory Bird Treaty Act, Bald Eagle Protection Act, Wisconsin Endangered and Threatened Species Law (State Statute 29.604 and Administrative Rule NR 27), Protected Wild Animal Law (Administrative Rule NR 10.02), and the Wisconsin Non-game Species regulations (State Statute 29.039).

Other laws, both state and federal, may apply to the protection of plants and animals in the state. Specific information may be obtained from your local Wisconsin DNR office, or the Bureau of Natural Heritage Conservation Program. The Resource Directory at the end of the chapter has additional resources on ETS species.

PRIVATE LANDS FREQUENTLY ASKED QUESTIONS

1. What does it mean when rare endangered, threatened and special concern (ETS) species are found on my land? *It means you have land that is quite different from most properties in the state. Native species that have been eliminated elsewhere still find a home on your land. You may have some legal obligations, but there may also be some benefits.*

2. How do I know if there is a rare species on my land? *Wisconsin DNR or U.S. Fish and Wildlife Service biologists may be able to assist you in determining if rare species are present on your property. For properties in MFL, the department requires a search of the Natural Heritage Inventory Database when a forester develops a management plan or sets up a timber sale. Although this database is our best information source for occurrences of rare species, most private lands in Wisconsin have not been inventoried, so there may be rare species on your land that have not been documented.*

If rare species are found on your property, that information is shared with you but is otherwise confidential. The Wisconsin DNR wants to encourage and help landowners protect and manage for these rare species, while still respecting your rights as a private property owner. In addition, the federal government offers many flexible tools that promote the conservation of rare species, while accommodating the land use plans of the private landowner. You can get more information about the status and distribution of rare species, or learn what species or natural communities are known from Wisconsin through the Bureau of Natural Heritage Conservation at: ***dnr.wi.gov – keyword "NHC."***

3. How does a landowner benefit from the knowledge that an ETS species occurs on their property? *You learn from biologists what makes your property special. You may get help with managing the natural resources on your land. Several programs are in place that can provide tax advantages or cost-sharing for management.*

4. What is the difference between endangered, threatened and special concern species? *"Endangered" means the species is in danger of becoming extinct. "Threatened" means the species is less vulnerable, but could become endangered. There are separate state and federal threatened and endangered species lists. "Special Concern" species are also tracked by the Wisconsin DNR and are suspected to be in danger of becoming threatened or endangered, although there is not enough data to know for sure at this time. See the Wisconsin Natural Heritage Working List for more information at:* ***dnr.wi.gov – search "natural heritage working list."***

5. What if the species are plants? *Plants found on private property belong to the landowner, as plants are only legally protected on public lands or private lands where federal funds are used. Of course, the Wisconsin DNR wants to encourage protection of rare plants and help the landowner manage them, as they are important to the state's biodiversity. In addition, forest certification programs require rare plants to be accommodated in some way.*

6. What if the rare species are birds or other animals? *Because animals can travel freely from one property to another, they belong to everyone. State and federal laws determine what anyone can do with these species. Laws also protect nesting birds or turtles from being disturbed during the nesting season.*

7. Will I still be able to use my property for timber harvest or recreation? *Many ecosystem-based, sustainable forestry activities do not negatively impact threatened or endangered species. Many forms of recreation and land uses are also compatible with the protection of rare species. For example, managing white-tailed deer populations through hunting can be important for reducing deer damage to rare species and their habitat. Situations may arise when there are conflicts between recreation or land management practices and the protection of rare species, but there are usually workable solutions.*

Natural Communities, High Conservation Value Forests, and State Natural Areas

PURPOSE

The purpose of this section is to increase awareness of Wisconsin's natural communities, including both representative and rare types. The relationship between high-quality natural community examples – High Conservation Value Forest (HCVF) and State Natural Area (SNA) – are discussed.

RATIONALE, BACKGROUND AND BENEFITS

A **natural community** is an assemblage of plant and animal species occurring together at a given place and time. The Wisconsin Natural Heritage Inventory (NHI) uses a system based on groups of plant species that differs from other commonly used forestry classification methods such as cover types (based on dominant tree species) and forest habitat types (focused on potential climax species). Although designed for different purposes, all of these systems can be used compatibly.

The Wisconsin NHI Program was established in 1985 through state statute (23.27) to identify natural areas meeting a critical level of importance in the state. Although the NHI program regularly conducts surveys throughout the state, much of the state has not been surveyed for the presence of high-quality natural communities including most private lands.

High-quality natural community types are identified based on certain features such as size, context, condition, species present, and amount of disturbance. The NHI program uses standard methods for evaluating natural community quality. High-quality examples of many forested community types are scarce in much of the state, even for natural community types that are, themselves, widespread. For example, northern mesic forests cover much of northern Wisconsin, yet most examples lack older trees, coarse woody debris, undisturbed ground layer, and other structural characteristics. For some of Wisconsin's widely distributed community types, older developmental stages are becoming increasingly less common based on forest inventory data from the last 20+ years. High-quality natural communities are sometimes used to locate areas of potentially high biodiversity.

Rare natural community types are usually localized and can be geographically restricted to small portions of the state. There are only a few rare forested natural community types, and they often occur within larger forests or in close association with other more common types. Most examples of these types, unless thoroughly degraded, are inherently valuable to biodiversity because of their scarceness. Examples of rare natural community types sometimes associated with forests include oak openings, bedrock glade and algific talus slopes.

High Conservation Value Forests possess exceptional ecological qualities. High-quality examples of natural communities, rare natural communities, or areas of otherwise high importance to biodiversity are often primary reasons for identifying HCVFs in Wisconsin. Maintaining HCVFs on a property can be important for biodiversity, as well as for research, monitoring, and comparison to other nearby areas. Some HCVFs are managed using special ecologically-based objectives; others are designated as long-term reference areas such as Wisconsin's SNAs.

State Natural Areas are officially recognized tracts of land or aquatic natural features which have experienced the least intrusive levels of human disturbance. They contain outstanding examples of native biotic communities and are often the last refuges in the state for certain endangered, threatened and special concern species. SNAs may also include exceptional geological features. Wisconsin's SNAs and other reserve areas allow us to better understand the ecology of forests with little past disturbance, and they provide important "benchmarks" to compare to our managed forests. Many SNAs and reserves are maintained passively, while other sites are maintained by fire or with appropriate silvicultural techniques.

The presence of rare and high-quality natural communities, High Conservation Value Forests (HCVFs), and State Natural Areas (SNAs) can provide many benefits for landowners and citizens of the State:

- Protect habitat for endangered, threatened and special concern (ETS) species.
- Provide reference areas to compare the effects of more intensively managed areas.
- Provide opportunities for scientific research where natural processes are allowed to proceed essentially unimpeded.
- Provide opportunities for formal and informal education to gain an appreciation and understanding of biotic communities and their component species.
- Provide opportunities for practicing ecosystem management.
- Provide areas which are managed more intensively (barrens and savanna) or less intensively (late succession to old-growth forest) than normal sustainable forest practices.
- Protect significant geological features.
- Provide a reservoir of genetic and biological diversity.

FORESTED NATURAL COMMUNITY TYPES

The following are brief descriptions for Wisconsin's forested natural community types, along with some considerations for identifying areas with high conservation value. Old forests with trees beyond economic rotation age, especially in combination with other ecological features, are important conservation opportunities in all of the types because of their general rarity and continued decline. Size, context, condition, degree of impact by invasive species, and deer browse are important to consider for any of these types.

The presence of special microsites such as seeps, springs, ephemeral ponds, and cliffs contribute to the ecological value of a site. Although not described here, these features are often embedded within larger forested areas and can be accommodated during routine management of the surrounding stands.

These are only short descriptions meant to increase awareness. The reader is also encouraged to see the Bureau of Natural Heritage Conservation natural communities web page found at: ***dnr.wi.gov – keyword "biodiversity."***

- **Black Spruce Swamp:** Characterized as a conifer swamp with high canopy closure dominated by black spruce. Significant examples have intact hydrology, are large in extent, or are found in association with a diverse array of other wetland types.
- **Bog Relict:** This geographically limited community is found south of the tension zone in Wisconsin and is often dominated by tamarack. It can contain many of the more widespread bog species found in the northern half of the state. These relicts are typically isolated from each other and can contain rare species. Avoiding impacts to hydrology and avoiding isolation of these small communities are important conservation opportunities.
- **Boreal Forest:** A forested community dominated by white spruce and balsam fir, often mixed with white cedar, white pine and paper birch that is limited to areas near the Great Lakes. Mature examples are rare in Wisconsin, and old-growth examples are virtually non-existent except for a handful of relicts. Conservation opportunities will often require active restoration techniques to replace conifer species.
- **Central Sands Pine-oak Forest:** This geographically limited natural community is found in the Central Sand Plains Ecological Landscape and is characterized by a diverse canopy of red pine, white pine, several oak species, and red maple. The ground layer is sparse – mostly Penn sedge and blueberries. Large blocks and older age classes would be of highest ecological importance.

- **Floodplain Forest:** Also known as bottomland hardwoods, this type is found along portions of large rivers. Characteristic trees include silver maple, river birch, green ash, hackberry, cottonwood, swamp white oak, and formerly elms. These forests are very diverse and larger patches can provide habitat for numerous rare species. Ecologically important sites contain older trees with intact hydrology and upland buffers. The best examples would have relatively unrestricted flood pulse events.
- **Great Lakes Ridge and Swale:** This forested community complex is restricted to a narrow fringe along the Great Lakes, and formed on old dunes and beach ridges created during past high water events. It contains exceptionally diverse habitats and requires protection to maintain its ecological connections.
- **Hemlock Relict:** These are isolated hemlock stands occurring in deep moist ravines or on cool, north and east-facing slopes in southwestern Wisconsin. These relicts are very rare with extremely small opportunities for enhancement, expansion or reproduction. Unusual plants and animals have been documented in a number of stands. Existing remnants should be considered for special management designation.
- **Mesic Cedar Forest:** This is a rare upland forest community limited to few mesic sites in northern Wisconsin, characterized by white cedar as a co-dominant tree. Associates include hemlock, white spruce, yellow birch, and white pine. All stands of this type are rare and should be considered for special management designation.
- **Mesic Floodplain Forest:** A very rare natural forest community found on alluvial terraces of streams flowing into Lake Superior. This forest is characterized by typical northern hardwood in the canopy, but the ground layer has an exceptionally diverse spring ephemeral flora with many southern species expanding beyond their typical range limit. These rare isolated terraces should be considered for special management designation.

Figure 3-9: A bald eagle resting on a white pine branch in northern Wisconsin.

- **Northern Dry Forest:** This relatively common forest community of the northern sand counties is characterized by the presence of jack pine, Hill's oak and occasional red pine. Stands of special ecological interest are often generated after a catastrophic fire, have older age classes with many openings, and can be managed using prescribed fire. This community can occur in close association with Pine Barrens, a globally rare community type that harbors numerous endangered, threatened and special concern (ETS) species.
- **Northern Dry-mesic Forest:** A common forested natural community type dominated by various combinations of white pine, red pine, red oak, and red maple. Stands of special ecological interest are older, large in extent, and of natural origin with a special emphasis on those stands where continued fire management is possible.
- **Northern Hardwood Swamp:** This forested natural community is found along lakes, streams and isolated basins and is dominated by black ash, sometimes with significant components of red maple and yellow birch. Sites of special ecological interest are large blocks of mature forest with intact hydrology. This type is threatened by emerald ash borer, as black ash often comprises the majority of the overstory.

- **Northern Mesic Forest**: A broad natural community type that combines northern hardwood and hemlock cover types. This is the most common natural community type in the north. Stands with the most ecological significance are within large blocks and contain mature trees, numerous tip-up mounds, abundant coarse woody debris, and intact ground flora. The majority of the High Conservation Value Forests (HCVFs) examples currently maintained as State Natural Areas (SNAs) or with other special management designations are hemlock-dominated and not species rich. Mature, more mesic examples with a rich ground flora are conservation priorities for Wisconsin.
- **Northern Wet Forest:** Roughly equivalent to the swamp conifer cover type, this forest is dominated by black spruce, tamarack and occasionally jack pine in some parts of the state. Stands of special ecological significance are mature with a nearly continuous canopy and intact hydrology.

Figure 3-10: Numerous "islands" of uncut trees in this clearcut stand, along with scalloped edges, provide good wildlife habitat and improved visual impact after timber harvesting.

- **Northern Wet-mesic Forest:** Roughly equivalent to the white cedar cover type, this natural forest community is dominated by white cedar, but also has significant balsam fir, black ash and spruces in the canopy. Many uncommon species are associated with this type. Most stands have a special ecological significance due to the confounding effect of deer on white cedar regeneration. Until effective cedar replacement can be assured, most stands should be considered for special management emphasis to maintain the type on the landscape.
- **Oak Woodland:** Once relatively common on Wisconsin's landscape, this natural forest community roughly intermediate in structure between oak opening and southern dry forest, is now virtually non-existent. Ecologically significant sites are limited to active restoration efforts. Sites should be evaluated for canopy structure, remnant oak woodland ground layer species, and the potential for long-term fire management. Contact a department ecologist for assistance with site evaluations.
- **Pine Relict:** Similar to hemlock relict, these conifer dominated communities are found in isolated locations in the driftless area of southwestern Wisconsin. This natural community has red pine, white pine and occasionally jack pine as the dominants, and is found on sandstone or dolomite outcrops. Regeneration is often problematic and should be attempted only with great care. Large examples are of high conservation significance.
- **Southern Dry Forest:** This natural forest community represents the oak cover type found on dry, especially sandy sites. White oak and black oak are the dominants, and often red oak and black cherry are associates. Shrubs are well-developed and diverse. Sites with special ecological significance are large blocks of mature forest with standing and fallen dead trees. There may be good opportunities to manage these areas in close association with savannas, restored prairies, and surrogate grasslands.

- **Southern Dry-mesic Forest:** Most closely associated with the red oak or central hardwoods cover types, this natural community is dominated by red oak with significant inclusions of white oak, basswood, sugar maple, red maple, and white ash. Sites with special ecological significance are large blocks of mature forest with numerous tip-up mounds, cavities and coarse woody debris.
- **Southern Hardwood Swamp:** This natural community is associated with isolated basins in glaciated southeastern Wisconsin and was probably never widespread in Wisconsin. Common dominants are red maple and green ash, as American elm is now rare. This natural community is rarely found in an unmanipulated condition. Sites with special ecological significance are those with intact hydrology and few invasive exotics such as buckthorns, honeysuckle and reed canary grass common to many wetlands in this part of the state.
- **Southern Mesic Forest:** This natural forest community can be confusing, because it is analogous to the northern hardwood cover types. However, it's found primarily south of the tension zone and usually has much different ground layer species than northern hardwoods north of the tension zone. Stands with the most ecological significance are large blocks of mature forest with abundant coarse woody debris and few invasive species.
- **Tamarack (Poor) Swamp:** This natural community is a broken or closed canopy tamarack swamp growing under limited influence of mineral enriched water. Alder is a common associate in the shrub layer. The understory is more diverse than black spruce swamps and may include more nutrient-demanding species. The best example would be large and contiguous with an intact hydrology.

Figure 3-11: Coarse woody debris in riparian and upland forests provide great habitat for nesting and foraging salamanders, small mammals, and birds such as this Cape May warbler.

- **Tamarack (Rich) Swamp:** This geographically limited forested wetland community is found south of the tension zone. The relicts have many northern species and have sustained severe alteration due to water level manipulation. This natural community type is rare, often declining, and should be considered for special management designation.
- **White Pine/Red Maple Swamp:** This geographically limited swamp community is restricted to the margins of the bed of extinct glacial Lake Wisconsin. It often occurs along headwater streams and seepage areas on gentle slopes. White pine and red maple are the dominants. This very rare natural community has few examples in reserve or High Conservation Value Forest (HCVF) status, and more examples should be considered for special management designation.

FIELD SURVEY CONSULTANTS AND OTHER RESOURCES

The following resources may be able to assist in field surveys to identify High Conservation Value Forests (HCVFs) and rare natural communities:

- Wisconsin DNR natural areas staff, ecologists, heritage zoologists, heritage botanists, non-game specialists, forest ecologists, or wildlife managers (see the Resource Directory).
- Local wildlife biologists, foresters, park managers, or naturalists.

Ephemeral Ponds

PURPOSE

Ephemeral ponds within forests provide habitat for several animal and plant species.

RATIONALE, BACKGROUND AND BENEFITS

Wisconsin has an abundant variety of wetlands and the mixture of land and water features across the landscape provides an important dimension to the habitats of many wildlife species. Ephemeral ponds, a type of wetland, provide important habitat for many wildlife species in Wisconsin's forests.

Ephemeral ponds are more than puddles. They support populations of invertebrates that consume forest litter that falls into the depressions. Some invertebrates, such as fairy shrimp, are specifically adapted to the short-lived nature of these seasonal ponds and never leave a particular pond. Invertebrates found in ephemeral ponds provide food for birds, mammals, amphibians, and other species that are sought after by larger animals. Red-shouldered hawks, a threatened species in Wisconsin, often chooses forested areas that contain a number of ephemeral ponds to ensure an adequate supply of prey for rearing young. Ephemeral ponds also provide an important source of spring food for breeding waterfowl and migrating birds.

Amphibians are important components of many forest ecosystems, and many depend on ephemeral wetlands for breeding habitat. These temporary or seasonal wetlands are important to amphibians because they do not contain fish populations which prey on salamander eggs. Blue-spotted and spotted salamanders will enter these ephemeral wetlands as soon as they lose their ice cover in spring. Pay attention to roadsides during the first warm rain of spring, and you will literally see the forest floor crawling with salamanders traveling to breeding sites. Five species of frogs are also heavy users of wetland inclusions. Anyone who has walked along a forest road at night can recall the croaking of wood frogs, the peeping of spring peepers, and the distinctive notes of chorus frogs. Frog songs can be so loud in these ephemeral ponds that they block out all other sounds. Later in the spring and early summer, Cope's and eastern gray tree frogs use these wetlands for breeding. Because of the high biomass of amphibians in forested habitats, they are extremely important both as predators of invertebrates, and as prey for other forest wildlife species. Some amphibians have been shown to demonstrate high site fidelity and often return to the same breeding pond.

Ephemeral ponds are easiest to identify in spring when they are full of melt-water from the spring runoff. Frogs calling in spring, vegetation, or topography might provide additional clues to their location.

Applying guidelines for water quality and retaining leave trees, snags, coarse woody debris, and slash during forest management activities provides key habitat features (including woody debris, litter depth and plant cover) in these areas, while preventing siltation, excessive warming, or premature drying-up of ephemeral ponds. Providing coarse woody debris in the stand surrounding a pond can provide valuable habitat for amphibians. Deepening ephemeral ponds to enhance water retention is usually not advisable. Digging deeper in sandy or loamy soils can cause the pond to drain quickly after frost leaves the soil. Deeper pools will sump the wetland as water levels subside, reducing surface area and wetland size.

THE NEED FOR RESEARCH AND MONITORING

Even though the ecological importance of ephemeral ponds has become nationally well-recognized, the total number and location of all such wetlands in Wisconsin's forests is unknown. Existing inventories, such as the National Wetland Inventory, are incomplete with regard to wetland inclusions. Furthermore, ephemeral ponds are sometimes difficult to recognize in the field. Uncertainty regarding the abundance and location of ephemeral ponds indicates the need to document their occurrence, and further research their role in forest ecology in Wisconsin.

EPHEMERAL PONDS

- **Ephemeral ponds** are also called seasonal ponds or vernal pools.
- Ephemeral ponds are wetland depressions that temporarily hold water in spring, early summer and after heavy rains. They typically dry up by mid to late summer.
- Ephemeral ponds do not have an inlet or outlet, and are not connected to lakes or streams.
- Ephemeral ponds do not support fish, offering important habitat for many amphibians.

Important clues for identifying ephemeral ponds include:

- An identifiable edge caused by annual flooding and local topography, usually with sparse vegetation in the depression itself.
- Standing water during the spring or fall, but it may be identified during dry periods by the lack of forest litter in the depression, or water stains or a layer of sediment on leaves.
- Wetland plants, like black ash and marsh marigolds, can sometimes be found in or around the depression.

NOTE: Replenished annually, leaf litter is consumed during inundated periods, and noticeably depleted thereafter. Deciduous litter will likely be consumed faster and more thoroughly than conifer litter.

Riparian Wildlife Habitat

PURPOSE

The purpose of riparian wildlife habitat is to provide site-level wildlife habitat features for species that utilize riparian ecosystems.

RATIONALE, BACKGROUND AND BENEFITS

Riparian areas are among the most important parts of forest ecosystems. These areas have high plant diversity, both horizontally and vertically from the water's edge, which contributes to the high diversity of animals that live in these areas. Up to 134 vertebrate species occur in riparian forests in this region, but many of these species will also use non-riparian forest habitat. The species that are of most concern in riparian areas are "obligate" species, which require both the water and surrounding forests as habitat. In Wisconsin, obligate riparian species include amphibians, reptiles, birds, and mammals. Numerous plant and invertebrate species are also strongly associated with these habitats. Different animals are associated with different stream sizes. In general, larger animals are associated with larger streams and smaller species with smaller streams. A reverse pattern is found in some salamanders.

Although some degree of mature forest cover is desirable along many riparian areas, all habitat conditions are valid, given long-term disturbance regimes. Some wildlife species, such as woodcock, require dense woody cover that can be provided by young forest or shrub cover in riparian areas. The greatest concern for riparian habitats is in areas of the state where uplands have been converted to agriculture. This situation occurs more in the southeastern and western portions of the state rather than in the north, which affords more flexibility in age classes, structures and cover type (see Chapter 5: Riparian Areas and Wetlands, for specific BMPs and harvesting criteria for riparian zones).

Figure 3-12: Wild lupine in central Wisconsin; the Karner blue butterfly's only known larval food plant. The Karner blue is listed as an endangered species, even though they are relatively abundant in parts of Wisconsin.

Forest streams come in many sizes, growing from spring-fed trickles to large rivers as they move downhill, and converge with one another to drain larger and larger watersheds. Along this gradient, the ecological characteristics of a riparian area change in a gradual continuum. Because of these characteristics, management guidelines for riparian areas in general should be considered on a landscape level.

It is important to keep in mind the following wildlife-related concerns for riparian habitats:

- **Mast**
  - Riparian edges often contain a higher concentration and richness of unique mast species, especially shrubs, than adjacent upland areas. It is well-documented that riparian areas are critical migratory stopover locations for birds that winter in the Neotropics. These areas often have more insect life in the spring before leafout than associated uplands. In the fall, dogwoods, nannyberry, wahoo, honeysuckle, elderberry, and other mast-producing shrubs and trees provide nourishment to birds migrating south and other species preparing for winter.
- **Leave Trees and Snags**
  - Prothonotary warblers, tufted titmice, wood ducks, and a number of other species are dependent on existing cavities in riparian forests. Woodpeckers and chickadees select dying or diseased trees in which to excavate cavities. It is important to leave existing cavity trees and potential snags for use by the many cavity nesters that utilize riparian forests.
  - Some riparian species require large super-canopy trees (trees above the existing canopy) for hunting perches and nesting sites. On larger rivers, osprey will often perch in a large, dead white pine above a river to look for prey.
  - Shade is essential for maintaining microhabitat conditions for some riparian animals. Winter wrens, northern waterthrushes and many salamanders like the cool, moist conditions created by a closed canopy riparian forest. Yellow warblers, willow flycatchers and some herps need more open riparian conditions. Providing a range of seral stages where appropriate will benefit a number of riparian species.
- **Coarse Woody Debris and Slash**
  - Many riparian animal species require downed logs for cover. Downed logs and slash in riparian areas provides additional microsites for insects and the species that prey on these insects. Salamanders, frogs and small mammals utilize these large logs as travel routes to avoid predation.

Figure 3-13: Large blocks of older forest are important to forest interior species such as this cerulean warbler.

- **Endangered, threatened and special concern (ETS) Species**
  - Many ETS species are found in riparian areas.
  - Many of the bigger blocks of forest in the southern half of Wisconsin occur in riparian zones along the larger rivers. These are important areas for forest interior species such as red-shouldered hawks, cerulean warblers, Acadian flycatchers, yellow-throated warblers, yellow-crowned night heron, and a host of other species found in the southern half of the state.
  - High-quality streams and rivers are important habitat for many rare dragonflies, fish, mussels and clams, and other invertebrates. Often the presence of these species is used to evaluate stream health. The middle St. Croix, middle and lower Chippewa, and lower Wisconsin are good examples of riparian systems that host many rare species.

- **Natural Communities and Sensitive Sites**
  - Many natural communities are associated with riparian ecosystems. Some, like floodplain forests, are always associated with riparian areas. Others such as northern sedge meadow, emergent aquatic and alder thicket are often associated with riparian areas, but can also be found in other situations. For a complete listing and description of natural community types in Wisconsin, see the Natural Heritage Conservation Program's natural communities web page at: ***dnr.wi.gov – keyword "biodiversity."***

These guidelines are applicable statewide.

LANDSCAPE IMPLICATIONS

In areas dominated by agricultural landuse practices (in southern and east-central regions), where riparian forests represent the majority of the forests in the area, consider using uneven-aged management. Most rare species associated with these forests require high-canopy closure and large blocks of forest.

ETS SPECIES ASSOCIATED WITH RIPARIAN ECOSYSTEMS

- Red-shouldered hawk[2]
- Cerulean warbler[2]
- Yellow-crowned night-heron[2]
- Western ribbonsnake[2]
- Yellow-throated warbler[1]
- Blanchard's cricket frog[1]
- American bullfrog[3]
- Prothonotary warbler[3]
- Smooth softshell turtle[3]
- Eastern Massassauga rattlesnake[1, 4]
- Many rare mussels and clams
- St. Croix snaketail, splendid clubtail and a host of other rare dragonflies
- Numerous other plants, snails and invertebrates
- Osprey[3]
- Acadian flycatcher[2]
- Wood turtle[2]
- Great egret[2]
- Bald eagle[3]
- Many rare fish species

1 Endangered – 2 Threatened – 3 Special Concern – 4 Candidate for Federal Listing

Figure 3-14: This stand of red pine has been thinned three times, and the shrub layer resulting from increased sunlight reaching the forest floor now provides good wildlife habitat.

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

ADDITIONAL RESOURCES ON ENDANGERED, THREATENED AND SPECIAL CONCERN (ETS) SPECIES INCLUDE:

- Natural Heritage Inventory Working List for Wisconsin ***dnr.wi.gov – keyword "NHI"***
- Natural Heritage Conservation Program web pages, especially the Species and Communities pages ***dnr.wi.gov – keyword "biodiversity"***
- *The Ecological Landscapes of Wisconsin* contains a great deal of useful information for applying ecosystem management in each of Wisconsin's 16 Ecological Landscapes. ***dnr.wi.gov – keyword "landscapes"***
- The Wisconsin Wildlife Action Plan lists the Species of Greatest Conservation Need in Wisconsin and the natural communities and Ecological Landscapes that are important for each species. Important "Conservation Opportunity Areas" have also been identified using information from the plan. ***dnr.wi.gov – keywords "wildlife action plan"***
- Nature centers, colleges and universities, and University of Wisconsin-Extension offices
- Local Wisconsin DNR biologists, ecologists, conservation wardens, foresters, park managers, or naturalists

FOREST AND BIODIVERSITY BOOKS

These publications describe important ecological concepts as they relate to forest management. They are excellent references for either the practicing forester or biologist and include ways to provide for biodiversity within the context of a working landscape.

- *Conserving Forest Diversity: A Comprehensive Multiscaled Approach.* Lindenmayer, D. B. and Franklin, J. F., Washington: Island Press, 2002.
- *Maintaining Biodiversity in Forest Ecosystems.* Hunter, M. L., Jr. (Editor), Cambridge, England: Cambridge University Press, 1999.
- *National Commission on Science for Sustainable Forestry*. National Council for Science and the Environment, Washington D. C., 2007. Conserving biodiversity through sustainable forestry. ***www.ncseonline.org/NCSSF/***
- *Wildlife, Forests, and Forestry: Principles of Managing Forests for Biological Diversity (2nd Edition).* Hunter, M. L., Jr. and F. Schmiegelow, 2010: Prentice-Hall, In Press: Englewood Cliffs, New Jersey.

HERPS OF WISCONSIN BOOKS

These publications provide an overview of biology and conservation, including a description and brief habitat information for amphibians, snakes, turtles and lizards of Wisconsin.

- *Amphibians of Wisconsin.* Bureau of Natural Heritage Conservation, Publication Number ER-105 2009, Wisconsin DNR, Madison, Wisconsin, 2009.
- *Snakes of Wisconsin (2nd Edition).* Wisconsin DNR Bureau of Natural Heritage Conservation, Publication Number ER-100 2008, 2008.
- *Turtles and Lizards of Wisconsin.* Wisconsin DNR Bureau of Natural Heritage Conservation, Publication Number ER-104 2002, 2002.

NATURAL HERITAGE CONSERVATION PROGRAM WEB PAGES

Housed on the Wisconsin DNR website, these pages provide a wealth of information on rare species, natural communities, the State Natural Areas Program, invasive species, the Wisconsin Wildlife Action Plan, and Bureau of Natural Heritage Conservation related news and events. These pages can be found at: ***dnr.wi.gov – keyword "NHC."***

A subset of these pages contain life history and identification tips for numerous species, descriptions of natural community types, county-level occurrence maps, and links to related information can be found at: ***dnr.wi.gov – keyword "biodiversity."***

These pages have replaced several earlier printed publications and are now the department's primary source of information for rare species and natural community information for department staff and the general public.

NATURAL HERITAGE INVENTORY DATA

The Wisconsin Natural Heritage Inventory (NHI) database contains status and distribution information for rare species and high-quality natural communities. Access to NHI data requires a license agreement with the department. There are also ways to access general NHI data for information and general planning purposes. General data are not sufficient for regulatory purposes. For more information on NHI data, see the department web page entitled "Accessing NHI data" ***dnr.wi.gov – keywords "NHI data."***

RUFFED GROUSE SOCIETY

For information on the management of forest habitats for ruffed grouse and other wildlife species, contact

The Ruffed Grouse Society
451 McCormick Road
Coraopolis, PA, 15108
Phone: 412-564-6747
www.ruffedgrousesociety.org

VERNAL POOLS: NATURAL HISTORY AND CONSERVATION

Vernal Pools: Natural History and Conservation. Colburn, Elizabeth, 2004. This book provides excellent background on the ecology of vernal pools in one comprehensive source. Numerous materials are also available on the web, including guidelines that have been developed and are in use by several states in the northeastern United States.

WILD TURKEY: ECOLOGY AND MANAGEMENT IN WISCONSIN

Wild Turkey: Ecology and Management in Wisconsin. Bureau of Science Services, Wisconsin DNR, Madison, Wisconsin, 2001. This publication gives a complete account of wild turkey re-introduction, management and ecology in Wisconsin. Landowners interested in managing their land for wild turkeys should consider this source as a definitive guide to wild turkey biology in Wisconsin.

WILDFLOWERS OF WISCONSIN AND THE GREAT LAKES REGION

Wildflowers of Wisconsin and the Great Lakes Region: A Comprehensive Field Guide. Madison, Wisconsin: University of Wisconsin Press, 2009. This guide contains more than 1,100 species of flowering plants, including many rare species. County-level range maps are provided for each species. These maps are a great companion to the Flora of Wisconsin: Consortium of Wisconsin Herbaria website and are small enough to carry.
wisflora.herbarium.wisc.edu/

WILDLIFE AND YOUR LAND: A SERIES ABOUT MANAGING YOUR LAND FOR WILDLIFE

Wildlife and Your Land: A Series About Managing Your Land for Wildlife. Wisconsin DNR Bureau of Wildlife Management. This source served as the foundation for many wildlife issues covered in this chapter of the *Forest Management Guidelines*. This collaborative effort focuses on different management issues land managers and owners should consider when managing their property. Available in hardcopy or online at:
dnr.wi.gov – keywords "wildlife and your land."

WISCONSIN BREEDING BIRD ATLAS WEBSITES

- This website displays the results of the Wisconsin Breeding Bird Atlas performed from 1995 to 2000 on private and public lands across the state.
  www.uwgb.edu/birds/wbba/

- This website displays the results of the Wisconsin Breeding Bird Atlas II performed from 2015 to 2020 on private and public lands across the state.
  wsobirds.org/atlas

These websites are a good source of information for the range and distribution of bird species within the state. They will generate a species list by quad or county, and also contains pictures of the species that could be used in identification.

WISCONSIN STATE HERBARIUM AND FRECKMANN HERBARIUM WEBSITES

This website contains online herbarium records for all plants found in Wisconsin. Search for plants by species, genus, family, common name, or many other characteristics. Each species description contains information on location, habitat, photos, and a floristic rating. The Wisconsin Herbarium site also contains links to the Atlas of the Wisconsin Prairie and Savanna Flora, the Lichens of Wisconsin, and other web resources. Rare plant locations are only given to the county level. ***www.botany.wisc.edu/wisflora/***

This website is an excellent companion to the Bureau of Natural Heritage Conservation web pages which can be found at: ***dnr.wi.gov – keyword "biodiversity."***

WISCONSIN WILDLIFE ACTION PLAN

Wisconsin Wildlife Action Plan. Wisconsin DNR, 2015. Wisconsin's Wildlife Action Plan (WWAP) identifies the native Wisconsin animals in greatest need of conservation, along with the habitats (natural communities) and places (Ecological Landscapes) they use.

The plan is part of a nationwide effort to outline steps needed to conserve wildlife and habitat before they become rarer and more costly to protect. The plan is available online, and a variety of tools have been developed to allow users quick access to information from the plan: ***dnr.wi.gov – keywords "wildlife action plan."***

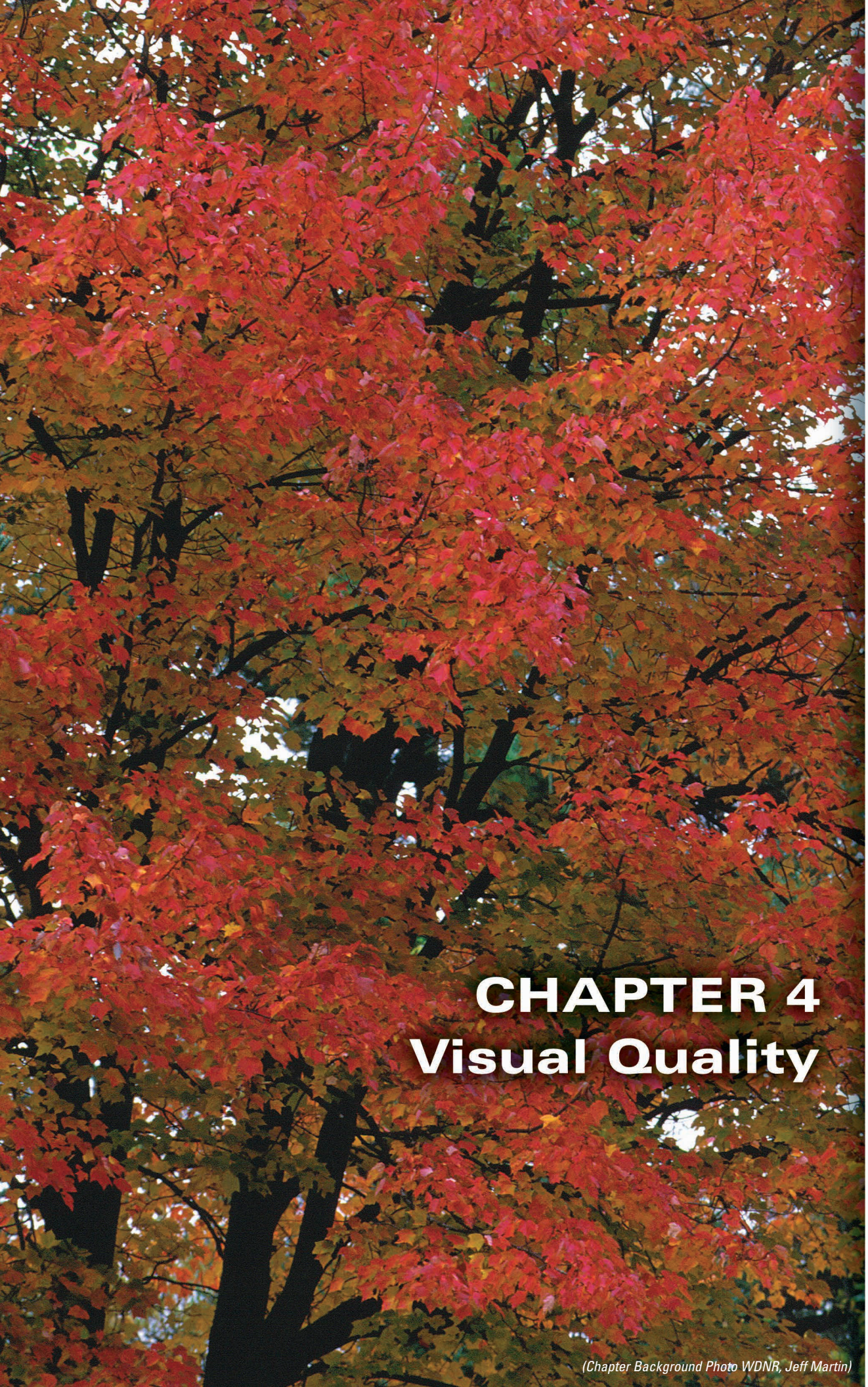
WISCONSIN'S BIODIVERSITY AS A MANAGEMENT ISSUE

Wisconsin's Biodiversity as a Management Issue. Wisconsin DNR, 1995. This report was written for Wisconsin DNR managers to provide a context for their work. This report is a good general source for information on the landscape surroundings on a given property, and provides an overview on the issues and implications of Wisconsin's rich biotic heritage as well as the ecological, social and economic issues tied to each major community type.

WOODCOCK MANAGEMENT PLAN

This online resource provides a national plan for woodcock recovery, as well as regional initiatives. Specific county targets for habitat restoration are included, and general guidelines for habitat management are provided.
timberdoodle.org/

NOTES



4

CHAPTER 4
Visual Quality

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 4
VISUAL QUALITY

THE VALUE OF VISUAL QUALITY

A Concern for Aesthetic Quality

Concern about the aesthetic quality of forested lands throughout the state is a great source of pride for Wisconsin citizens. Scenic beauty – or "visual quality" – is one of the primary reasons people choose to spend their recreation and vacation time in or near forested areas. They are also attracted by the peace and quiet of the outdoors – the serenity, the solitude, and a host of other emotional, spiritual and sensory responses that make up the richly aesthetic and deeply personal experience that is so closely tied to time spent in or near our forests.

Wisconsin forests are particularly vital to the health of two industries: tourism and forest products. Many of the demands on the forests from these two industries are compatible and even complementary. See Chapter 13: Timber Harvesting for specific techniques to balance timber harvesting and visual quality.

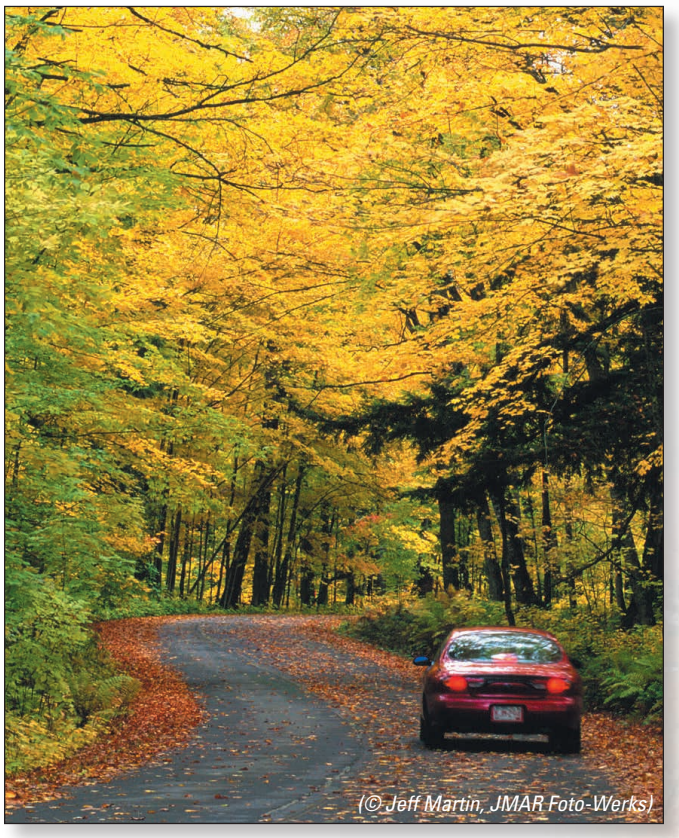


Figure 4-1: The "most sensitive" level applies to those travel routes where significant public use occurs, and where the visual quality is of high concern to all typical users.

Figure 4-2: Scenic quality is one of the primary reasons people choose to spend their recreation time in or near forested areas.

Figure 4-3: Trilliums in Oneida County.

Benefits of Visual Quality Management

Visual quality is one important aspect of the broad, multi-faceted concept of integrated forest resource management. Visual quality management can:

- Enhance the visual quality of forested lands for recreational users which results in a healthy tourism economy.
- Enhance public acceptance of forest management and timber harvesting, therefore, helping to sustain a healthy forest products industry.
- Minimize the visual and audible impacts of forest management activities on tourists and other recreational users.
- Minimize the visibility of harvest areas by limiting apparent size of harvest.
- Minimize the visual impact of slash.
- Minimize the impact of landing operations on recreational viewers and users.

Figure 4-4: Careful planning and control of the logging operation can have a major impact on the visual quality following a timber harvest.

Figure 4-5: Slash from pine harvests is much smaller in size than hardwood tops and limbs. Slash from mechanical harvesting, commonly used in pine, aspen and birch, is usually compacted by the processing machine.

Figure 4-6: This "hedge" of common buckthorn creates a solid wall of vegetation completely disrupting any view of the forest. Consider nonnative invasive plants during management activities as they can greatly decrease visual quality of forests.

- Minimize the visual contrast created by broken or leaning trees or extensive areas of dead trees.
- Reduce the visual impacts associated with the design and use of forest access roads.
- Reduce the visual impact of site preparation practices, and reduce the time that the effects of these practices are visible.
- Promote more natural-appearing stands.
- Enhance the aesthetics of visual management areas by minimizing visual impacts of timber stand improvement activities.
- Reduce the visual impacts of treated vegetation.
- Reduce noise and unsightliness related to gravel pits.

Figure 4-7: Untreated logging slash, such as these walnut tops, takes longer to decay and is often objectionable to landowners. Lopping of tops or harvesting firewood may provide a solution.

Figure 4-8: Large, unbroken clearcuts along well-traveled roads are often viewed by the public as unsightly, at least until the new regeneration becomes established on the site.

Figure 4-9: This aerial view shows a mosaic of pine and aspen stands with scalloped boundaries in a portion of the Northern Highland State Forest that is managed to enhance aesthetic quality.

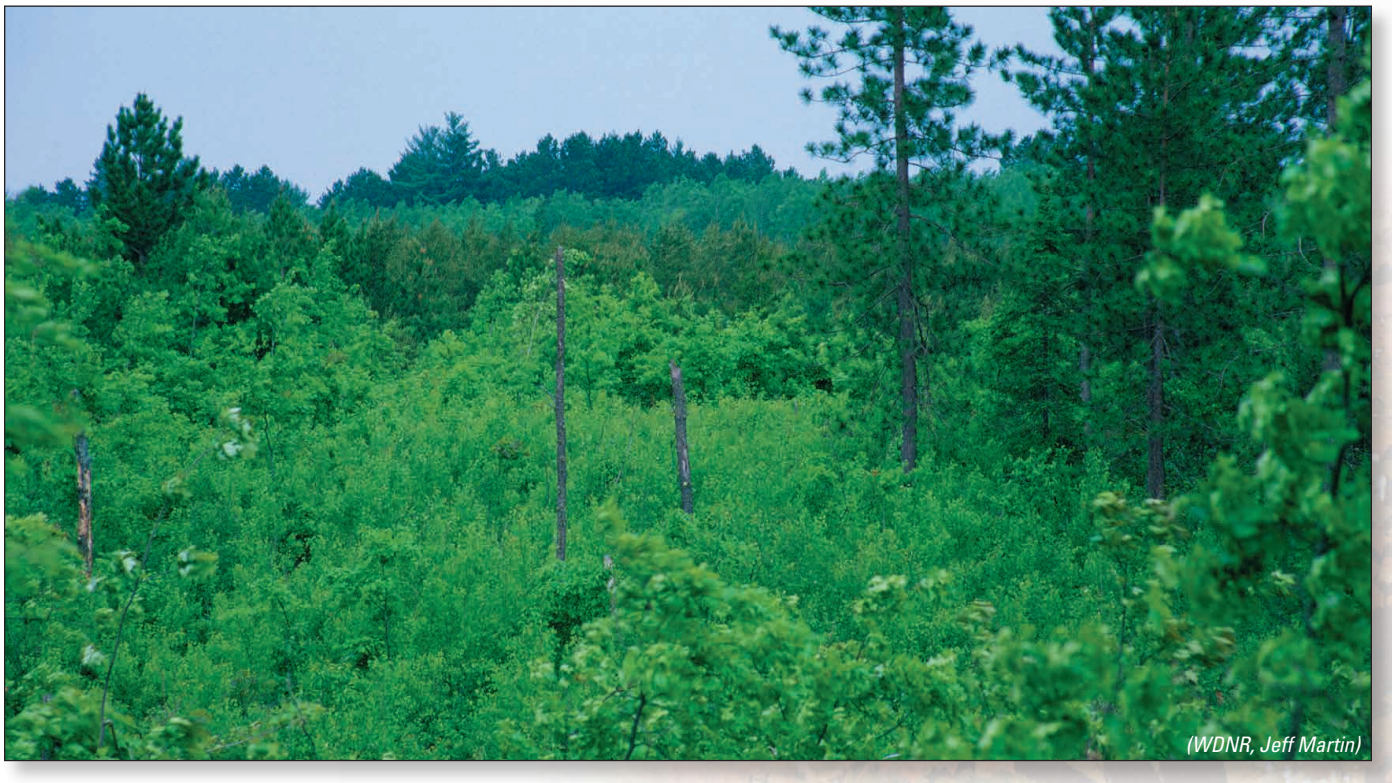


Figure 4-10: This ground-level photo was taken in the center of the aerial view shown in Figure 4-9 while looking toward the lower left. This area, managed for aesthetic quality, shows oak sprouts and young aspen in the foreground, young jack pine and older aspen in the middle, and mature red and jack pine in the background.

VISUAL SENSITIVITY LEVELS

Recognizing Different Levels of Visual Sensitivity

Some of the factors important in the determination of visual sensitivity include:

- The perceived degree of sensitivity of users of that travel route or recreation area concerning landscape aesthetics.
- The volume and type of use the travel route or recreation area receives.
- The speed of travel within the route or area.

Figure 4-11: This major highway, a "most sensitive" example, carries a high traffic load through scenic hill country in Wisconsin.

Figure 4-12: An example of a "moderately sensitive" area, this narrow blacktop road winds alongside scenic Otter Creek in the Baraboo Hills.

Visual Sensitivity Levels

MOST SENSITIVE

Applies to travel routes and areas where significant public use occurs, and where visual quality is of high concern to typical users. Examples of such routes may include public highways, local roads, recreational lakes and rivers, and designated recreational trails and areas that provide a high level of scenic quality.

MODERATELY SENSITIVE

Applies to travel routes or recreation areas, not identified as "most sensitive," where visual quality is of moderate concern to typical users. Examples of these routes and areas may include public highways and local roads, recreational lakes and rivers, and designated recreational trails that provide moderate to high scenic quality but less significant public use.

LESS SENSITIVE

Applies to travel routes or recreation areas, not identified as "most sensitive" or "moderately sensitive," where visual quality is of less concern to typical users. Examples of these routes may include public highways and low-volume local forest roads, non-designated trails, and non-recreational lakes and rivers.

Figure 4-13: Example of a "less sensitive" area along this back road that receives very little traffic.

The Value of Recognizing Different Levels of Visual Sensitivity

Recognizing the level of visual sensitivity helps the landowner, resource manager and logger to choose the visual quality guidelines that help fulfill the landowner's expectations.

Timber sale contracts should reflect differences in visual sensitivity. An area classified as "most sensitive" would normally have different contract specifications than those used in an area classified as "less sensitive." Landings, for example, should be avoided within view of travel routes or recreation areas classified as "most sensitive," while they might be visible in areas classified as "less sensitive," but located outside the travel route right-of-way.

Figure 4-14: The selective thinning in this red pine stand was designed to mimic natural changes that occur over time. Trees were removed from all size classes, so that the remaining stand has a mix of sizes, quality and tree spacing; therefore, providing a more "natural" and less "plantation" look.

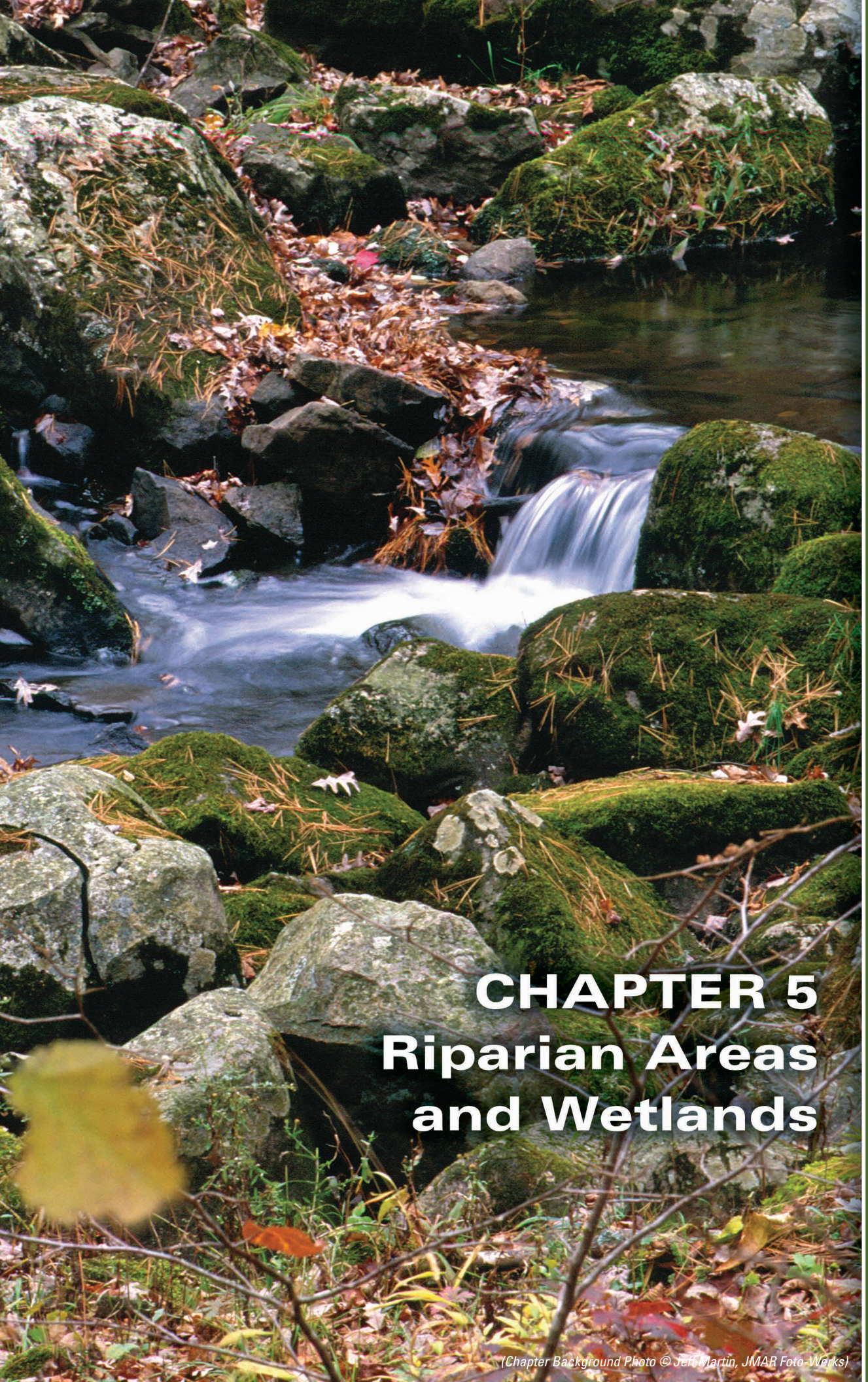
RESOURCE FOR ADDITIONAL INFORMATION

This resource is specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

Figure 4-15: Autumn scenery in the Baraboo Hills showcases the diversity found in a mixed pine and hardwood forested landscape.

WOODLAND VISIONS – APPRECIATING AND MANAGING FORESTS FOR SCENIC BEAUTY

Woodland Visions – Appreciating and Managing Forests for Scenic Beauty, L. Klessig, UW-Extension Publ. No. G3762, 2002. Woodland owners prize their property for its wildlife habitat and natural beauty as much as for its timber value. This softcover book considers this important – and often overlooked – perspective in woodland management planning. According to the author, Lowell Klessig, "Good forest management can enhance scenic benefits not only for woodland owners, but also for the surrounding community." This publication is available in hardcopy or electronic form online at: ***woodlandinfo.org/publications/forest-management#roads***.

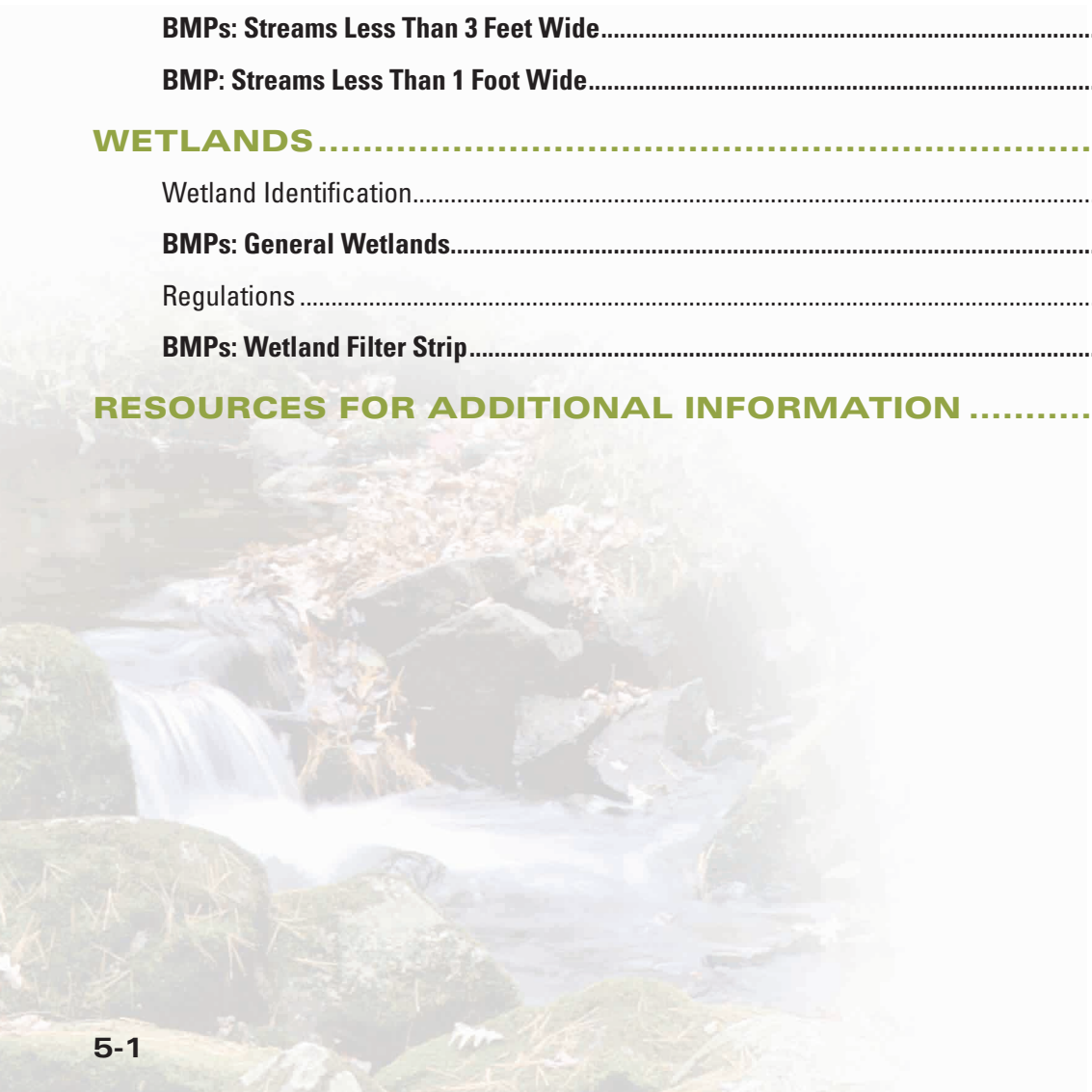


5

CHAPTER 5
Riparian Areas and Wetlands

(Chapter Background Photo © Jeff Martin, JMAR Foto-Works)

CHAPTER 5
RIPARIAN AREAS AND WETLANDS



THE VALUE OF RIPARIAN AREAS

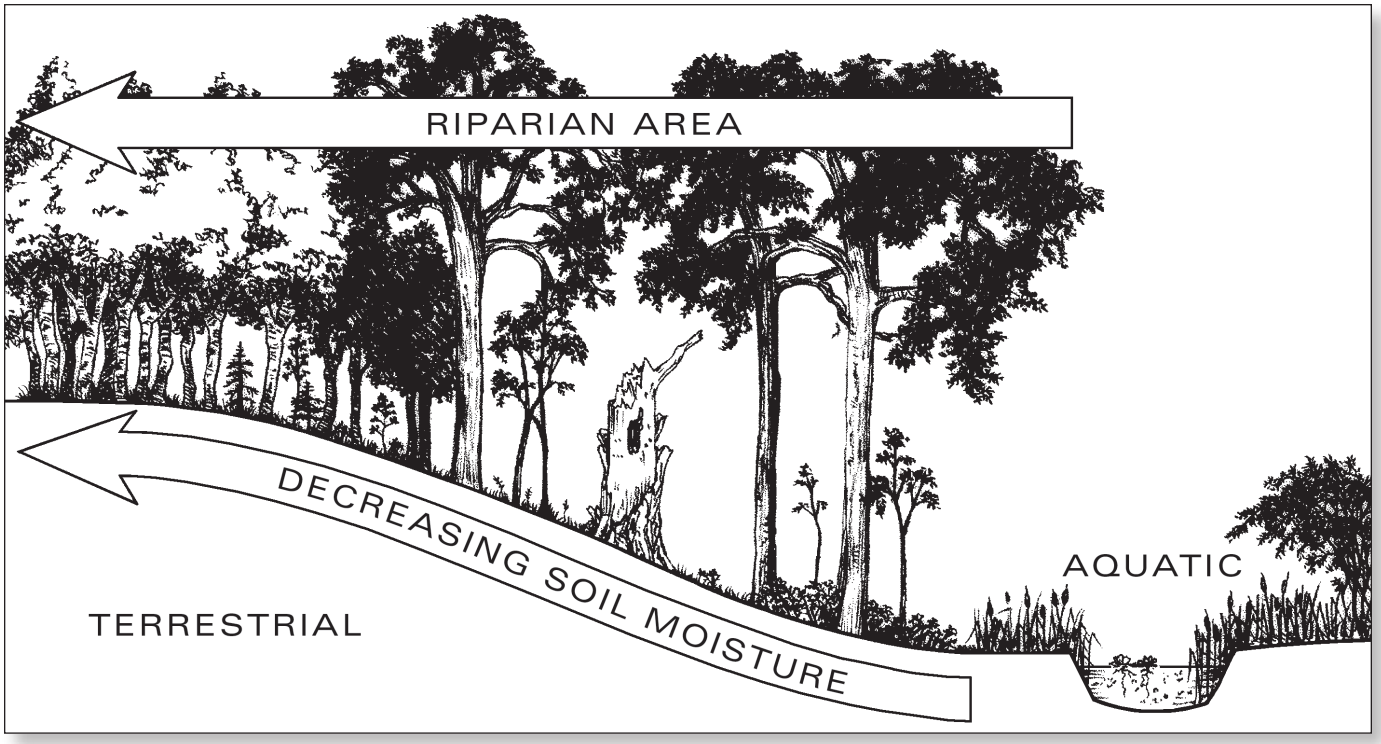


Figure 5-1: Transition from aquatic to terrestrial habitat in a riparian area. *(Adapted from Figure RMZ-1, pg. 4, Riparian Areas, Voluntary Site-level Forest Management Guidelines: Sustaining Minnesota Forest Resources)*

A Transition from Aquatic to Terrestrial Ecosystems

A riparian area is the area of land and water forming a transition from aquatic to terrestrial ecosystems along streams and lakes (see Figure 5-1).

Riparian areas are among the most important and diverse parts of forest ecosystems. They support high soil moisture and a diversity of associated vegetation and wildlife, and they perform important ecological functions that link aquatic and terrestrial ecosystems. Riparian areas help to:

- **Filter sediment and nutrients from runoff.** As runoff flows over the soil and duff layer (needles, leaves and decaying matter), it can slow and drop sediment that it is carrying. This settling process keeps sediment and nutrients out of lakes, streams and wetlands.
- **Allow water to soak into the ground.** The leaves, twigs and stems of vegetation in riparian areas slow surface runoff, allowing water to soak into the ground. This helps to reduce peak flow levels in streams. It also replenishes groundwater, helping to maintain lake levels and stream flows.
- **Stabilize lakeshores and streambanks.** The roots of trees and plants along lakes and streams can reduce soil erosion by holding soil in place, making it more difficult for waves, currents and runoff to wash the soil away. Plants or even dead and down vegetation can also reduce the impact of raindrops on bare soil, decreasing erosion.
- **Shade streams.** Streamside trees offer shade, keeping the water from becoming too warm for aquatic life in the summer. As water temperatures rise, the dissolved oxygen levels decrease. Maintaining water temperatures are especially important in cold water trout streams and their associated communities.
- **Provide food and habitat for aquatic organisms.** Fallen leaves and twigs are the base of the food chain for aquatic organisms in small forest streams. Large woody debris, including logs and branches, provide critical habitat for fish and aquatic organisms.

Protecting Water Quality

Forests play an important role in the water cycle, contributing to the high quality of water found in Wisconsin's lakes, streams and wetlands. The term "water quality" broadly encompasses the chemical, physical and biological aspects of lakes, streams and wetlands. Chemical properties of water include pH, dissolved oxygen, nutrients and the presence of chemical pollutants. Physical properties include turbidity and temperature. The characteristics and natural processes of waterbodies are also important aspects of water quality. These include stable channels, transport of nutrients, volume and speed of water, streambed and lakebed materials, and leaves, sticks, and logs that naturally fall into the water.

Forestry Best Management Practices for Water Quality (WQ-BMPs) are intended to provide simple and cost-effective methods for protecting water quality in lakes, streams and wetlands – including important ecological and waterbody characteristics – before, during and after forestry management activities.

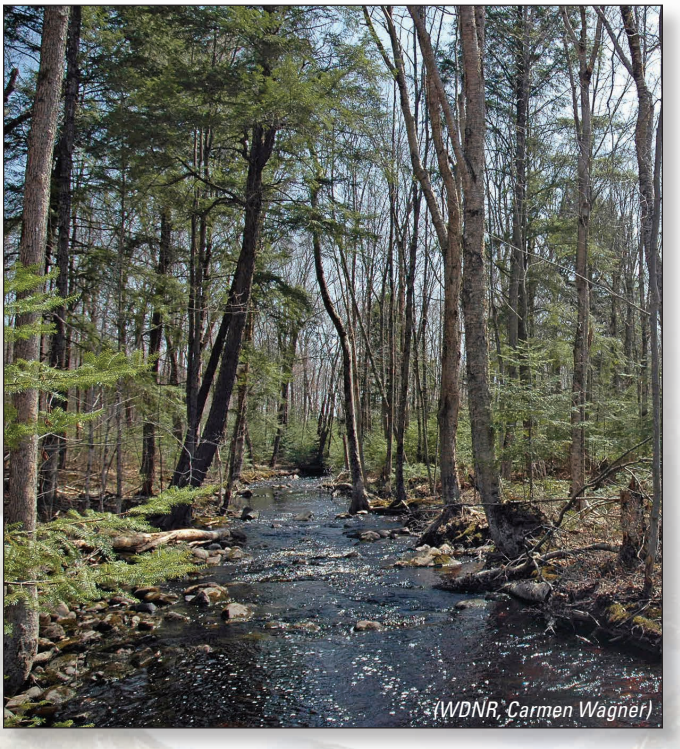


Figure 5-2: Riparian management zones (RMZs) provide a natural source of wood, leaves and other organic material which are important components of aquatic ecosystems.

WQ-BMPs help to protect:

- **General water quality,** by minimizing inputs of polluted runoff
- **Water temperature,** by ensuring an adequate and appropriate amount of shade along shorelines and streambanks
- **Nutrient balance,** by providing necessary inputs of organic material and nutrients that serve as the basis of aquatic food chains
- **Habitat diversity,** by making certain there is an adequate source of large woody debris for the aquatic system
- **Hydrologic process,** by limiting disturbances to water flow patterns
- **Soil quality,** by limiting disturbances and compaction

Figure 5-3: Temporary stream crossings can provide access to areas not needing permanent access, while allowing the timber harvest, and greatly reducing the potential impacts of the stream crossing.

Figure 5-4: Excessive rutting not only impacts soil and water quality, it can also damage trees and reduce regeneration.

Figure 5-5: Riparian management zones along streams help moderate stream temperatures by retaining trees to shade streams.

Maintaining water quality can be a complex process, but WQ-BMPs provide easy, practical ways to achieve this goal. Most of these BMPs address water quality concerns by providing methods to keep sediment out of lakes, streams and wetlands and by preserving the physical integrity and natural processes of water resources. If these issues are addressed, then most other aspects of water quality will also be protected.

If WQ-BMPs are not followed, water quality has the potential to be impacted in a number of ways including:

- **Reducing the soil's ability to absorb water.** This can occur when the forest floor is rutted, compacted or otherwise damaged by equipment.
- **Increasing the potential for soil erosion.** The likelihood of soil being carried away by runoff increases when soil is moved or when bare soil is exposed.
- **Concentrating water flows.** Roads, skid trails, landings, and drainage structures can collect runoff and funnel it, eroding soil and creating gullies.
- **Diverting water flows.** Roads and skid trails can intercept water flowing over or through the soil. If the natural flow pattern (hydrology) is altered, wetlands or other water resources may be denied the water that they depend on or may become impounded (flooded) with water as their natural drainageways are blocked by roads and skid trails.
- **Increasing water flows.** Harvesting a significant percentage of the trees in a watershed can increase the amount of water running off the land, since fewer trees are left to use the water. Higher water flows can increase the potential for streambank erosion and may lead to flooding.
- **Reducing the benefits of vegetation next to water resources.** Harvesting adjacent to streams can open the tree canopy and cause more light to reach the water surface. This may cause water temperatures to rise. Harvesting next to lakes and streams can also remove the natural source of woody debris for aquatic habitat, and can eliminate the leaf litter that is an important food source for many aquatic insects.

Figure 5-6: Monitoring teams visit timber sales to ensure that Forestry BMPs for Water Quality are being followed and that BMPs are working as intended.

Forestry BMPs for Water Quality

The most practical and cost-effective method to assure that forestry operations do not adversely affect water quality in Wisconsin is through the use of the voluntary **best management practices (BMPs)**. These BMPs are voluntary in the sense that they are not legally mandated. However, the Wisconsin DNR strongly encourages their use by all Wisconsin forest landowners, land managers and forestry professionals.

Many public and private landowners in Wisconsin use Forestry BMPs for Water Quality (WQ-BMPs) to guide their management activities. Those who have made commitments to follow these BMPs include:

- National forests
- State forests
- County forests
- The majority of Wisconsin's large land ownerships (formerly known as industrial forestlands) which are participating in forest certification programs.

In addition to WQ-BMPs, you should be aware of existing municipal, county, state, and federal regulations relating to forest management and water quality (see Appendices D and E for information on permits and regulations).

This guide can help you when making decisions about management activities on your land. **WQ-BMPs are identified by "💧" to help separate them from other recommendations in this guide. Applications of WQ-BMPs may be modified for specific site conditions with guidance from a natural resource professional, if modifications provide equal or greater water quality protection, or if the modification has no impact on water quality.** Seek professional advice on WQ-BMPs and all forest management activities from natural resource professionals such as:

- Consulting foresters
- Industrial foresters
- Wisconsin DNR foresters, fish managers and water quality staff
- USDA Natural Resources and Conservation Service staff
- County Land Conservation Department staff

Careful planning for forest management activities, such as road construction, timber harvesting and site preparation, will help protect water quality. A well thought-out plan will lead to harvest operations that use WQ-BMPs, remove forest products efficiently and profitably, and promote sustainable forest growth and water quality protection.

A comprehensive forest management plan should include WQ-BMPs. The level of formality and detail should be appropriate to the project size, cost and environmental risk. The plan should also be flexible and adaptable to changing conditions.

Wisconsin DNR foresters and consulting or industrial foresters can work with you to develop a list of WQ-BMPs to include in your forest management plan. Cost-sharing assistance may be available for plans written by a consulting forester.

Contractors (e.g., loggers or road developers) along with landowners, land managers and foresters are all responsible in planning, designing and implementing WQ-BMPs. They should select the best forest management strategy to protect water quality that is specific to their site and timber harvest.

Figure 5-7: Discuss any water quality concerns with your forester and logger before timber harvesting starts.

Figure 5-8: The location of roads, skid trails and landings should be determined before harvesting. This will ensure that adequate riparian management zones are maintained near streams and lakes, and that sensitive areas are avoided like springs, seeps and wetlands.

RIPARIAN MANAGEMENT ZONES

What Exactly is a Riparian Management Zone?

Riparian management zones (RMZs) are areas next to lakes and streams where management practices are modified to protect water quality, fish habitat and other aquatic resources. These areas are complex ecosystems that provide food, habitat and movement corridors for aquatic (water) and terrestrial (land) communities. In fact, 80 percent of the endangered and threatened species in Wisconsin spend all or part of their lives in these areas. Besides their wildlife habitat value, RMZs are vital in helping to minimize the effects of nonpoint source pollution on adjacent surface waters.

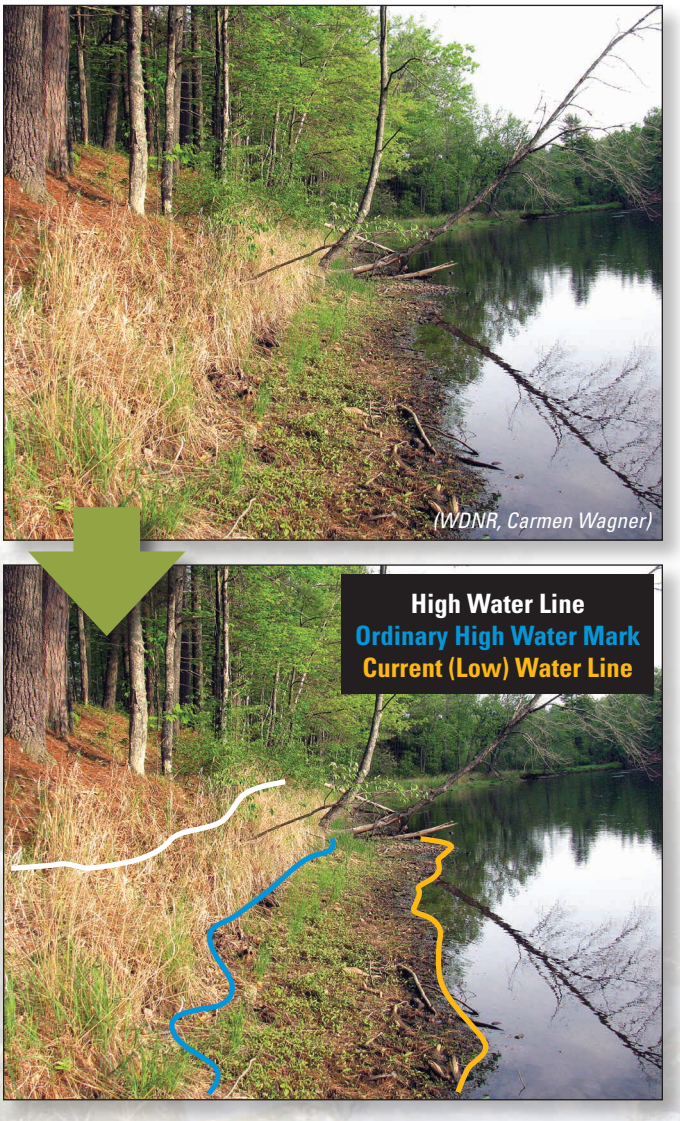


Figure 5-9: Ordinary high water mark for a stream.

Regulations

In addition to the recommended WQ-BMPs, all cutting practices next to navigable waterways must be consistent with local zoning ordinances. Chapter NR 115, Wisconsin Administrative Code, sets statewide minimum standards for the cutting of trees and shrubs in shoreland areas to protect the natural scenic beauty, control erosion and reduce the flow of sediments and nutrients from the shoreland area. Every county and many towns have a shoreland zoning ordinance which addresses vegetation management and other activities near lakes and streams. Before conducting any shoreland harvesting, contact local zoning offices for permit and regulation information.

Navigable stream and wetlands crossings, grading next to lakes and streams, and other forestry activities are subject to permits. Contact a local Wisconsin DNR water management specialist for more information at: ***dnr.wi.gov – keyword "waterway."***

DETERMINING NAVIGABILITY OF WATERWAYS AND WATERBODIES

LAKE/POND

A waterbody is navigable if it 1) has an ordinary high water mark, 2) has a bed and banks, and 3) is a "reasonably permanent" body of water, although it may dry up during periods of drought.

STREAM

A waterway is navigable if it 1) has a bed and banks, 2) can float the smallest recreational craft on a regular reoccurring basis.

ORDINARY HIGH WATER MARK (OHWM)

The point on a bank or shore up to which the presence and action of water is so continuous that it leaves a distinct mark either by erosion, destruction of terrestrial (land) vegetation, or other easily recognized characteristics.

BMPs FOR RIPARIAN MANAGEMENT ZONES

The recommended RMZ width is measured along the lay of the land (the linear distance along the ground). It is not a horizontal distance unless the ground is level. Using best professional judgment, the width of the RMZ and associated WQ-BMPs may be modified to ensure water protection or if water quality will not be impacted.

It is important to remember that water quality broadly encompasses chemical, physical and biological characteristics of lakes and streams – it is not just water clarity.

THE THREE RIPARIAN MANAGEMENT ZONE (RMZ) CATEGORIES

RMZ = 100 Feet: Lakes, designated trout streams and streams 3 feet wide and wider.

RMZ = 35 Feet: Steams less than 3 feet wide.

RMZ = 35 Feet: Streams less than 1 foot wide.

NOTE: The RMZ width is measured along the lay of the land (the linear distance along the ground). It is not a horizontal distance, unless the ground is level.

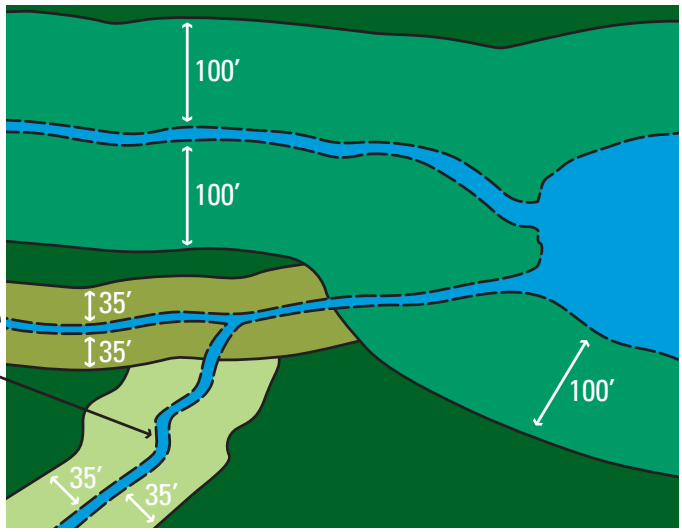
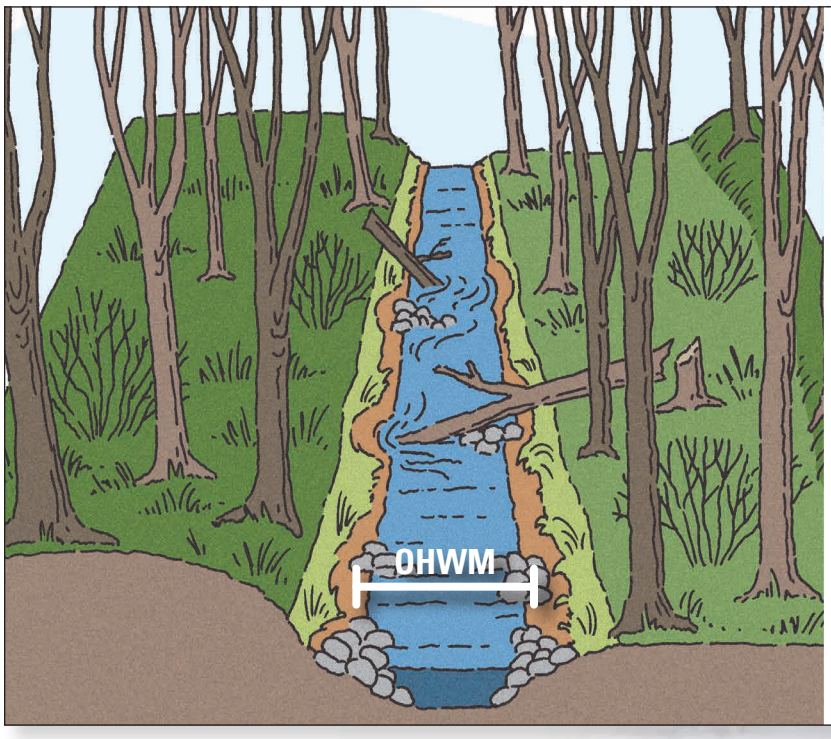


Figure 5-10: Three Riparian Management Zones (Wisconsin's Forestry Best Management Practices for Water Quality, PUB-FR-093 2010)



Stream width is measured at the ordinary high water mark (OHWM). The OHWM is the point on the stream bank where the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation or other easily recognized characteristic.

The width of the stream should be measured at a straight channel segment within the management area. The ideal location to measure stream width would be an area that is representative of the stream throughout the management area. The width should not be measured at the stream's widest points such as in the bends of the stream channel.

Figure 5-11: How to Measure Stream Width (Wisconsin's Forestry Best Management Practices for Water Quality, PUB-FR-093 2010)

BMPs Common to All Three RMZ Categories

These BMPs are applicable to all riparian management zones (RMZ):

- Locate roads outside the RMZ unless necessary for stream crossings. For stream crossings, follow recommendations in the Stream Crossings section of Chapter 12: Forest Road Construction and Maintenance starting on page 12-6.
- Locate landings outside the RMZ.
- Do not dispose of or pile slash that originated from outside the RMZ to within it. However, slash from trees within the RMZ may remain there. Keep slash out of lakes, streams and areas where it may be swept into the water.
- Minimize soil exposure and compaction to protect ground vegetation and the duff layer.

Figure 5-12: The RMZ is a strip of land alongside streams and lakes extending landward from the ordinary high water mark. On this river, a RMZ that is 100 feet wide would be used.

BMPs: Lakes, Designated Trout Streams and Streams 3 Feet Wide and Wider

The riparian management zone (RMZ) for these waters is a strip of land running along the shoreline of lakes and on each side of streams. It begins at the ordinary high water mark and extends a minimum of 100 feet landward. The Wisconsin DNR maintains a county-by-county ***listing of all designated trout streams available at: dnr.wi.gov – keywords "trout management."***

- Do not operate wheeled or tracked equipment within 15 feet of the ordinary high water mark except on roads or at stream crossings.
- Operate wheeled or tracked equipment within 15 to 50 feet of the ordinary high water mark only when the ground is frozen or dry.
- Harvesting plans should leave at least 60 square feet of **basal area** per acre in trees five inches **DBH** (diameter at breast height) and larger, evenly distributed.
- Use selection harvests and promote long-lived tree species appropriate to the site. Long-lived hardwood species include sugar maple, red maple, basswood, cottonwood, white ash, black ash, elms, and oaks. Long-lived conifer species include white pine, red pine, eastern hemlock, and white cedar.
- Do not harvest fine woody material within 50 feet of the ordinary high water mark. NOTE: This BMP may be modified for specific site conditions, for specific operational issues, or to meet specific management objectives if water quality will not be impacted. Additional guidelines can be found in *Wisconsin's Forestland Woody Biomass Harvesting Guidelines* available online at: ***https://councilonforestry.wi.gov/Pages/WoodyBiomass/Overview.aspx***.
- Harvesting intervals should be a minimum of 10 years.
- Develop trees 12 inches DBH and larger.

BMPs: Streams Less Than 3 Feet Wide

The riparian management zone (RMZ) for these streams is a strip of land on each side of the stream, beginning at the ordinary high water mark and extending a minimum of 35 feet landward.

- Operate wheeled or tracked equipment within 15 feet of the ordinary high water mark of streams only when the ground is frozen or dry.
- Use selection harvests and promote long-lived tree species appropriate to the site. Long-lived hardwood species include sugar maple, red maple, basswood, cottonwood, white ash, black ash, elms, and oaks. Long-lived conifer species include eastern hemlock, white pine, red pine, and white cedar.
- Do not harvest fine woody material within 15 feet of the ordinary high water mark. NOTE: This BMP may be modified for specific site conditions, for specific operational issues, or to meet specific management objectives if water quality will not be impacted. Additional guidelines can be found in *Wisconsin's Forestland Woody Biomass Harvesting Guidelines* available online at: ***https://councilonforestry.wi.gov/Pages/WoodyBiomass/Overview.aspx***.
- Harvesting intervals should be a minimum of 10 years.
- Harvesting plans should leave at least 60 square feet of **basal area** per acre in trees five inches **DBH** (diameter at breast height) and larger, evenly distributed.

BMPs: Streams Less Than 1 Foot Wide

The riparian management zone (RMZ) for these waters is a strip of land on each side of the stream, beginning at the ordinary high water mark and extending a minimum of 35 feet landward.

- Operate wheeled or tracked equipment within 15 feet of the ordinary high water mark only when the ground is frozen or dry.
- Do not harvest fine woody material within 15 feet of the ordinary high water mark. NOTE: This BMP may be modified for specific site conditions, for specific operational issues, or to meet specific management objectives if water quality will not be impacted. Additional guidelines can be found in *Wisconsin's Forestland Woody Biomass Harvesting Guidelines* available online at: ***https://councilonforestry.wi.gov/Pages/WoodyBiomass/Overview.aspx***.

Figure 5-13: This stream measures 2.9 feet across and has a recommended RMZ width of 35 feet.

WETLANDS

Figure 5-14: Wetlands protect shorelines by absorbing waves and holding soil in place.

Wisconsin state statutes (section 23.32) define a wetland as "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." Wetlands can be as small as a 500 square foot ephemeral pond, or as large as the 32,000 acre Horicon Marsh. Wetlands perform many functions, often providing valuable ecosystem services, including:

- **Fish and wildlife habitat.** Many animals, including nearly 40 percent of Wisconsin's bird species, live in or use wetlands for food, nest sites and cover. One-third of the plants and animals on Wisconsin's state endangered and threatened list depend on wetlands.
- **Flood protection.** By storing runoff from heavy rains and snowmelt, wetlands reduce flood peaks by as much as 60 percent. The Environmental Protection Agency estimates that an acre of wetlands can store one to 1.5 million gallons of floodwater.
- **Water quality protection.** Wetlands store and filter pollutants from surface waters. Some wetlands could remove as much pollution as a five million dollar water treatment plant.
- **Groundwater recharge and discharge.** Some wetlands use surface water to recharge groundwater supplies. Other wetlands discharge groundwater to the surface, an important wetland function that helps to stabilize stream flows, especially during dry months.
- **Shoreline protection.** Shoreland wetlands act as buffers between the land and water. They protect against erosion by absorbing the force of waves and currents. The roots of wetland plants further help by anchoring soil in place. Without this wetland buffer, the shoreline becomes undercut and collapses.

Wetlands can be difficult to work in because of the water and organic material in their soils. Wetland soils have low weight-bearing capacity, making them weaker than upland soils and more susceptible to rutting. In addition, it is common for water to be moving through the soil near the surface. The wetland WQ-BMPs are designed to prevent erosion, minimize changes to the surface and below-surface water movement, and to strengthen or increase the bearing capacity of the soil. Changes in a wetland, especially in water movement, can affect the health of the wetland ecosystem and the functions it performs.

Wetland Identification

Wetlands are areas where standing water or saturated soil conditions are present long enough to support water-loving plants like marsh marigolds, willows, tag alders, and other species. These wet conditions will also lead to development of specific soil types that can help identify wetlands. Wetland soils develop after repeated cycles of saturation which last 14 days or more. These saturated conditions may only exist every other year (50 percent of the time). When there is standing water or the soil is saturated, anaerobic conditions exist and the soil pores are filled with water instead of air.

Wetlands are common along the edges of lakes and streams, but can also be found in flat areas or depressions which collect water. Wetlands are also found in unlikely places, such as on hillsides, where water may seep out of the ground.

More than 30 different types of wetlands are recognized in Wisconsin. Wetland types that are common in forested areas include ephemeral ponds, floodplain forests, northern hardwood swamps, northern wet-mesic forests, and tamarack/spruce swamps.

There are a number of tools that can help you make a preliminary determination as to whether your project will affect wetlands including:

- Wisconsin DNR Wetland Inventory maps
- Wisconsin DNR Wetland Indicator maps
- Natural Resources Conservation Service (NRCS) Soil Surveys

These maps can be reviewed at Wisconsin DNR and local zoning offices. They are also available online at the Wisconsin DNR and NRCS websites. Remember that maps are just guides and a field visit is necessary to confirm what the maps show. Wetland indicators to look for in the field include water, soils and vegetation.

Figure 5-15: Ephemeral ponds provide important habitat for many amphibian and bird species.

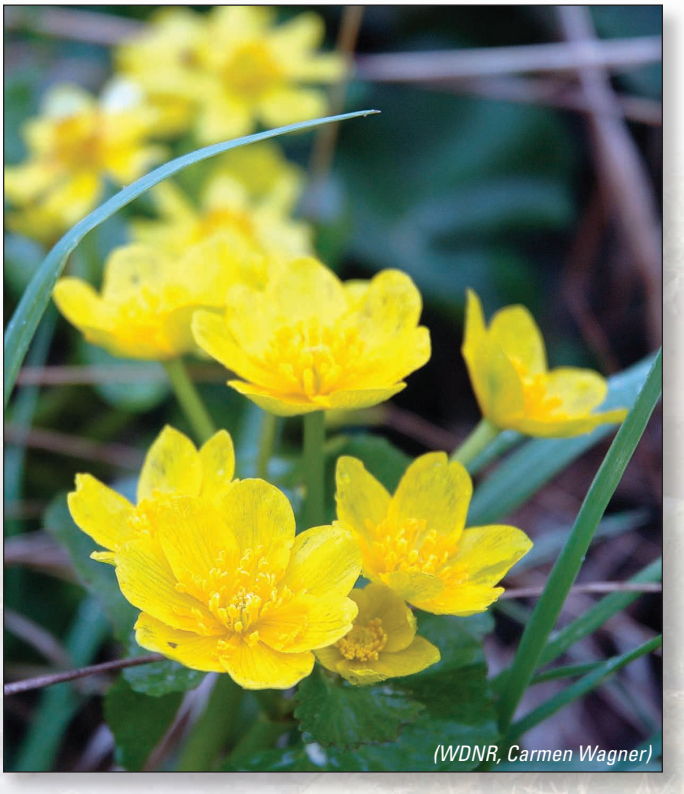


Figure 5-16: Marsh marigolds are a common wetland plant.

BMPs: General Wetlands

- Whenever practical, avoid locating roads and landings in wetlands; otherwise use extreme caution.
- Whenever possible, forest management activities in wetlands should occur on frozen ground to minimize rutting.
- For activities in wetlands, consider allowing more flexibility regarding completion dates in timber sale contracts, allowing the logger time to complete logging activities during firm or frozen ground conditions.
- Do not dispose of or move upland slash into a wetland. However, slash from trees in the wetland may remain in the wetland. NOTE: Using slash for a temporary wetland crossing to prevent rutting is encouraged and addressed in Chapter 12: Forest Road Construction and Maintenance, page 12-18.
- Keep slash out of open water.
- Only use pesticides labeled for use in wetlands.
- Whenever practical, avoid equipment maintenance and fueling in wetlands. Otherwise, use extreme caution when doing so. Clean all spills promptly.

Figure 5-17: To help support equipment and minimize rutting, slash can be used as a temporary wetland crossing. See Chapter 12: Forest Road Construction and Maintenance for more information about this practice.

Regulations

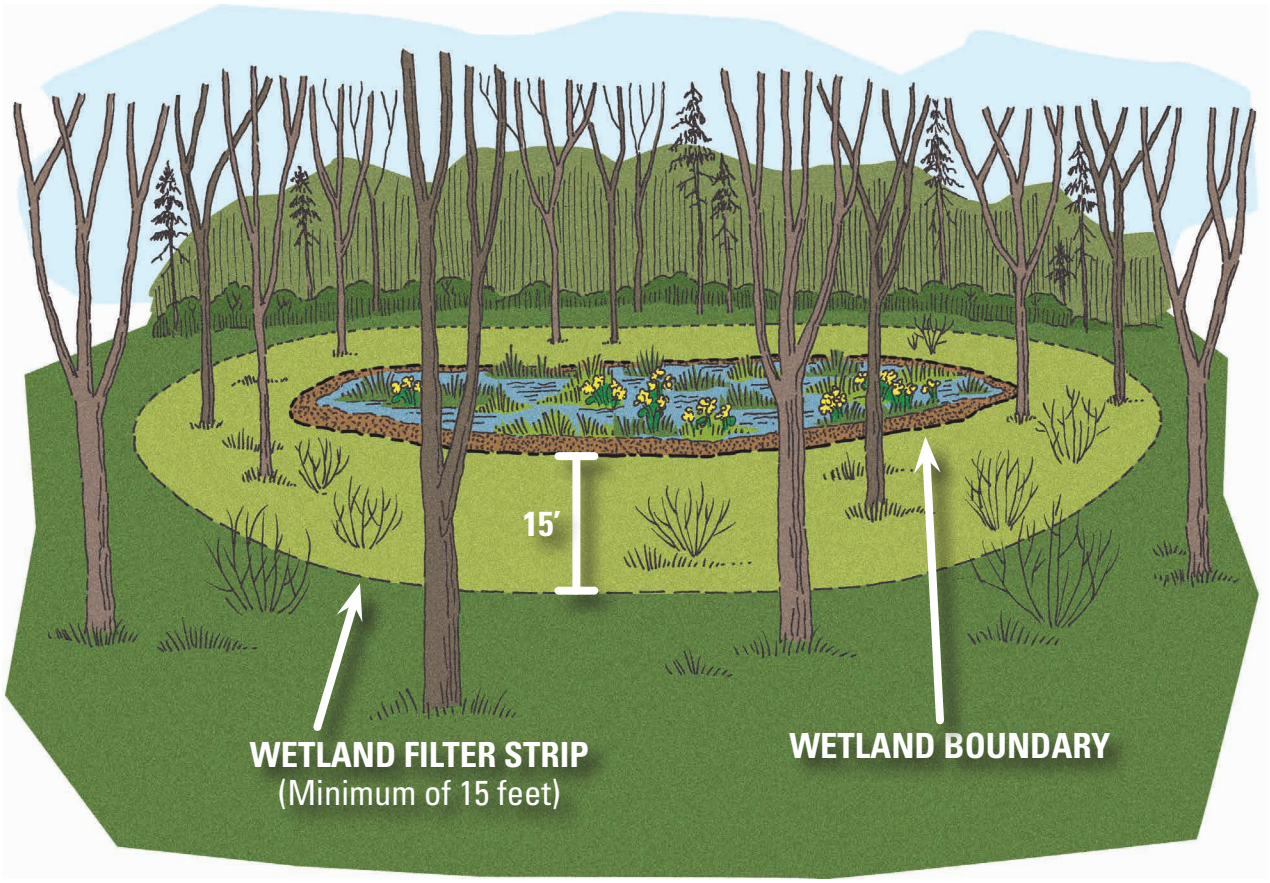
Activities in wetlands are often subject to municipal, county, state, and federal permits and regulatory requirements. Permit and regulatory information can be found in Appendices D and E. If you are building a road or conducting an activity in an area suspected to be a wetland, be sure to contact the following offices regarding applicable permits and regulations:

- local zoning offices (town, village, city, and/or county)
- local Wisconsin DNR water management specialist
- local U.S. Army Corps of Engineers (USACE) project manager

BMPs: Wetland Filter Strip

Filter strips are strips of land located adjacent to wetlands that trap sediment and other pollutants from runoff before it reaches wetlands. Harvesting and other forest management activities can occur both in the wetland and the filter strip. Care should be taken to prevent exposing bare soil that may erode into the wetland. A wetland filter strip begins at the edge of the wetland and extends a minimum of 15 feet away from the wetland.

- Whenever practical, avoid locating roads and landings in the wetland filter strip; otherwise use extreme caution.
- Minimize soil exposure and compaction to protect ground vegetation and the duff layer in the wetland filter strip.
- Operate equipment in the wetland filter strip only when the ground is firm or frozen.



A wetland filter strip begins at the edge of the wetland and extends a minimum of 15 feet away from the wetland. NOTE: The width of a wetland filter strip is measured along the lay of the land (the linear distance along the ground). It is not a horizontal distance, unless the ground is level.

Figure 5-18: How to Measure Wetland Filter Strips (Wisconsin's Forestry Best Management Practices for Water Quality, PUB-FR-093 2010)

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

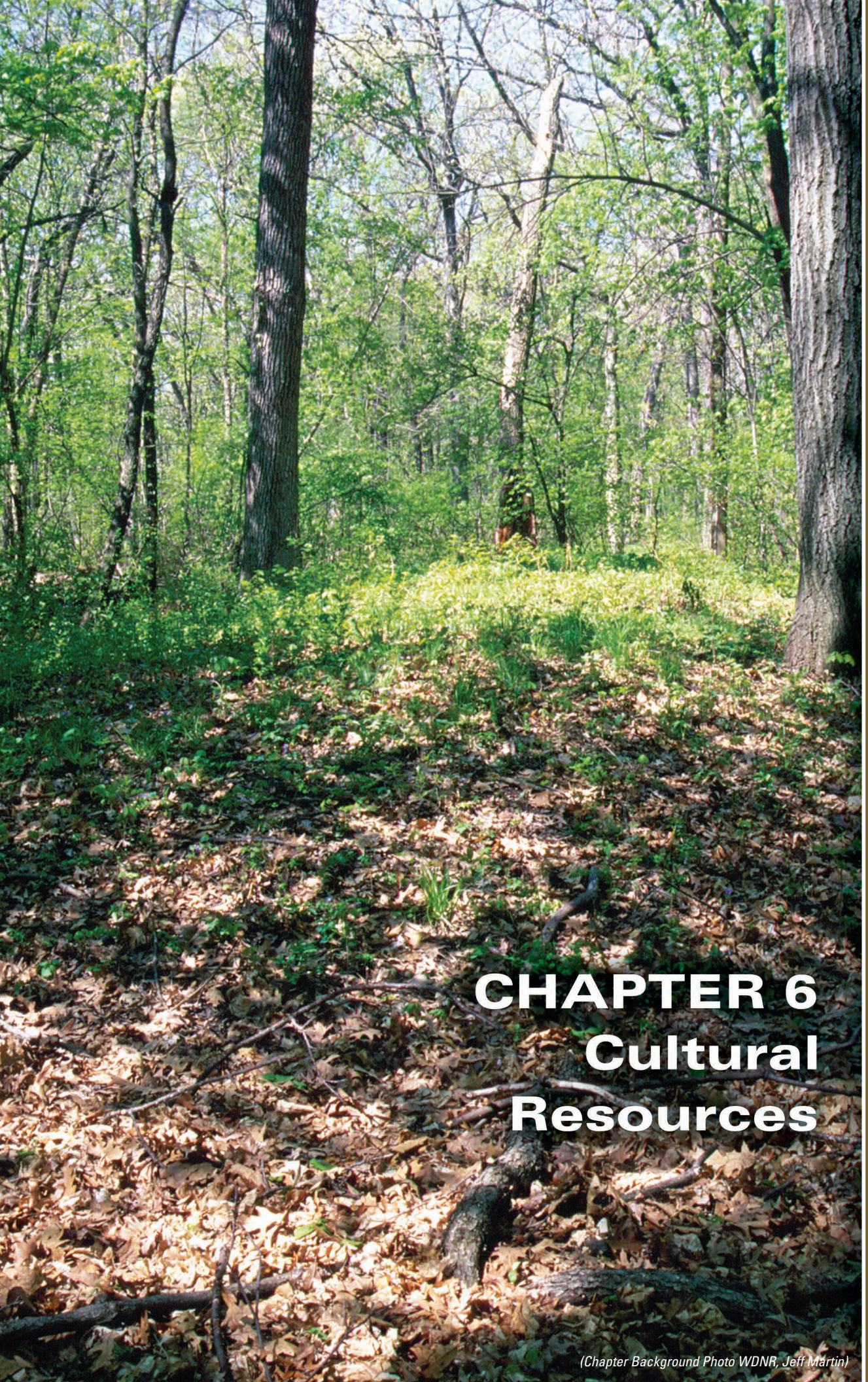
Figure 5-19: Designated trout streams, regardless of stream width, should have at least a 100-foot wide RMZ.

WISCONSIN WETLANDS ASSOCIATION

http://wisconsinwetlands.org/

WATER QUALITY FORESTRY BMPs

dnr.wi.gov – keywords "water quality forestry BMPs"



6

CHAPTER 6
Cultural Resources

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 6
CULTURAL RESOURCES

CULTURAL RESOURCES

Figure 6-1: Indian burial mounds are a cultural resource that can be found in many Wisconsin forested areas. Although not as large as some, this mound is easily spotted because the understory has been removed. Other mounds may not be as easily detected when forest operations are conducted. All burial mounds and other cemetery areas are protected against unauthorized disturbance.

Forest Management for the Protection of Cultural Resources

This chapter of the guidelines was developed to provide landowners, loggers and resource managers with an increased awareness of cultural resources and recommendations on how to protect them during forest management activities. Those involved in managing forestlands need to understand that:

- Cultural resources are scarce and nonrenewable.
- Good forestland management is compatible with the protection of cultural resources.

There is a growing recognition that cultural resources have value and should be wisely managed. Cultural resources represent parts of an inheritance shared by all people. This heritage is of fundamental value to modern-day societies. Cultural resources often possess spiritual, scientific and other values that are weighed differently by different cultures. Today the management of cultural resources is a necessary component of land stewardship. Additionally, such resources may be protected by federal, state and local laws.

What Cultural Resources Are

Cultural resources include historic structures, archaeological sites, cemeteries, and traditional-use areas, among others. Together, they represent roughly 13,000 years of human occupation in Wisconsin – from the end of the last ice age to the present day. Prehistoric cultural resources reflect the activities of Indian people prior to initial French contact in 1634. Since the first written records of Wisconsin began at that time, 1634 marks the beginning of the historic period. To be considered historic, a cultural resource usually has to be at least 50 years old or older. Types of cultural resources include, but are not limited to:

- **Historic Structures**
  - Houses, barns and outbuildings
  - Lime kilns
  - Bridges and railroad trestles
  - Schools and churches
  - Stores and office buildings
  - Mills and factories
- **Cemeteries**
  - Platted cemeteries
  - Family cemeteries and individual graves
  - Burial mounds
- **Archaeological Sites**
  - Campsites and villages
  - Caves and rock shelters
  - Quarries and flintknapping workshops
  - Large animal kill and butchering stations
  - Ridged fields and other types of garden beds
  - Enclosures and earthworks
  - Fish weirs
  - Rock art sites
  - Ruins of trading posts and homesteads
  - Shipwrecks
- **Traditional-use Areas**
  - Sugar bushes
  - Medicine gathering areas
  - Sacred springs
  - Ceremonial sites

Economics of Cultural Resource Management

Economically, cultural resource management (CRM) will not usually pay for itself, but some forest landowners will discover that reserved and protected cultural resources can be financial assets – and may require certain accommodations through forest certification programs.

- Cultural resource conservations often contribute to soil, water and wildlife habitat conservation measures.
- The return on investment in the preservation, rehabilitation and adaptive reuse of above-ground cultural resources is often reflected in increased resale values, and may be used as an effective tool for developing a sense of corporate or community identity that encourages new investment.
- A growing number of federal and state laws provide financial incentives for preserving and protecting cultural resources. For example, through conservation easements, landowners may qualify for a federal income tax deduction or property tax credits. Further tax credits are available for National Register-listed properties and burial areas.

Figure 6-2: This millstone was found near the site of a grist mill that burned to the ground in the early 20th-century.

Figure 6-3: On this 1,000-year-old Indian village site, intact archaeological deposits lie only six to 10 inches below the ground surface, and harm can easily be done by very shallow ground disturbance.

Potential Impacts

In general, cultural resources are fragile. Many archaeological deposits lie within a few inches of the ground surface. Hence, even very shallow ground disturbance can destroy the context of artifacts or features such as the dirt floors of ancient houses. Threats range from natural forces (e.g., erosion, flooding, weathering, and fire) to human action (e.g., logging, agriculture, mining, land development, and vandalism). Potentially damaging effects to cultural resources resulting from forestland management activities include:

- Soil disturbance and/or compaction
- A change in the vegetation that is part of a traditional-use area
- Damage to above-ground features

Cultural Resource Management and the Law

The legal basis for cultural resource management (CRM) is rooted in federal and state legislation concerned with natural resource conservation and environmental protection going back to the early 1900s. The National Historic Preservation Act (NHPA) of 1966, as amended, is the centerpiece of the national historic preservation program. It established the National Register of Historic Places and provides for State and Tribal Historic Preservation officers to implement the national preservation program. Section 106 of NHPA requires that federal agencies consider the effects of their activities on cultural resources. Federal law applies whenever activity takes place on federal land, will use federal funds, or will require a federal permit.

The Wisconsin Field Archeology Act requires state agencies to contact the Wisconsin Historical Society (WHS) if the agency's actions may impact an archaeological site or historic structure listed in the WHS cultural resource inventory. State law applies whenever the activity is on state-owned land, will use state funds, or requires a state permit. Harvests that occur without any state involvement are exempt from this review unless new logging roads are to be constructed. Keep in mind that **State law affords special protection to burial sites, regardless of age or land ownership (including private lands)**. All human burials are afforded the same legal protection as platted cemeteries.

The level of protection on a site can vary depending on whether there is federal or state involvement (e.g., funding, licensing, permitting, or if a parcel was purchased in whole or part with funds provided by state or federal funding).

Figure 6-4: Few abandoned buildings from the 19th-century are as intact as this old log house. It is more likely that rotted wood and a cellar depression remain where a building once stood.

Cultural Resource Inventories

The Wisconsin Historical Society maintains an inventory of archaeological and burial sites as well as historic structures reported to their office. However, since most of the state has never been formally surveyed, unreported cultural resources likely outnumber those listed in their inventories. Archaeological sites are more apt to be inventoried if they have been plowed, exposing artifacts on the field surface, or if they have above-ground features such as burial mounds or piles of logging camp refuse. Access to archaeological and burial site inventories may be restricted to protect sites from looting, discourage trespass, and show respect for sites that some regard as sacred. The statewide inventory of known historic structures is openly available through the Wisconsin Historical Society's website at: ***www.wisconsinhistory.org***.

Assessing Cultural Resources

If a forest management parcel has not been previously surveyed for cultural resources, individuals may conduct their own informal assessment of the area's potential for having cultural resources. One might begin by checking existing maps, air photos and printed historical information, and then assess the landscape. The following have high potential for cultural resources:

- Current shorelines or terraces adjacent to lakes, rivers or streams, and shorelines of ancient lakes and old river channels
- Junctions of waterbodies, including river junctions, and lake inlets and outlets
- Peninsulas or points of land along a shoreline, including islands
- Good places to camp, including areas where people camp now
- Areas adjacent to fish spawning beds, good fishing spots and wild rice beds
- Transportation routes (e.g., old trails, roads or portages)

Field Identification of Cultural Resources

During a walk-over inspection of the management area, in preparation for a timber sale, forest managers and landowners may discover unrecorded cultural resources. Some things to look for are:

- High spots offering a panoramic view
- Unusual natural features
- Surface artifacts (check bare spots, tree tip-ups and cut banks)
- Surface features
  - Cellar and well holes
  - Cement or asphalt slabs
  - Fieldstone foundations
  - Miscellaneous building materials (bricks, roofing materials, plaster, and stucco)
  - Metal well pipes
  - Earthen berms and trenches
  - Shallow depressions (such as graves or ricing pits)
- Milled lumber (such as boards suitable for burial crosses, spirit houses or building construction)
- Domestic or nonnative plants (including lilac bushes, fruit trees, forget-me-nots, daylilies, etc.)
- Old roads, trails and portages (especially where two come together)
- Trash dumps containing antique items or jumbo-sized tin cans
- Standing structures and buildings

Assessing Management Alternatives

- **Protection by law.** If the pre-field review indicates that the project area contains a site protected by law (such as a burial site), further action will be determined by statute or regulations.
- **Identification as a high-sensitivity site.** If cultural resources are known to exist or if the pre-field review and walk-over inspection indicate their presence, the site has high sensitivity. In this case, it is recommended that the forest manager avoid the sensitive area or bring in a cultural resource management professional to conduct a survey.
- **Identification as a low-sensitivity site.** If no cultural resources have been recorded and the pre-field review and walk-over inspection yielded no indications of important cultural resources, the site would have low sensitivity. Proceed with the management activity.

When Accidental Discovery Occurs

Unrecorded cultural resources may be discovered during operations. Guidelines for proceeding depend on the nature of the discovery.

- In the case of human burials, if such discovery occurs, temporary suspension of operations in the vicinity of the discovery is required. **If a human burial site is accidentally discovered, contact the Burial Sites Preservation Office at the Wisconsin Historical Society (800-342-7834 or 608-264-6493).**
- For other types of cultural resources, such as archaeological artifacts, temporary suspension is not required, but is recommended. Suspending operations in the immediate vicinity of the cultural resource will provide time to contact a cultural resource professional, or develop plans to apply appropriate guidelines to avoid or mitigate potential effects.
- Documentation of cultural resources discovered during forest management activities is not required. However, landowners and operators are encouraged to make a written record of their discoveries, and share that information with the Office of the State Archaeologist at the Wisconsin Historical Society.

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

NATIONAL PARK SERVICE - NATIONAL REGISTER OF HISTORIC PLACES

www.nps.gov/nr/

WISCONSIN HISTORICAL SOCIETY (WHS)

See "Historic Preservation" link at the bottom of the page.

www.wisconsinhistory.org/

DEPARTMENT OF NATURAL RESOURCES - CULTURAL RESOURCES

www.dnr.wi.gov – keyword "historic"

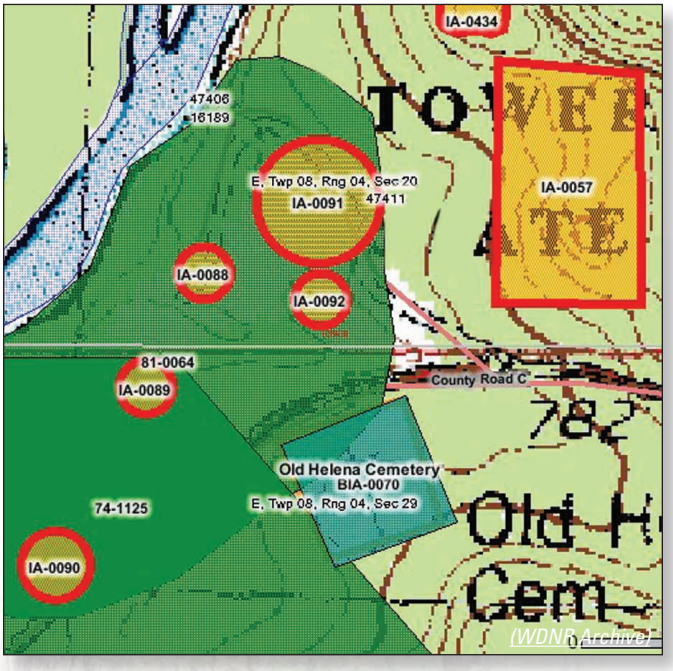
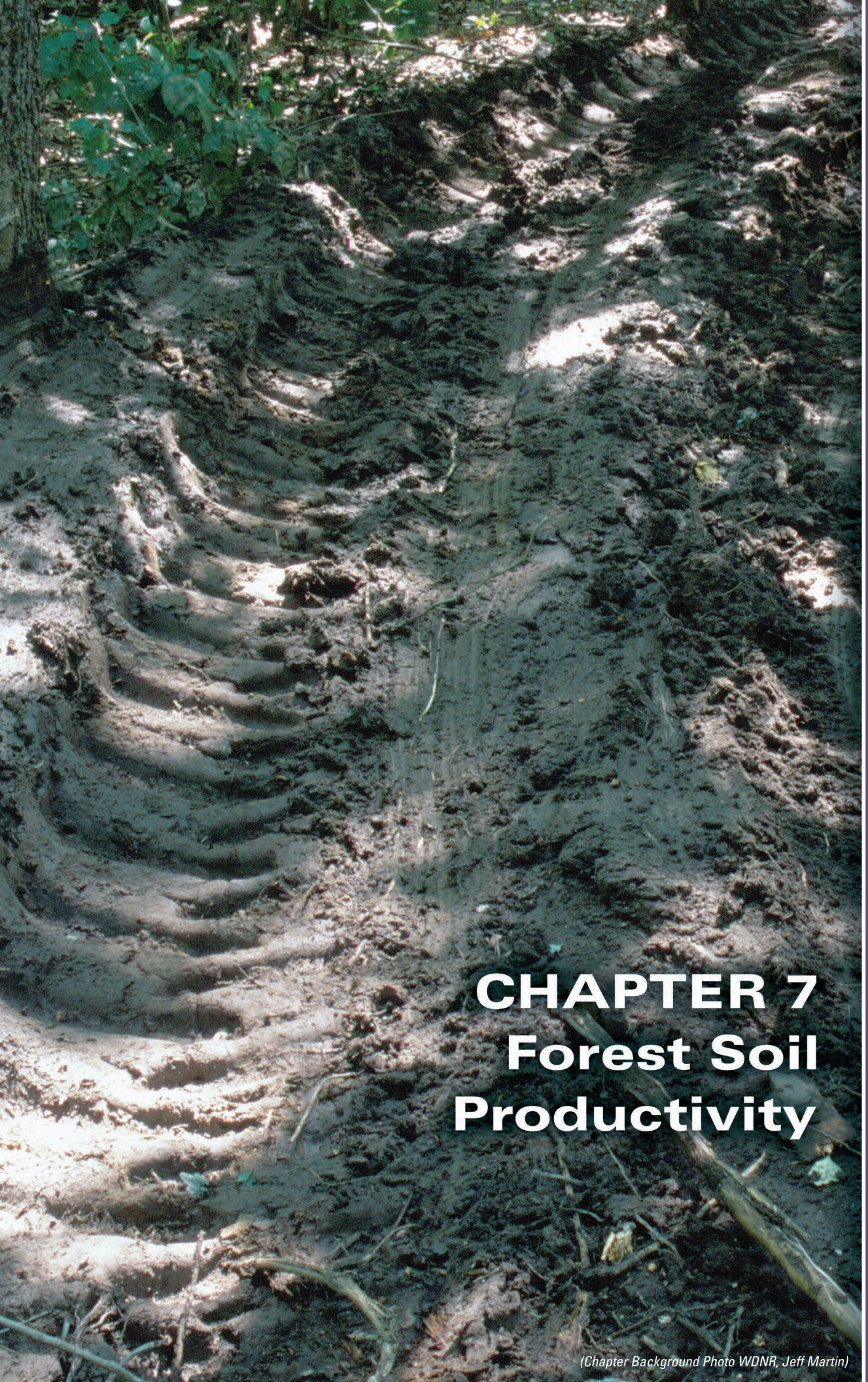


Figure 6-5: The Wisconsin Historical Society maintains the state's official inventory (including maps and data) of archaeological sites and historic structures.

NOTES



7

CHAPTER 7
Forest Soil Productivity

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 7
FOREST SOIL PRODUCTIVITY

THE VALUE OF FOREST SOIL PRODUCTIVITY

Sustainable Soil Productivity

Soil productivity is defined as the ability of the soil, in its normal environment, to support plant growth. In forest management, soil productivity is often measured in species composition and volume of timber produced.

Soil is one of the fundamental resources of the forest. Identifying and minimizing negative impacts to the soil is an essential part of sustainable forest management. Primary considerations in maintaining soil productivity include the following:

- Typically, the more productive a soil, the more timber harvesting that can be supported over time. It also affects other forest attributes, such as wildlife habitat, biodiversity and ecosystem services. Maintaining the productivity of forest soils is key to meeting society's need for forest products and other amenities of the forest, while ensuring future harvesting can be possible.
- Soil productivity is a strong influence on the species of trees that will grow on a site as well as their rate of growth.
- Maintaining soil productivity keeps forest soils in a condition that favors regeneration, increases survival, and increases long-term growth of the forest.
- Maintaining forest soil productivity is less costly than repair after soils have been damaged.

A certain amount of soil impact is inevitable when conducting some forest management activities. In some cases, soil impacts actually promote tree regeneration. This chapter will describe which practices help promote healthy forests and which practices are harmful to forests.

Figure 7-1: Soil type can tell a forester about the potential species the soil is capable of producing, along with the potential growth rates.

SOIL CHARACTERISTICS AND POTENTIAL IMPACTS

Three Related Groups of Soil Characteristics

Soils have physical, chemical and biological components, all of which must be maintained to sustainably manage forests.

- The physical properties of soil include such factors as texture, structure, porosity, density, drainage, and hydrology.
- The chemical properties of soil include its nutrient availability and rates of nutrient cycling, and pH level.
- The biological properties of soil include the multitude of organisms that live in soil and have a role in plant growth. These include mycorrhizae, other fungi, bacteria, and many invertebrates.

Characteristic 1: Physical Characteristics of Soil and Potential Impacts

Soil physical properties are very important in determining tree species composition and rate of growth. These properties impact tree rooting, availability of water and nutrients, availability of oxygen, and water movement through the soil. Negative impacts that can occur during forest management activities include compaction, puddling, rutting, and displacement. These disturbances can be caused by movement of heavy equipment during timber harvesting activities if the harvest occurs during times of the year when the soil is wet or if harvest machinery is not appropriate for the type of forest ground. A consulting forester may require forest harvests to occur during dry or frozen ground conditions and may even require low pressure tire or tracked equipment, depending on the site conditions.

SOIL COMPACTION

Soil compaction is the increase in soil density resulting from heavy loads applied to the soil surface. Compaction results in the loss of pores (air gaps) in the soil structure. The number and size of pores in the soil directly affect air and water movement in the soil. Having large pores in the soil is particularly important in regulating the rates of water and air movement.

The first few trips with heavy equipment over the soil surface produce the greatest increase in soil density (i.e., the most compaction; see Figure 7-2). Machine vibration may also contribute to compaction.

Limiting soil compaction is important because it can decrease the rate of tree growth (Pritchett 1979, p. 444). Compaction leads to a lack of oxygen and the build-up of carbon dioxide and other toxic gases in the soil which can cause damage to tree roots. Soil micro-organisms that play a role in making nutrients available to plants are also negatively affected by the lack of oxygen and high levels of toxic gasses. Compaction further affects root growth by making it more difficult for the roots to grow through soil. It decreases pore space, which reduces the rate of water movement into the soil so that less moisture is available for plant growth. Also, compaction causes more rainfall to flow overland, which can increase erosion and sedimentation.

Recovery of compacted soil is variable depending on the severity of the compaction and local conditions. Compaction is a long-term rather than short-term effect. Severely compacted soils may require up to 40 years or more to recover naturally, according to Hatchell and Ralston, 1971. Froehlich and McNabb, 1984 state that "... the effects of soil compaction should be assumed to persist for several decades on forest sites." Soil compaction is a concern on soils with higher amounts of organic matter, more so than sandy soils. Loggers can reduce the amount of soil compaction by using low pressure tires, using tracks on their tires or placing harvested tree tops along their paths to reduce soil compaction. Professional foresters are aware of the conditions that cause soil compaction, and will write specific language into a timber sale contract to ensure contractors minimize soil compaction issues. Landowners should also be proactive and discuss issues such as soil compaction with your forester.

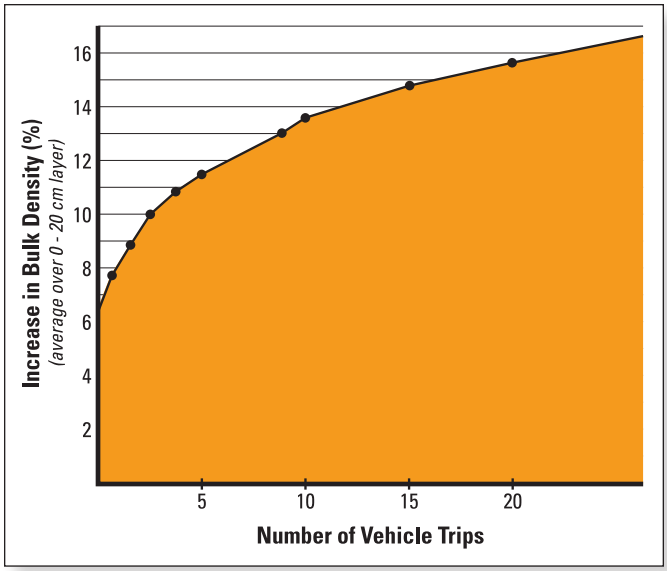


Figure 7-2: Effect of vehicle trips on soil density. *(Adapted from Froehlich et al., 1980)*

Figure 7-3: Tracked vehicles or vehicles with oversized tires like the one pictured above, have lower ground pressure and can help limit the negative impact on soils that compaction or rutting would cause.

Even in cold climates, where the action of freezing and thawing presumably loosens soils quickly, the density of compacted soils decreases slowly (Voorhees, 1983 and Corns, 1988). In an ongoing study in Minnesota and the Lake States (Stone and Elioff, 1998), no reduction in soil density has been measured after five years of intentional compaction.

Cattle can also cause soil compaction when allowed to trample the soil in forests and woodlots. Damage can be particularly severe when grazing pressure is heavy, soils are wet, and livestock use continues over a long time period. Tree roots may be directly damaged by hoof impacts that create wounds where insects and diseases can enter trees. Seeds, seedlings and saplings of many tree species are browsed, reducing or eliminating forest regeneration and recruitment. Cattle also affect vegetation. In extreme cases, the herbaceous layer may disappear leading to additional loss of infiltration capacity and reductions in soil moisture. Aggressive nonnative and sometimes invasive plants, many of which are spread by cattle, easily invade disturbed areas like these. Spiny or thorny plants that cattle do not eat are allowed to grow and may become overabundant, creating an impenetrable bramble. Livestock should be excluded from woodlands that support any quality trees or other desirable vegetation.

PUDDLING

Puddling is the loss of soil structure that results from squeezing and churning wet soils with the tires or tracks of heavy equipment. Puddling often occurs in ruts with standing water. Soil particles become dispersed in water, and after they have dried and settled, the smaller particles form a crust on the surface. Puddled soils affect forest regeneration and growth in ways similar to compacted soils.

RUTTING

Rutting is the creation of depressions made by the tires of vehicles such as skidders, log trucks and pickup trucks, usually under wet conditions. Rutting occurs when soil strength is not sufficient to support the applied load from vehicle traffic.

- Rutting directly affects the rooting environment. It physically wounds or severs roots, compacts and displaces soil, and compacts pores which lowers oxygen levels and limits water movement.
- Rutting disrupts natural surface water hydrology by damming surface water flows, creating increased soil saturation up-slope from ruts. Alternatively, ruts that run parallel to a slope can divert water flow away from a site, drying or draining it. This is extremely evident in organic soil wetlands where 90 percent of the horizontal water flow takes place in the top 12 inches of the soil. Ruts can also concentrate water movement increasing erosion and sedimentation.
- Soil rutting typically occurs along with other physical soil impacts, including compaction and puddling.

DISPLACEMENT

The surface layers of most forest soils are very important to site productivity. These layers are rich in organic matter, contain the bulk of the soil's nutrient and moisture-holding capacity, and support the microbial population. Surface layers cushion soil from traffic and buffer extremes in temperature. Organic matter contributes to soil aeration, and provides sites for seedling germination and rooting. Conserving organic matter is an important factor in maintaining site productivity. Displacement of surface soils, whether moved within a stand or removed from the site, can be detrimental.

Loose, sandy soils are sometimes impacted by heavy equipment on slopes or roadcuts. These sandy soils can slump downhill due to gravity, or can be eroded by wind and water. The continual displacement of the surface soil prevents revegetation on these areas, and removes them from productivity.

Figure 7-4: In this case, soil compaction and erosion is the result of heavy foot traffic on shallow soil along a popular trail. Injuries to roots and reduced aeration can kill trees. Similar damage can also be caused by livestock grazing, vehicle traffic, and other concentrated land uses.

SOIL EROSION

Soil erosion is most commonly associated with roads and skid trails (see Chapter 12: Forest Road Construction and Maintenance). Erosion seldom occurs on areas with established vegetative cover or flat areas. Care must be taken to protect bare soil, especially during harvesting practices that removes forest cover on steeper slopes (e.g., coppice, overstory removal, seed tree, etc.). Extra care should be taken on long slopes or slopes greater than 10 percent. Sometimes, large, dense infestations of certain nonnative invasive plant species (e.g., honeysuckles) may contribute to increased erosion, as these species do not hold soil in place as well as native plants.

WATER TABLES

Forests on sites that have water levels near the surface are sometimes subject to a rise in water tables after a harvest. The rise in water tables, also known as "swamping out," occurs due to the loss in uptake of water by trees. For example, many ash stands occur in these high water table areas. Care should be given when conducting harvests in these areas to not remove all the overstory trees, as that will create a rise in the water table and may make it difficult to regenerate new trees in these areas.

PROTECTING SOIL PHYSICAL PROPERTIES

- **Compaction and Rutting:** Finer textured soils such as silt and clay soils or soils shallower to bedrock are more susceptible to compaction and rutting. It may be important to adjust harvest timing and techniques to protect these soils. Coarse textured and fast draining soils may not require some of these considerations and it may be possible to harvest these sites year round, but conditions and sites can vary. Care should still be used to evaluate all soils prior to harvesting to determine if adjustments should be made.

Figure 7-5: Excessive ruts caused by logging equipment should be dealt with promptly – before rain or melt water turns them into major gullies.

The timing of forest management activities, type and placement of infrastructure (roads, landings, etc.), selection of equipment, and operating techniques are all critical factors in avoiding effects to the soil resource. It is important to avoid operating heavy equipment on a site when adverse soil impacts are likely, and to limit harvest operations on a site to the smallest area possible. Limiting operations to drier seasons or to frozen ground conditions can limit impacts to the soil. Spring and summer, following heavy rains, and in the fall just before freeze up are times to avoid as saturated soil conditions can be present and should be avoided. On sensitive soils during saturated conditions, management activities could result in heavy damage.

The preferred operating season for any one site may vary depending on local climatic conditions, equipment being used, and operating techniques. The use of low ground pressure (LGP) equipment and operating techniques such as the use of slash mats can extend operating seasons on low-strength soils. Infrastructure development, including roads, landings and skid trails, almost always results in direct soil compaction and reductions in forest growth. It is critical to minimize the area occupied by infrastructure to reduce the impact to soil productivity.

Figure 7-6: Compaction and rutting can cause ponding and slow water infiltration. Ponds may benefit amphibians, but they reduce forest productivity and can result in erosion and sedimentation.

- **Erosion:** Erosion can be a problem on areas where there is a lack of vegetative cover, such as on roads or skid trails. Erosion can lead to soil losses and sedimentation of streams and other water bodies. Techniques for limiting soil erosion and sedimentation from roads are discussed in Chapter 12: Forest Road Construction and Maintenance.
- **Swamping:** Rises in the water table can be avoided by considering subsurface soil conditions and their effect on drainage, and avoiding excessive harvesting on these sites. Swamping typically occurs on "moist, level to gently sloping sites where lateral drainage is restricted and impervious layers prevent downward movement of water" (Pritchett 1979, p. 459).

POSITIVE IMPACTS FROM SOIL DISTURBANCE

As a landowner and/or manager, there are a lot of considerations when managing land and establishing a timber harvest. While this chapter has provided important aspects to consider in order to protect soil, not all disturbances are negative. It is important to note that in some instances disturbance is needed to help promote certain species. For example, soil scarification is a common practice used to help promote oak or birch on a site. Soil scarification is the exposing of mineral soil, often accomplished by running a bull dozer with a blade across the surface of the soil. Some tree species do better when mixed with mineral soil, which is why scarification is important. Root raking is another tool used in combination with a bull dozer that has shown to be successful in promoting oak regeneration.

Contacting a professional forester who works in your region and is familiar with your soil type will be able to best navigate what practices should be avoided, and what types of soil disturbance practices may actually help achieve your objectives.

Characteristic 2: Chemical Characteristics of Soil and Potential Impacts

Soil chemical properties include nutrient availability and pH of the soil. Soil chemical characteristics are influenced by many factors including soil origin, soil texture, drainage, degree of soil weathering and development, and organic matter content. Forest management affects the nutrient status of a soil/site through 1) removal of nutrients in forest products and 2) disturbance of surface soils through harvesting and site preparation activities.

NUTRIENT CYCLING

Nutrient cycling is the process by which nutrient elements move into, out of and within an ecosystem. Forested ecosystems receive natural inputs of nutrients through atmospheric deposition and mineral weathering (see Figure 7-7).

Throughout the life of a stand, these inputs can be very significant. Outputs of nutrients occur through timber harvesting or other practices that remove soil or organic material from the site, and through leaching and surface runoff.

NUTRIENT STATUS AND REMOVALS

Soils accumulate nutrients through mineral weathering and contributions from the atmosphere (Kolka et al. 1996). Nutrients are lost from a site through leaching, volatilization (conversion to a gas) in the case of nitrogen, and removals in harvested wood. If nutrient losses are greater than nutrient inputs over the time period it took to grow the forest, nutrient depletion can occur (Johnson et al. 1988). The likelihood of nutrient depletion is greater with shorter rotations, when working with nutrient-demanding species, or when whole-tree harvesting occurs.

The nutrient availability of sites in Wisconsin varies widely, depending on the origin and the depth of soil. For example, one soil may contain 50 times the amount of calcium in the rooting zone than another soil formed from a different parent material (Grigal and Bates 1992). Some soils have little potential for mineral weathering, as minerals are lacking in the parent material.

Soils shallow to bedrock have less nutrient-holding capacity because the volume of soil available to roots is smaller. This "affects nutrient and moisture supplies, root development, and anchorage against windthrow" (Fisher and Binkley 2000, p. 272). Gale and Grigal (1987) showed that 95 percent of fine roots occurred within the upper 40 inches of soil, indicating that this soil zone supplies nearly all of the available nutrients. Soils shallower than 40 inches are potentially more susceptible to nutrient depletion (Grigal and Bates 1992). Forest growth is correlated with depth to bedrock or another root-restricting layer (e.g., fragipan), with the greatest decline in growth evident on soils less than 10 inches deep (Fisher and Binkley 2000).

Wetland soils also have a unique nutrient status. These soils are saturated to a zone near the surface, and mineral weathering is slowed by a lack of oxygen availability in the soil. Many of these soils receive nutrient inputs only from runoff, and are particularly susceptible to nutrient losses due to harvesting, especially potassium (K) and phosphorous (P). Grigal (2004) has estimated that for these kinds of sites in Minnesota, "about 30 percent of the system K and 20% of the P would be lost in each 50 year rotation…This is a consequence of the low rates of natural K and P replacement in peatlands, and implies a high potential for deficiencies to occur with intensive harvest" (Grigal 2004).

There is uncertainty in predicting the exact amount of potential nutrient losses due to harvesting, and more research is needed in this area. It is known that some tree species accumulate more nutrients than others, and harvesting nutrient-demanding species removes more nutrients from the site. Nutrient-demanding tree species include the aspens, oaks, and northern hardwood species (Perala and Alban 1982, Johnson et al. 1988, Rutkowski and Stottlemyer 1993). A whole-tree harvest or a harvest for woody biofuels removes more nutrients than traditional harvesting. When nutrient-demanding tree species are whole-tree harvested, or removed in biofuel harvests on sites with limited nutrient capital, concerns for potential nutrient depletion are greatest. Studies in Michigan on sandy outwash soils found nutrient depletion in conjunction with whole-tree aspen harvest (Stone, 2001). This is a concern for Wisconsin sites with low nutrient availability.

Nutrients are stored in different amounts in various parts of a tree. On average, about half of the mineral nutrients are contained in tree tops (material less than 4" diameter); however, the amount varies by species and season. Some species (e.g., aspens) store a large amount of calcium and magnesium in the bark.

Figure 7-7: Nutrient Cycling (Adapted from Figure S-2, pg. 17, Forest Soil Productivity, Voluntary Site-level Forest Management Guidelines: Sustaining Minnesota Forest Resources)

Seasonal movement of nutrients within the tree itself inform a decision about whether to harvest in the summer, when the foliage of deciduous trees would be removed during whole-tree harvests, versus harvesting in winter. In fall, nutrients move from leaves to twigs and small branches, which are still removed in a winter whole-tree harvest, so the overall nutrient benefits gained by a winter harvest appear to be relatively small (Grigal and Bates 1992, Pastor 1989, Pastor and Bockheim 1984, Johnson et al. 1982). Seasonal harvest restrictions may be important for other reasons, such as avoiding nesting disturbances to wildlife species.

Factors that affect the amount of nutrient removal associated with timber harvest include 1) type of harvest and amount of material removed; 2) tree species and components (branches, foliage, bole, bark) being harvested; and 3) season of harvest. For example, a whole-tree harvest during the growing season removes virtually all nutrients stored in the above ground part of the trees. In the case of a traditional harvest with limbing at the stump, nutrients in the crown and other non-merchantable portions are retained on site. If trees are skidded to a landing before limbing, the nutrients in the crown are removed from the immediate vicinity, but could be moved back into the stand.

NUTRIENT-RETENTION STRATEGIES

- Retain or redistribute slash (tops and limbs) on the site.
- Avoid whole-tree harvesting on nutrient-poor sites.
- Avoid whole-tree harvesting of nutrient-demanding tree species.
- Avoid shortened rotations. Check the Wisconsin DNR *Silviculture Handbook* for recommended rotation lengths.

Many modern harvesting systems require full-tree skidding for efficiency of the operation. In these situations, slash can be redistributed out to the site from the landing. Caution should be exercised during non-frozen seasons to avoid trafficking additional areas while redistributing slash. The negative effects of soil compaction due to increased trafficking could outweigh the positive benefits of redistributing slash. It may be advantageous to leave clumps of slash (drags left along skid trails) or leave slash in the skid trails.

WISCONSIN'S FORESTLAND WOODY BIOMASS HARVESTING GUIDELINES

Wisconsin's Forestland Woody Biomass Harvesting Guidelines focus on the sustainable harvest of woody biomass from forested areas within the context of generally accepted forestry practices, and provide considerations and recommendations applicable to stand and site-level management. These guidelines, when applied in concert with other forest management guidelines (*Wisconsin Forest Management Guidelines*, (FMGs), *Wisconsin Forestry's Best Management Practices* (BMPs) and the *Wisconsin DNR Silviculture Handbook*), address potential impacts of increased biomass harvesting on biodiversity conservation, soil nutrient depletion, physical properties of soil, and water quality. The objective is to provide guidance to forest resource managers, loggers, equipment operators, contractors, and landowners in Wisconsin, and to facilitate operational analysis and informed decision-making regarding the harvest of woody biomass from forestland.

Traditional timber harvests generally remove woody material greater than four inches in diameter from the bole of a tree for use in traditional forest products, while smaller material is left on site. In "biomass harvests," the entire above ground portion of a tree may be removed, including trunk, branches, bark, and leaves or needles. The harvest of fine woody material from forests results in increased removals from a site as compared to traditional timber harvesting, and a higher level of nutrient export. While bio-energy is the typical use for this material, it is important to note that these guidelines apply to any sale of fine woody material regardless of whether the product is energy production.

Wisconsin's Forestland Woody Biomass Harvesting Guidelines can be found on the Council on Forestry website at: ***https://councilonforestry.wi.gov/Pages/WoodyBiomass/Overview.aspx***.

Figure 7-8: Retaining slash on skid trails is an effective way of reducing soil compaction and rutting from use of heavy logging machines.

Characteristic 3: Biological Characteristics of Soil and Potential Impacts

Biological characteristics of soil include the populations of plants and animals, including microflora (fungi, bacteria, algae) and microfauna (worms, arthropods, protozoa). Forest soils contain a multitude of microorganisms that perform many complex tasks relating to slash and litter decomposition, nutrient availability and recycling, and tree metabolism and growth. Generally, the number of organisms is greatest in the forest floor and the area directly associated with plant roots (Pritchett, 1979).

The population of soil organisms (both density and composition) and how well that population thrives is dependent on many soil factors including moisture, aeration, temperature, organic matter, acidity, and nutrient supply (Pritchett, 1979).

Mycorrhizae are soil fungi that grow into tree root hairs, forming a symbiotic relationship that is important in nutrient uptake for most tree species, particularly on nutrient-poor sites. Tree species that rely on mycorrhizal fungi include pine, spruce, fir, maple, ash, birch, beech, oak, basswood, black walnut, black cherry, and willow. Afforestation has proven difficult in areas where mycorrhizae are not present in the soil, and trees planted in such sites are sometimes inoculated with a mycorrhizal fungus to improve establishment. Loss of the forest floor layer, or deforestation that dries and warms a site, can negatively impact populations of mycorrhizal fungi.

Infiltration of moisture into the soil is aided by dense ground vegetation and thick forest floor, or duff layers, which act to intercept and hold rainfall. Activities that remove or thin the herbaceous plant cover and duff layer will contribute to greater runoff and potential erosion. The use of vehicles in forested sites can damage ground vegetation and remove or displace the forest floor layer. Trampling and grazing by cattle can also have these effects, particularly when combined with soil compaction that also reduces infiltration capacity. Some nonnative invasive shrubs contribute to reduced infiltration, by capturing virtually all available sunlight so that no herbaceous plants grow beneath them, leaving the soil bare and unprotected.

Some nonnative invasive plants directly change the chemistry and interrelationships of mycorrhizal fungi. Common buckthorn leaves are very high in nitrogen and decompose very quickly. This alters the soil carbon: nitrogen ratio that favors invasive species. It also reduces the leaf litter layer and organic matter in the soil, thereby reducing water infiltration rates and water holding capacity. This combination makes seedling germination and survival difficult for any native trees and understory plants. Garlic mustard interferes with tree regeneration by releasing chemicals that harm a soil fungus many trees depend on for growth and survival. Some bush honeysuckle species release chemicals into the soil which inhibit the growth and reproduction of other plants and act as a deterrent to insect herbivory. (See Forestry BMPs for Invasive Species [IS-BMPs] on page 7-12 and in Chapter 8: Threats to Forest Health.)

"Pit and mound topography" is a term that refers to the soil surface in a forest where occasional large trees have fallen or been blown down. The tree's root system pulls up a mound of soil, leaving a pit where the tree formerly stood. These pits are important sites for water infiltration into soils, especially on slopes, and also create puddles and ephemeral pools that benefit amphibians and invertebrate organisms.

Physical and chemical soil characteristics can be influenced by forest management as previously discussed. Impacts to these soil properties may directly impact soil biology, thereby impacting the functions of the organisms – many of which are beneficial to plant growth. Implementation of practices that protect the physical and chemical properties of the soil also protects the habitat of the soil organisms and sustains their populations.

Figure 7-9: Buckthorn, a nonnative invasive species, has invaded this woodland in southern Wisconsin, changing the soil chemistry and reducing the water infiltration and holding capacity. These changes make tree seedling germination and survival difficult.

APPLYING GUIDELINES TO VARYING SITE CONDITIONS

Forests in Wisconsin grow on a variety of soils and site conditions. These different site conditions include soil types formed from different parent materials, varying topography, and with different management histories.

Because site conditions vary, it is important for individuals making forest management decisions to evaluate the soil and topography of each site.

Site-specific information helps the manager develop individualized prescriptions to ensure productive capacity is not reduced as a result of forest management activities.

Figure 7-10: Retaining slash may be a bit unsightly, but it provides some shelter for new seedlings and adds organic matter and nutrients to the soil. When crushed by heavy equipment, it decomposes rapidly.

BMPs: Invasive Species

Certain types of soil disturbance can encourage an invasion of nonnative plants which can have an impact on soil productivity. Consider the following Forestry BMPs for Invasive Species (IS-BMPs) to avoid or minimize impact to forest soils. (See Chapter 8: Threats to Forest Health for more on invasive plants and IS-BMPs.)

- 3.4 Plan management activities to limit the potential for the introduction and spread of invasive species.
- 4.3 Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.

RESOURCES FOR ADDITIONAL INFORMATION

SILVICULTURE HANDBOOK

Silviculture Handbook. Wisconsin Department of Natural Resources, Publication Number 2431.5, Madison: Wisconsin Department of Natural Resources, 2010.

SOILS LAB ANALYSIS

University of Wisconsin Soil and Plant Analysis Labs are located in Madison and Marshfield.
uwlab.soils.wisc.edu

WEB SOIL SURVEY MAPPING PORTAL

The NRCS Web Soil Survey provides soil data and information produced by the National Cooperative Soil Survey in an easy to use interactive web mapping application.
websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

WISCONSIN'S FORESTLAND WOODY BIOMASS HARVESTING GUIDELINES: FIELD MANUAL FOR LOGGERS, LANDOWNERS, AND LAND MANAGERS

Wisconsin's Forestland Woody Biomass Harvesting Guidelines: Field Manual for Loggers, Landowners, and Land Managers. Wisconsin Department of Natural Resources, Publication Number FR435-2009, Wisconsin Department of Natural Resources, 2009.
https://councilonforestry.wi.gov/Pages/WoodyBiomass/Overview.aspx.

WISCONSIN NATURAL RESOURCES CONSERVATION SERVICE (NRCS)

Published soil survey reports for most Wisconsin counties are available through your local NRCS or county Land Conservation Department offices. Soil survey reports include:

- Detailed soil maps on an aerial photo background
- Descriptions of the soils
- Soil use and management information
- Recreational development information
- Soil property and interpretation information in table format

More information about soil survey reports is available at:
www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey.

8

CHAPTER 8
Threats to Forest Health

(Chapter Background Photo WDNR, Bryn Scriver)

CHAPTER 8
THREATS TO FOREST HEALTH

WHAT ARE THREATS TO FOREST HEALTH?

There are many factors that can affect the health of a forest. Some are abiotic, such as damage from wind, drought, hail, or fire. Others are biological, such as insects, disease-causing organisms, and worms and plants which compete with desirable forest species. This chapter only addresses biological threats to forest health and productivity.

Wisconsin forests have a long co-evolutionary history with native insects and diseases, but these natives can still be very damaging. Forest tent caterpillar and spruce budworm are two native pests that periodically increase to very high populations and cause heavy defoliation and mortality of their hosts. However, outbreaks are naturally limited by natural enemies of the pests and/or the overinflated pest population changing the conditions that favored the development of the outbreak. For example, a jack pine budworm outbreak leads to defoliation and death of mature jack pines that supported initial growth of the pest population; as the budworm population faces starvation, it becomes vulnerable to attack by disease and parasitoids. Starting in the early twentieth century and increasingly in recent years, nonnative pests and diseases have presented a greater threat to Wisconsin forests. For this reason the focus of this chapter will be on invasive species.

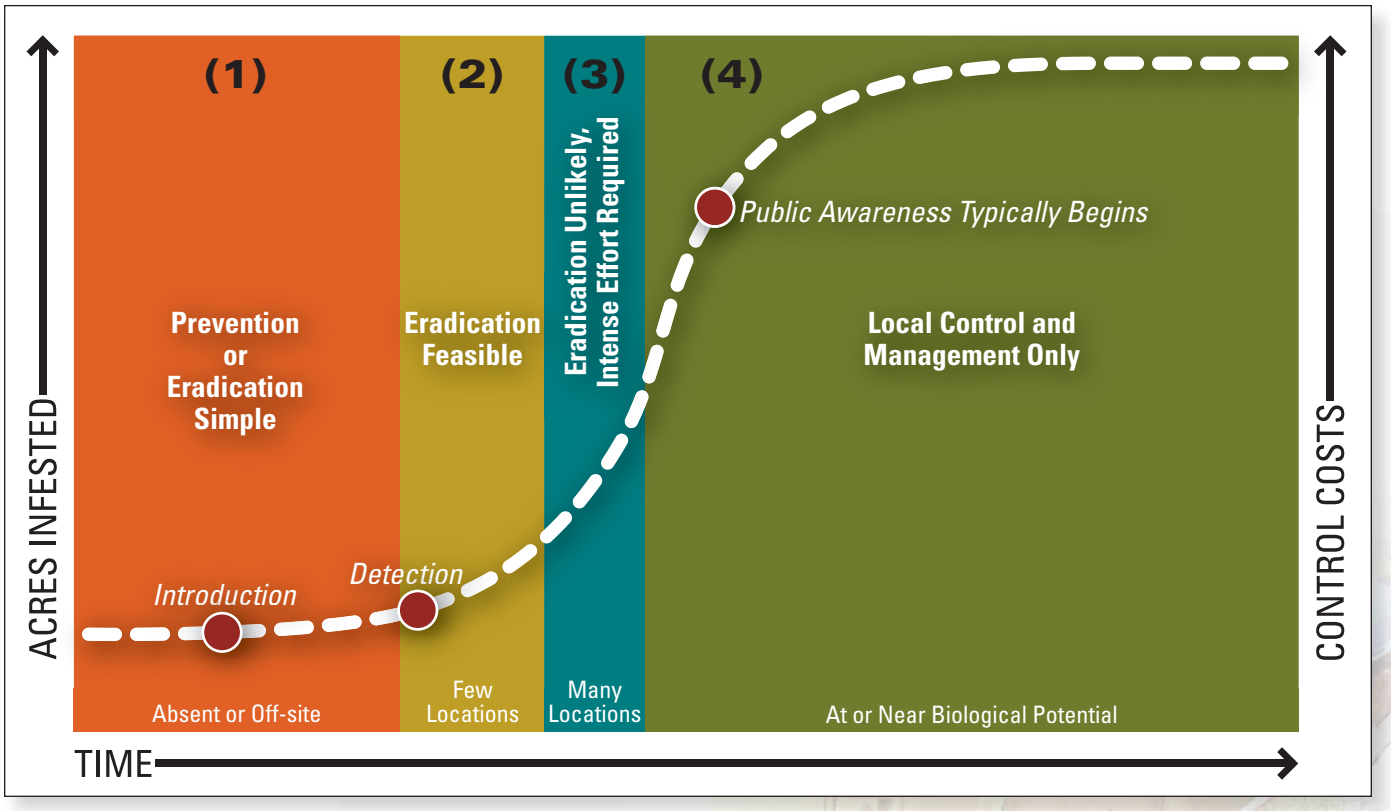


Figure 8-1: Invasive Plant Increase Over Time and Control Potential. The process of invasion is characterized in four phases. The first phase (1) is the introduction phase where prevention or eradication is possible. Typically an introduced species must survive at low population densities before it becomes invasive in a new location; some species are present for many years before they exhibit damaging potential. The second phase (2) has a few populations and eradication is still feasible, though increasingly difficult. If an invasive species is detected early, when it is only found in low numbers in a few locations, it may be possible to eradicate it. The third phase (3) is characterized by many more populations and eradication is unlikely, though it may be possible to slow the spread of the species from the area of infestation. The fourth phase (4) begins when the population is at or near its biological potential and local control and management of damage inflicted by the species is the only option.
(Figure Credit: The Nature Conservancy, John Randall)

WHAT ARE INVASIVE SPECIES?

For the purposes of this guide, any plants, insects, worms, and disease-causing organisms are considered invasive if they are not native to an area and cause harm to ecosystems, the economy or human health.

Most species that have been accidentally or deliberately introduced and established cause no harm or may even be considered beneficial (e.g., daffodils, honeybees). Only a small proportion of these nonnatives have gone on to cause damage and be classified and/or regulated as invasive species (e.g., garlic mustard, emerald ash borer). Even among these invasive species, a few may have useful characteristics that are valued by some people (e.g., reed canary grass).

A notable difference between native and invasive pests and diseases is that invasive species are often harder to control. One reason control of invasives presents a challenge is these species generally posses the advantage of having arrived in an area absent of natural enemies and competitors that keep them largely in check in their native range. In addition, native host species that did not evolve alongside the invasive species are unlikely to have evolved effective defenses against them, allowing the invasive to attack relatively unopposed.

The number of introductions of foreign species has been increasing dramatically since the early 1900s and remains on the rise. This increasing trend of introductions parallels the increasing volume of global trade. The increasing speed with which cargo moves from continent to continent and around the country favors survival of plants and insects that hitchhike in cargo. In the past, cargo containers were opened at the first point of entry, which somewhat limited the spread of nonnative species, but in the present day, cargo containers are quickly transported to their final destination before unpacking, effectively transporting nonnative species to a wide range of new destinations every year. The introduction of invasives is only expected to increase over the coming years, therefore, invasives pose both a present and future threat to forest health in Wisconsin.

Figure 8-2: Japanese barberry for sale at a nursery.

Figure 8-3: Japanese barberry invading a woodland.

INVASIVE SPECIES ARE A THREAT TO FORESTS

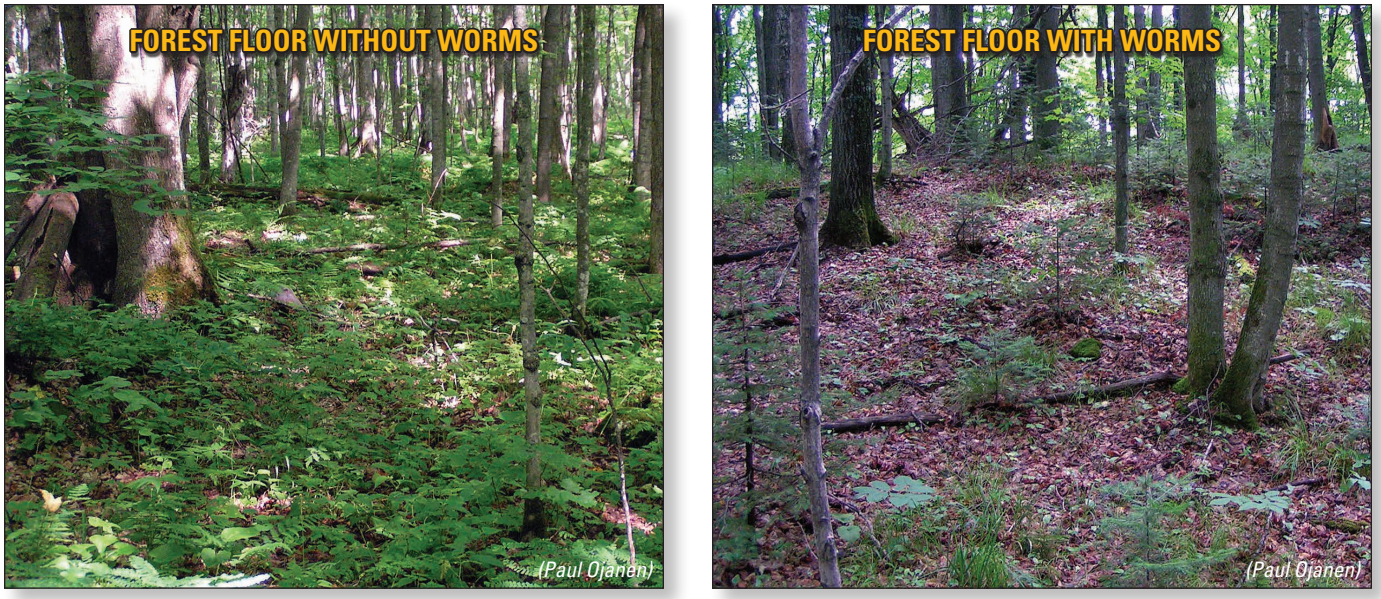


Figure 8-4: Notice abundant sugar maple seedlings in the stand without worms, compared to the absence of tree seedlings where worms are present.

Invasive insects and diseases have had a significant, negative impact on several commercially important tree species, causing widespread mortality in some and a reduction of growth in others. Invasive plants and worms can have a more forest-wide effect, preventing successful regeneration of tree species and eliminating most native species of the herbaceous layer.

- **Emerald ash borer (EAB)** attacks and kills all North American species of ash it has encountered. There appear to be individuals with some resistance but it is rare. This pest has the potential to cause the commercial extinction and possibly the actual extinction of ash species on this continent. Commercial extinction is the reduction of a species to such low numbers that, although it is still present, harvesting it is no longer profitable.
- **Chestnut blight *(Cryphonectria parasitica)*** killed all American chestnut back to their rootstocks within 40 years, resulting in the economic extinction of this valuable and formally abundant species. The species survives as sprouts on dwindling rootstocks and in isolated groves far from the native range.
- **Gypsy moth** preferentially feeds on oaks, causing repeated defoliation during the development and peak of outbreaks which weakens and contributes to mortality of even dominant trees.
- **Beech bark disease complex** (of an invasive scale and either a native or an invasive *Nectria* fungus) rapidly kills American beech. Between one and five percent of the beech population is resistant to the scale disease, and holds the hope of recovering this species. However, the genetic bottleneck it will go through is expected to reduce genetic diversity and may leave the species vulnerable to other pests and diseases.
- **Dutch elm disease** has removed American elm as a canopy dominant species in lowland forests, although the species persists as a short-lived tree along forest edges.
- **Invasive plants** directly impact forest health and species composition by reducing tree regeneration, growth and longevity. Common buckthorn *(Rhamnus cathartica)* and nonnative earthworms alter forest soil structure and chemistry impacting tree regeneration and growth *(Bohlen et al. 2004, Heneghan et al. 2004, 2006)*.
- **Invasive worms** devour the layer of leaf mold many northern forest trees and herbs require for seedling survival. Worms also compact the soil and homogenize the layers to the detriment of adult trees.

INVASIVE SPECIES AND FOREST MANAGEMENT

Figure 8-5: The garlic mustard that dominates the understory in this stand will greatly impact forest stewardship.

As invasive species spread to new areas, forest management or stewardship plans may need to be adjusted to minimize or account for the impact invasives may have on achieving the goals of the plan. Talk with your forester about invasive species that could impact the plan for your forest, and learn how to identify and manage species spreading into or increasing in abundance in your area. Stay alert for their presence and impact on your property, and if necessary, work with your forester to adjust the management plan to maintain a productive and sustainable forest. For example:

- Where established, emerald ash borer (EAB) is killing all ash trees. Managers of properties where the loss of ash would impact their forest stewardship goals should work with their forester to minimize financial losses from EAB, and to regenerate a diverse forest in the wake of the killing front from this pest.
- Increased competition from invasive shrubs including buckthorns and honeysuckles has made regeneration of desirable forest trees impossible if the invasive plants are not controlled following thinnings or harvests. Treatments to reduce invasive plants may need to be added to stewardship plans where these plants are abundant.

Figure 8-6: Extensive ash mortality caused by EAB in southeast Wisconsin.

Forest management activities can create site conditions suitable for many opportunistic invasive species. These conditions can occur through site disturbance that exposes soil and creates a seedbed for invasive plants, or by releasing invasive plant seeds that are already present. Forest management activities may also increase the likelihood of invasive **propagules** being accidentally introduced to a site. However, some simple precautions can largely reduce the risk of inadvertently introducing or encouraging invasive plants, worms, diseases and pests. When planning control of one invasive species, keep in mind that others may also need to be managed at the same time for successful maintenance of the forest.

Figure 8-7: Common buckthorn was removed from this stand to promote regeneration. The ensuing disturbance allowed garlic mustard to take hold and flourish.

PROPAGULE

Any reproductive structure or part of an organism that can grow independently of its parent source. In plants, this may be a fruit, seed, bud, tuber, root, stem with rooting structures, or shoot. In forest insects, this may be an egg, larva, pupa or adult. In forest diseases, this may be a spore, mycelial fragment (similar to roots), or a fruiting body.

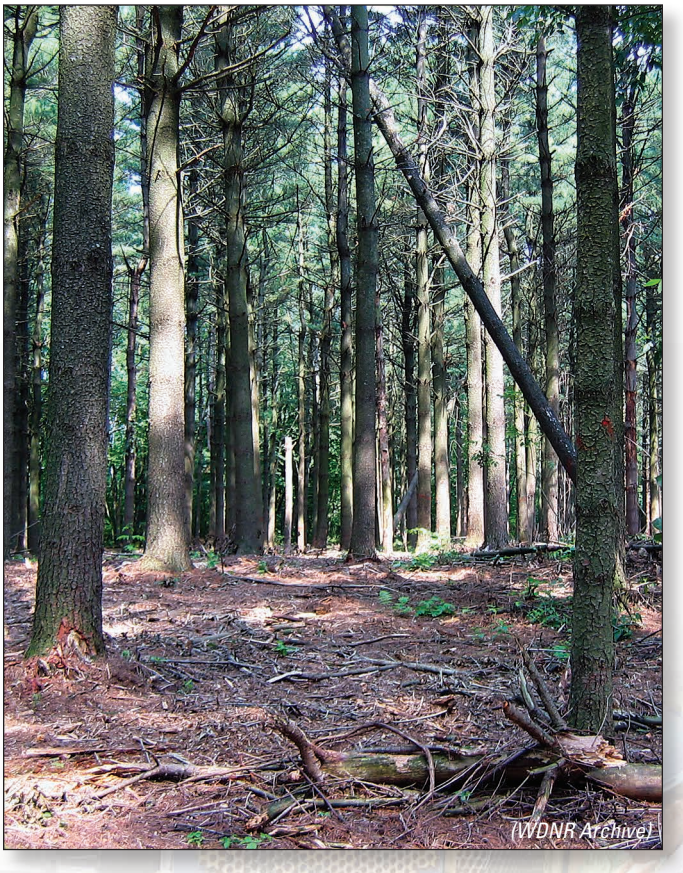


Figure 8-8: The brushing activity has created a favorable bed for invasive plants to grow. It is important to understand the species that were removed as well as those that are nearby, in order to achieve regeneration of desirable species.

ELEMENTS OF INVASIVE SPECIES MANAGEMENT

Invasive species management includes several elements: prevention, early detection and rapid response, control, monitoring, and restoration. Depending on the invasive species you are managing and the situation on your property, your management plan will emphasize action in one or more of these elements.

- **Prevention.** If a property is free of a potentially damaging invasive species, it makes sense to take precautions not to introduce them. Invasive Species Best Management Practices (IS-BMPs) are voluntary precautions that will reduce the risk of introducing many invasive plants, worms, pests and diseases. IS-BMPs have been developed for forestry activities, as well as for recreational users, transportation and utility corridor maintenance, and urban forestry. The IS-BMPs can be found at: ***www.wisconsinforestry.org/initiatives/other/invasive-species-bmps/overview***.
- **Early Detection and Rapid Response.** If an invasive species is detected when its population is still low and isolated, it will be easier to eradicate or contain it. Detection depends on landowners or managers being aware of invasive species that pose a significant threat to achieving the goals for the property and where they are most likely to show up first. Timely response is easier if planned ahead of arrival of a damaging invasive.
- **Control.** Where an invasive species is well established, management should focus on ensuring it doesn't prevent achievement of the goals for the property. The impact of some invasive species may be so severe that property goals may need to be modified. For most invasive species, however, management will be limited to specific areas of the property or when the population threatens to exceed a threshold for damage. Control programs can include manual, mechanical, chemical, biological, and/or cultural components.
- **Monitoring.** Most landowners and land managers will not need complex monitoring programs. Instead, periodic inspections to detect new invasions and to evaluate the success of control measures can be performed. Monitoring can be integrated with other forest activities such as reforestation surveys.
- **Restoration.** The process of restoration involves assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. For most properties, restoration will only be needed in extreme cases where a dominant native species has been eliminated by an invasive pest or disease or where the impact of invasive plants has been heavy and prolonged.

Figure 8-9: Black swallow-wort is a fast-growing vine that will climb trees and shrubs, ultimately engulfing the canopy and shading out its host. Populations are limited to areas in southern Wisconsin, so early detection of the plant is critical. Once identified, it should be controlled quickly to prevent its rapid spread.

Figure 8-10: Traps are used to detect the presence of emerald ash borer.

FORESTRY BMPs FOR INVASIVE SPECIES

Invasive Species Best Management Practices (IS-BMPs) for forestry were developed by the Wisconsin Council on Forestry in 2009 and are intended to aid in the management and control of invasive plants, insects, and diseases in Wisconsin forests. They describe voluntary practices that may reduce the impact of invasive species during forest management activities. Applicable IS-BMPs have been included within several chapters to assist foresters, landowners and loggers in incorporating invasive species issues in their forest management activities. IS-BMPs are identified by " " to help separate them from other recommendations in this guide. The numbers associated with the IS-BMPs refer to the actual BMPs within the forestry field manual *Forestry Best Management Practices for Invasive Species: A Field Manual for Foresters, Landowners, and Loggers* that can be found at: ***www.wisconsinforestry.org***.

BMPs: General

The following are IS-BMPs that generally apply to all activities that take place during forest management. Consult *Forestry Best Management Practices for Invasive Species: A Field Manual for Foresters, Landowners and Loggers* in order to fully understand the intent and meaning of any given IS-BMP. Chapters refer to the specific chapters in the forestry field manual.

CHAPTER 3: MANAGEMENT PLANNING

- 3.1 Include a strategy for managing invasive species.
- 3.2 Prior to implementing management activities, scout for and locate invasive species infestations, consistent with the scale and intensity of operations.
- 3.3 Consider the need for action based on: 1) the degree of invasiveness; 2) severity of the current infestation; 3) amount of additional habitat or hosts at risk for invasion; 4) potential impacts; and 5) feasibility of control with available methods and resources.
- 3.4 Plan management activities to limit the potential for the introduction and spread of invasive species.
- 3.5 Plan for post-activity management of highly damaging invasive species.

CHAPTER 4: FOREST STEWARDSHIP

- 4.1 Provide training in identification of locally known invasive plants and pests to forest workers.
- 4.2 If pre- or post-activity control treatments are planned, ensure that they are applied within the appropriate time window.
- 4.3 Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.
- 4.4 Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.
- 4.5 Take steps to minimize the movement of invasive plants, insects, and diseases to non-infested areas, during forest stewardship activities.
- 4.6 Take reasonable steps to avoid traveling through or working in small, isolated, populations of invasives during forest stewardship activities.

MANAGEMENT OF SELECT FOREST PESTS AND DISEASES

Overall forest health can be encouraged by forestry practices that maintain vigorous growth of better quality trees. By maintaining a diversity of species in a forest, forest managers contribute to the resistance of the entire system to the spread of pests and diseases, and promote the recovery of forest function in the event a component tree species is reduced or eliminated. Occasionally, however, it will be necessary to address individual pests or diseases that threaten the goals for a property. The following tables (Tables 8-1A through 8-1H) list some of the most common and damaging insects and diseases affecting Wisconsin's forests and key management considerations. You can visit the resources at the end of this chapter for more information.

WHITE PINE BLISTER RUST *(Cronartium ribicola)*
TREE SPECIES AFFECTED: WHITE PINE

Figure 8-11: A bleeding canker caused by the fungus white pine blister rust (Cronartium ribicola).

- **Prevention** (if conditions are favorable for blister rust)
  - Manage young white pine under an existing overstory.
  - Plant two rows of a non-susceptible coniferous species, such as spruce, around a white pine planting. The spruce will help to disrupt the movement of infectious spores from gooseberry *(Ribes)* to white pine.
  - Since lower branches are most likely to become infected, begin pruning lower branches of white pine when they are five to seven years old. Attempt to maintain 2/3 of the tree height in live branches. At no time should branches be pruned from more than 1/2 the height of the tree. Prune over time until bottom 9' (minimum) to 17' are free from branches.
  - It is not necessary to prune every tree. Prune only trees on the outside rows bordering areas where there are *Ribes* plants, and the most desirable individuals in the interior of the stand. Aim to prune 100 to 200 trees per acre in natural stands, and 350 per acre in pure white pine plantations.
  - Avoid planting white pine adjacent to woodlots that contain *Ribes* plants, and exhibit conditions that enhance lasting dew formation such as frost pockets, small openings and north aspects.
- **Early Detection**
  - Check trees for flagging branches (dying branches with brown foliage), particularly in lower 9' of stem.
  - Look for areas of rough, dark bark where stem may be constricted and oozing pitch.
  - In spring, check for yellow to orange blisters on branches or the trunk.
- **Control and Management**
  - Trees with blister rust cankers on the main stem or within 4" of the main stem cannot be saved; therefore, pruning will not help.
  - Branches with cankers located 4" or more from the main stem should be removed, no matter where they occur in the crown of the tree.
  - Remove trees with cankers on the main stem during timber harvest or as soon as possible, as spores from active cankers will re-infect *Ribes* and increase the amount of disease in the area.
- **Monitoring**
  - Look for new flagging branches each year and remove them.
- **Restoration**
  - Needs and options will be site specific.

Table 8-1A: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for White Pine Blister Rust (Cronartium ribicola)

OAK WILT *(Ceratocystis fagacearum)*
TREE SPECIES AFFECTED: OAK

- **Prevention**
  - **Urban/Residential Setting:** Oak trees are most susceptible to overland spread in spring and early summer. The Wisconsin DNR advises to avoid pruning, cutting or wounding oaks from April through July 15. If daytime temperatures reach 60°F for seven consecutive days prior to April, stop pruning as transmission of oak wilt is possible. Do not resume pruning until after July 15.
  - **Forested Setting:** For information, refer to *Oak Wilt: Harvest Guidelines for Reducing the Risk of Introduction and Spread in a Forest Setting* at: ***dnr.wi.gov – keywords "oak wilt."***

Figure 8-12: Discolored red oak leaves infected with Ceratocystis fagacearum.

- **Early Detection**
  - **Red Oak Group:** Look for leaves turning a bronze or water-soaked color and rapidly falling from the tree any time from late June to August, or trees losing a portion of leaves in September, and then rapidly losing all leaves just after leaf-out the following spring.
  - **White Oak Group:** Trees drop leaves on one or more branches several years in a row.

- **Control and Management**
  - **Underground Spread:** Disrupting root grafts can stop the underground spread of the fungus. Options include physically severing roots with a vibratory plow, cable plow or trencher. Not all sites are suitable for this option. Steep slopes prohibit the use of root barrier equipment and sites with large rocks inhibit barrier placement. Locating barriers correctly is crucial to success. Guidance on barrier placement is available in *Oak Wilt Management: What are the Options* (University of Wisconsin-Extension Bulletin G3590) or consult a forest health specialist. Other management methods to limit movement of the pathogen in roots chemically or physically have been implemented in the field with some success. Consult a forest health specialist for more information.
  - **Overland Spread:** If healthy trees are wounded during the high risk period of April through July 15 in urban areas, the wounds should be treated with a tree-wound paint to prevent contact with sap-feeding beetles that transmit the fungal spores.

(Continued on page 8-11)

Table 8-1B: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for Oak Wilt (Ceratocystis fagacearum)

OAK WILT *(Ceratocystis fagacearum)* (continued)
TREE SPECIES AFFECTED: OAK

Trees that die from oak wilt produce fungal fruiting mats typically the following spring. If this wood is moved, oak wilt spores will be released at the new location and the disease may spread into unaffected areas. **Wood from trees that have died from oak wilt and have bark that is still tightly attached could harbor fungal fruiting mats.** This wood must receive special treatment (see "Firewood" and "Other Wood Products") before being moved. Once the bark has become loose and falls off the wood, the mats are no longer infectious. In that case, no special treatment is necessary and movement of the wood is no longer a concern.

- **Firewood:** Two methods of wood treatment are effective in preventing overland spread via firewood:
  - **Debarking** (removing the bark from the wood) will prevent the fungal mats from forming. Debarking must be conducted before fungal mats form, and should occur in the late summer, fall or winter following tree death.
  - **Cutting, splitting, stacking and covering the wood with 4 mil. or thicker plastic** will prevent overland spread. All sharp edges or stubs should be cut to eliminate the possibility of puncturing the plastic. The entire pile must be sealed all around. Seal the bottom by covering it with dirt. If the wood is not burned over the winter following tree death, leave the tarp on through the next growing season (until October 1) or until the bark is loose. Once the bark is loose, the wood is no longer infectious.
- **Other Wood Products:** Wood from infected trees may be utilized. Logs with tightly attached bark must be utilized before April 1. Wood chips from infected trees are **unlikely** to serve as a source of spores as chips dry out quickly, and the oak wilt fungus is not a good competitor with other wood decay fungi.
- **Monitoring**
  - Look for wilting foliage on oak trees late June to August.
- **Restoration**
  - Needs and options will be site specific.

Figure 8-13: Red oak rapidly losing its leaves in July; this tree is infected with Ceratocystis fagacearum, the cause of oak wilt.

Table 8-1B: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for Oak Wilt (Ceratocystis fagacearum) (continued from page 8-10)

HETEROBASIDION ROOT DISEASE *(Heterobasidion irregulare)*
TREE SPECIES AFFECTED: RED OR WHITE PINE, SPRUCE AND OTHER CONIFERS

- **Prevention**
  - Prevention of Heterobasidion root disease (formerly known as Annosum root rot) is the most important approach to management as there are no treatments for this disease once infection has occurred. A practical guide is available to help landowners/property managers determine whether a fungicide treatment should be considered to reduce the risk of introduction of Heterobasidion root disease to their pine stand at: ***dnr.wi.gov – search "root disease."*** Information on fungicides registered for this purpose and application options are also available at that website.

- **Early Detection**
  - Look for conifers with thinning crowns, reduced growth in height, diameter and shoots. Also be aware of individuals or pockets of dead and dying pine or spruce in the overstory and understory. Crown symptoms typically appear three to eight years after a thinning or partial harvest where stumps are left among living trees.
  - Additionally, look for individuals or pockets of dead trees with fruit bodies at the root collar of dying or dead trees or stumps (to see this, you may have to pull the duff layer back).

- **Control and Management**
  - Options for management are dependent on several factors. Details on options can be found at: ***dnr.wi.gov – search "root disease."***

- **Monitoring**
  - See "Early Detection."

- **Restoration**
  - This fungus can survive for decades in wood. Expect some further mortality to occur to susceptible species when attempting regeneration. Deciduous trees are resistant to the disease; conversion to hardwoods should be considered, if it is appropriate for the site.
  - After harvest, infected sites may be replanted or naturally regenerated to conifers. In the southeastern United States, regeneration losses have been documented to be a total of about five percent with additional disease development following thinnings. This data is currently not available for Wisconsin.

Figure 8-14: A pine stump with Heterobasidion irregulare fruiting bodies – the cause of Heterobasidion root disease.

Table 8-1C: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for Heterobasidion Root Disease (Heterobasidion irregulare)

BUTTERNUT CANKER *(Sirococcus clavigignenti-juglandacearum)*
TREE SPECIES AFFECTED: BUTTERNUT

- **Prevention**
  - Do not bring diseased butternut wood or bark in close proximity to any healthy butternut trees.
- **Early Detection**
  - Look for elliptical cankers oftentimes oozing dark-colored liquid on root flares, main stems or branches.
- **Control and Management**
  - Encourage regeneration of potentially resistant butternut: 1) Retain all butternut trees with more than 70 percent live crown and less than 20 percent of the combined circumference of the bole and root flares affected by cankers. 2) Retain all butternuts with at least 50 percent live crown and no cankers on the bole or root flares.
  - Currently no individuals are known to have canker resistance. A few healthy butternut trees have been found growing among diseased and dying trees and may be resistant to the disease.
  - Cut butternut trees with less than 70 percent live crown and more than 20 percent of the combined circumference of the bole and root flares affected by cankers.
- **Monitoring**
  - Following control and management, monitor competition for sunlight from other trees and shrubs. Some vegetation management may be needed to allow sunlight to reach butternut seedlings growing under potentially resistant trees.
- **Restoration**
  - See "Control and Management."

Figure 8-15: A butternut tree that is infected with Sirococcus clavigignenti-juglandacearum, the cause of butternut canker.

Table 8-1D: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for Butternut Canker (Sirococcus clavigignenti-juglandacearum)

BEECH BARK DISEASE COMPLEX
(*Cryptococcus fagisuga* and *Neonectria* spp.)
TREE SPECIES AFFECTED: AMERICAN BEECH

- **Prevention**
  - Do not bring beech wood or bark in close proximity to healthy beech.
- **Early Detection**
  - Newly infested trees will have tiny spots or patches of "white wool" tucked into rough areas of bark on the trunk. These are the scales that cause the wounds that allow entry of the *Neonectria* fungi. As the scale population builds, the entire trunk and large branches of the tree can become covered with white wool.
  - Tarry spots are often an early symptom of trees infected by *Neonectria*. Tarry spots occur when a brownish fluid oozes from a dead spot on the trunk.
- **Control and Management**
  - Management options are largely based on the disease status of the forest and the percent of beech present. Detailed guidance can be found at: ***dnr.wi.gov – keywords "beech bark disease."***
  - This disease typically causes infected trees to fail, break or "snap." This can cause a hazardous situation if failure threatens to injure people or property. Remove these hazard trees promptly when scales are found.
- **Monitoring**
  - A small percentage of American beech are resistant to the scale that makes infection by the disease possible. Report beech that are free of scales when surrounding beech are infested to a forest health specialist so that these resistant trees may be included in breeding programs to develop resistant beech for restoration of this species. Contact information for forest health specialists can be found at: ***dnr.wi.gov – keywords "forest health staff."***
- **Restoration**
  - Retain any beech that are free of scales when surrounding trees are infested. These are resistant trees.

Figure 8-16: An American beech with black tar-like spot (sign of fungal canker) and beech scale (white fluffy substance).

Table 8-1E: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for Beech Bark Disease Complex (Cryptococcus fagisuga and Neonectria spp.)

EUROPEAN GYPSY MOTH *(Lymantria dispar)*
TREE SPECIES AFFECTED: OAK

- **Prevention**
  - As of 2017, gypsy moth is still not established in counties on the far western side of Wisconsin. A Slow the Spread (STS) program uses traps to detect outlying populations which are then treated to prevent westward spread of the invasive pest. A quarantine has also been established to limit the spread of gypsy moth. For more information on the STS and aerial spray programs, the current range of gypsy moth in Wisconsin, or a map of the areas under quarantine, go to ***gypsymoth.wi.gov***.
  - Gypsy moth is often moved as egg masses on firewood, outdoor furnishings or vehicles stored outdoors. To avoid importing gypsy moth to your property, obtain firewood close to where you will use it and check outdoor items and vehicles stored outdoors for egg masses. Remove the egg masses before moving these items from areas where gypsy moth is established. Homeowners can go to: ***datcp.wi.gov/ Pages/Programs_Services/ GMPvtCitizen.aspx*** for instructions and a checklist for self-inspection to ensure you are complying with regulations to prevent the spread of gypsy moth.
- **Early Detection**
  - Look for tan-colored egg masses left behind by the female moths. The egg masses are the size of a nickel or quarter, and are covered with thousands of tiny, fuzzy hairs. Old egg masses that hatched last spring are soft, pale and not a concern. Egg masses can be found on tree trunks and the underside of branches, as well as on buildings, firewood, vehicles, play sets, and other outdoor objects.
  - Gypsy moth caterpillars change appearance as they grow. Young caterpillars are black or brown and about 1/4" in length. Mature caterpillars can be as long as 2-1/2" and have distinctive pairs of blue and red dots running down their backs.
  - Gypsy moth adults are seen only in mid-summer. Males are grayish brown and can fly; females are white and cannot fly.
  - If you find gypsy moth in the far western counties of the state, outside of the quarantined area, report them to: ***gypsymoth@wisconsin.gov***. Include electronic images with your report.

(Continued on page 8-16)

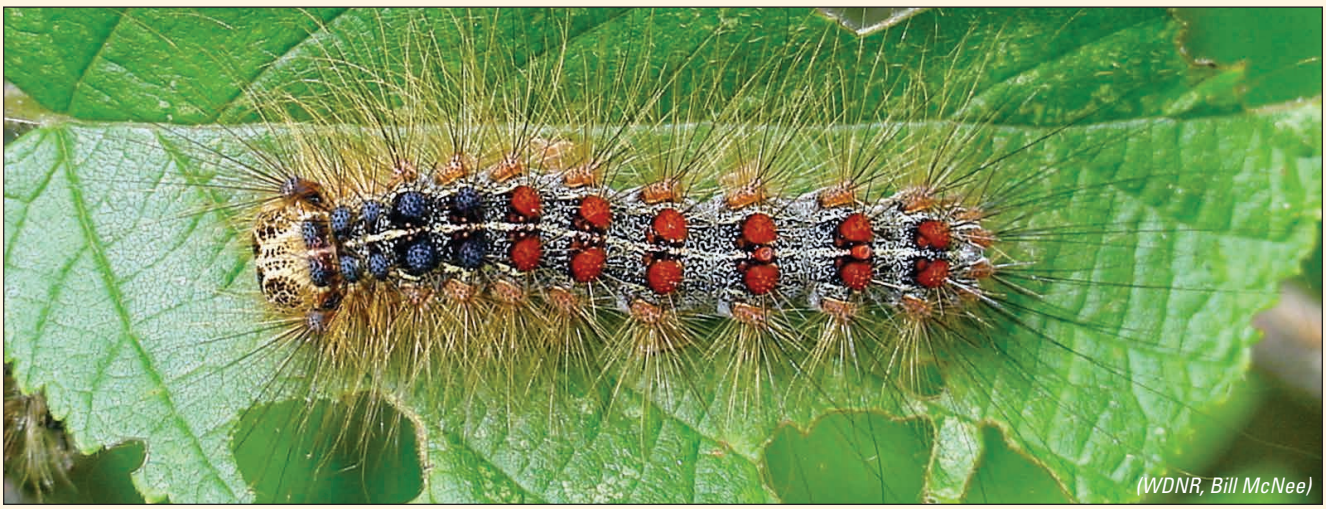


Figure 8-17: Gypsy moth caterpillar.

Table 8-1F: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for European Gypsy Moth (Lymantria dispar) (continued on page 8-16)

EUROPEAN GYPSY MOTH *(Lymantria dispar)* (continued)
TREE SPECIES AFFECTED: OAK

- **Control and Management**
  - Gypsy moth only causes significant defoliation during intermittent outbreaks when the population increases to very high numbers. In most of the state, outbreaks may occur about every 10 years. In stands of oak on dry, sandy soils, outbreaks may cycle more frequently, about every five years. In Wisconsin, most outbreaks last only a single season. Introduced fungal or viral diseases typically cause the collapse of an outbreak population.
  - Healthy, vigorous trees can typically weather defoliation, and grow a second set of leaves in early July. Stressed or suppressed trees may not be able to recover. Such a natural thinning can benefit a forest by removing these unproductive trees and making the resources they had been consuming available to the survivors. For this reason, control of the damage gypsy moth does is most economically accomplished by maintaining a vigorous stand that can withstand the stress of defoliation. For silvicultural guidance relevant to management of gypsy moth, see *Managing Gypsy Moth in Forests or Woodlots* at: ***gypsymoth.wi.gov/***.
  - Thinning a stand causes stress to residual trees and if coincident with defoliation can lead to significant mortality. Conduct egg mass surveys the fall prior to thinning oak dominated stands and delay thinning if population of the pest is high enough to threaten defoliation of the stand. After defoliation, delay thinning for a year or two until trees regain vigor.
  - If necessary, gypsy moth defoliation can be prevented over large areas using aerially applied insecticide. Guidance on how to arrange for an aerial spray is available at: ***gypsymoth.wi.gov***.
- **Monitoring**
  - The number of egg masses per acre present by late summer can help predict the expected level of defoliation the following spring. Predictive surveys don't need to be done every year; only in stands and in years where you would need to take an action such as delaying a thinning. Directions on how to conduct a predictive survey are available under *How to Predict Next Year's Damage* at: ***gypsymoth.wi.gov***.
- **Restoration**
  - Dead trees may be salvaged for financial value, or may be left for wildlife habitat. Assess the level of mortality and work with your forester to implement actions that may improve the vigor of residual trees and maintain a productive and sustainable forest.


(WDNR, Bill McNee)

Figure 8-18: Female adult gypsy moth, egg mass and pupal case.

Table 8-1F: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for European Gypsy Moth Lymantria dispar) (continued from page 8-15)

CONIFER BARK BEETLE (*Ips* spp. and *Dedroctonus* spp.)
TREE SPECIES AFFECTED: CONIFERS

- **Monitoring**
  - Look for individual trees or pockets of dying and dead conifers with small exit holes, pitch tubes on the bark, and/or bark beetle galleries under the bark of the tree(s).
  - Fine reddish brown boring dust can be found in bark crevices, at the base of the tree, on understory broadleaf plants, and/or in spider webs.
  - Watch for tree crowns fading from green to light green to straw yellow to red to brown.

- **Prevention, Control and Management**
  - If the conifer stand is overstocked, thin to maintain a vigorous and healthy growing condition. Healthy conifers are able to resist bark beetles.
  - If trees have low vigor due to drought or defoliation, consider a pre-salvage harvest, following guidelines for removal of breeding material.
  - Promptly salvage or destroy potential bark beetle breeding material (including logs and tops down to 2" in diameter), such as trees that are severely damaged by wind, lightning, fire, disease, insects, or other destructive agents.
  - Thin between September 1 and April 30. During harvest remove cut logs and tops down to 2" in diameter from the site by May 1 (if cutting during the winter) or within three weeks if cut from May 1 to August 31.
  - Smaller branches that are left on the site should be left attached to stem wood to speed drying or if possible have the logging debris/slash scattered into openings to aid in drying out the material.
  - Minimize the damage to crop trees during logging operations. When thinning, use the lightest suitable equipment to minimize soil compaction and root injury. Wounds to the trees and/or roots especially during hot, dry weather, attract bark beetles.
  - Use the conifer species and spacing intervals best suited to that site to minimize site related stressors.

- **Restoration**
  - Needs and options will be site specific.

Figure 8-19: Bark beetle feeding gallery and adults.

Table 8-1G: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for Conifer Bark Beetle (Ips spp. and Dedroctonus spp.)

EMERALD ASH BORER *(Agrilus planipennis)*
TREE SPECIES AFFECTED: ASH

- **Prevention**
  - Be aware of if emerald ash borer (EAB) has been confirmed in your community. A current map of the municipalities where EAB has been confirmed can be found at: ***emeraldashborer.wi.gov***.
  - If your property is away from municipalities where it has been confirmed, take precautions to avoid introducing it. If you use firewood on the property, obtain it from a nearby source. EAB is easily moved in firewood.
  - If EAB has been confirmed in your municipality, take precautions to avoid spreading EAB to un-infested areas. Regulations on Transport, Utilization and Disposal of Ash Wood and Voluntary Recommendations to Reduce Spread of EAB in Potentially Infested Wood can be found at: ***emeraldashborer.wi.gov***.

- **Early Detection**
  - Become familiar with the symptoms and signs of EAB and EAB look-alikes. Information on identifying EAB and its damage can be found at: ***emeraldashborer.wi.gov*** under the tab "Report EAB." If you suspect you have found a new EAB infestation please report it at the above website and include an electronic image. Typically, EAB infestations are difficult to spot until they have been established for four to five years.

- **Control and Management**
  - As of 2017, there are no practical insecticide treatments for woodlots to control EAB. Consult ***emeraldashborer.wi.gov*** for the latest advances in the management of EAB.
  - There are pesticide treatments to preserve individual, high-value trees if applied soon after infestation, before noticeable thinning or dieback has occurred.

Figure 8-20: Emerald ash borer larvae in serpentine feeding galleries.

  - Discuss silvicultural options with your forester to reduce losses and impact to the sustainability of your forest. Management plans may need to be updated taking into account EAB.
  - Practice sustainable forestry. Removing all ash prior to EAB establishment in the local area is not recommended but, if stands contain greater than 20 percent ash, the amount of ash could be reduced through thinning to minimize future financial losses from EAB.
  - Contact Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) regulatory staff for intrastate movement and USDA Animal Plant Health Inspection Service (APHIS) staff for interstate movement.

- **Restoration**
  - Needs and options for restoration will be site specific. Stands with a high proportion of ash may be more susceptible to takeover by invasive plants, and may require control of the invasive plants and planting of desirable tree species. Forests with minimal ash and high species diversity will be better able to recover following the mortality of the ash without additional management.

Table 8-1H: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for Emerald Ash Borer (Agrilus planipennis)

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

BEST MANAGEMENT PRACTICES FOR INVASIVE SPECIES

The Wisconsin Council on Forestry website includes Best Management Practices of Invasive Species for:

- Forestry
- Recreational Users
- Urban Forestry
- Right-of-Way Management

www.wisconsinforestry.org

UNIVERSITY OF WISCONSIN DEPARTMENT OF PLANT PATHOLOGY

The University of Wisconsin Department of Plant Pathology website provides access to publications on many common diseases of trees. This website also has instructions for submitting a plant disease sample for diagnosis.
pddc.wisc.edu

UNIVERSITY OF WISCONSIN INSECT IDENTIFICATION LAB

Electronic images or physical samples may be submitted for identification to the University of Wisconsin Insect Identification Lab.
labs.russell.wisc.edu/insectlab

WISCONSIN DNR FOREST HEALTH RESOURCES

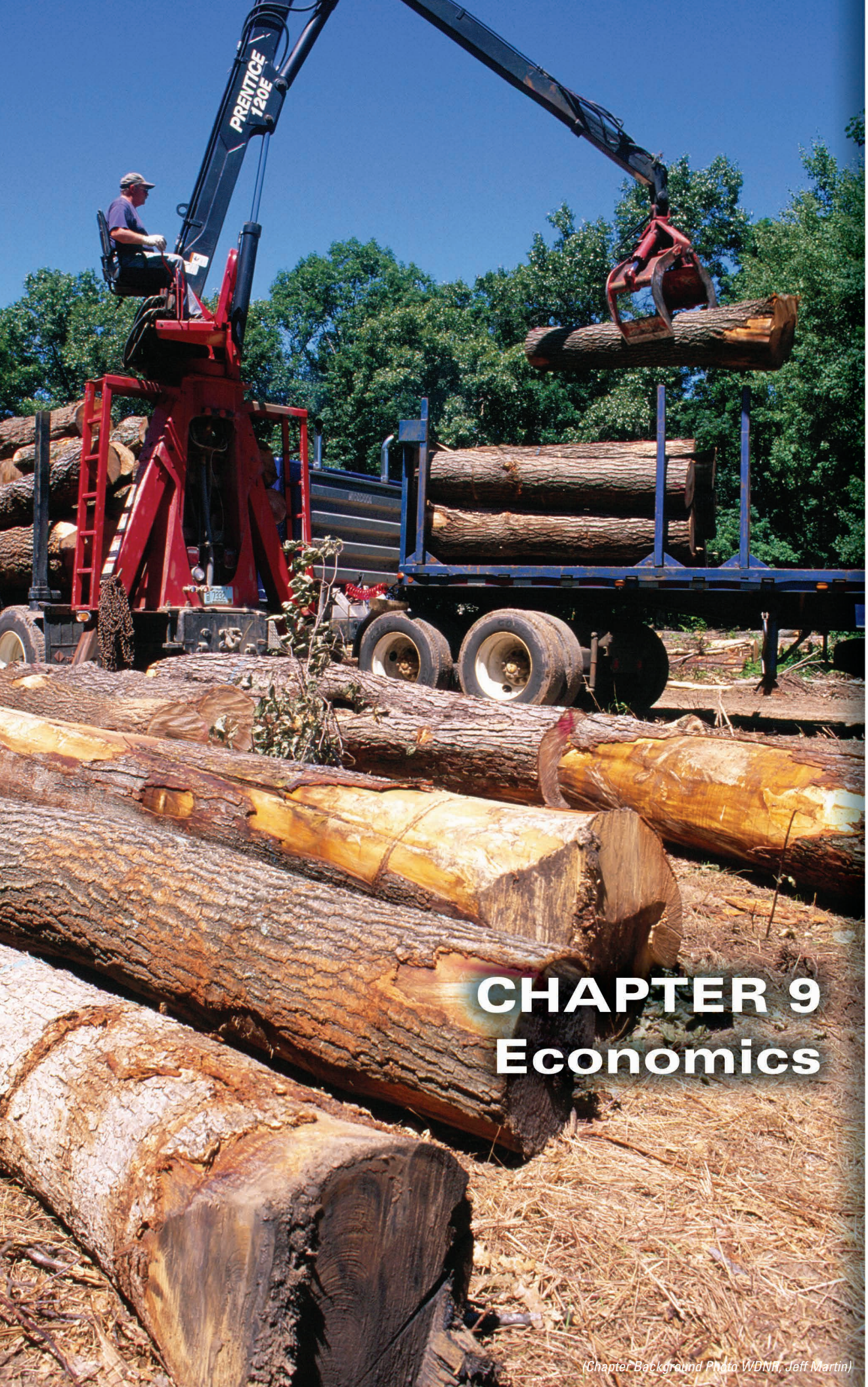
- Forest health specialists are located around the state to assist foresters, forest landowners and property managers with identifying causes of forest health issues and give technical guidance on returning forests to full health and productivity. Contact information for regional forest health staff can be found at the Wisconsin DNR forest health staff page.
  dnr.wi.gov – keywords "forest health staff"
- The Wisconsin DNR Forest Health webpages contain up-to-date management guidance for many of the most damaging pests, diseases and invasive plants in Wisconsin.
  dnr.wi.gov – keywords "forest health"
- The DNR Forest Health staff post regular newsletters that landowners can subscribe to that provide information on developing pest, disease and invasive plant issues. To subscribe, you can visit:
  forestrynews.blogs.govdelivery.com/category forest-health-news.

WISCONSIN'S EMERALD ASH BORER INFORMATION SOURCE

The Wisconsin state emerald ash borer website provides a one-stop site for information on the distribution, identification of signs and symptoms, management options, and quarantine regulations for emerald ash borer.
emeraldashborer.wi.gov

WISCONSIN'S GYPSY MOTH INFORMATION WEBSITE

Information on the distribution, quarantine regulations, state spray treatments, identification, monitoring, and management options for gypsy moth in Wisconsin can be found at the states informational website.
gypsymoth.wi.gov



9

CHAPTER 9
Economics

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 9
ECONOMICS

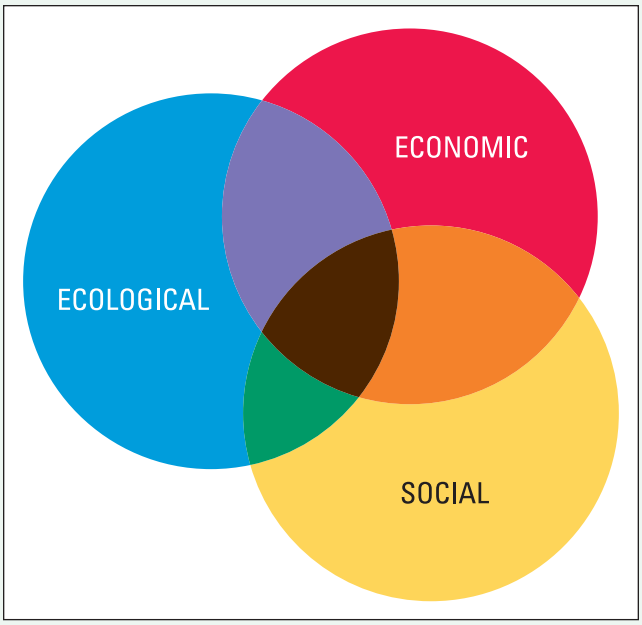


Figure 9-1: Sustainable forestry is based on the three pillars of ecological, economic and social sustainability. All three must be met for practices to be truly sustainable.

A COUPLE WORDS OF CAUTION

First, when investing in financial markets, most people combine their own research with the advice of a broker or financial planner before making an investment decision. In a similar vein, landowners can usually benefit from the information and assistance of a professional forester, when making decisions about how to manage their forests.

Second, "economic" arguments are sometimes presented as justification for engaging in unsustainable forestry practices, such as high grading, that "takes the best and leaves the rest." Not all management that is financially attractive is sustainable, and not all practices that maximize forest growth are necessarily good financial investments (see Figure 9-1). Many practices will cost money, either out-of-pocket, or in the form of reduced income. Forest management is a lot like maintaining an automobile – you can skimp on routine maintenance to save a few dollars in the short run, but you usually pay for it later with more expensive repair bills!

Figure 9-2: Large, high quality trees, such as this walnut, have a very high value. However, the time required to reach this size should also be considered by the wise investor.

About 360,000 Wisconsinites own forestland, mostly for its recreational and aesthetic values. While producing timber or managing the forest as an investment are not the primary reasons most people own forestland, landowners are sensitive to what it costs them, and at some point, they usually have an opportunity to realize income from their forest. Like everyone else, forest landowners also invest in stocks, bonds or mutual funds. Yet all too often, forestry investments are not scrutinized as critically as other financial investments. As a result, forestry investments capable of generating a favorable rate of return are not recognized, or conversely, investments are made that are sometimes not justified financially. Just as forestry involves good stewardship of natural resources so, too, sound financial management requires careful stewardship of investment capital. This chapter provides an overview of the basic principles and methods of investment analysis, and a number of tips on how to help maximize the returns from your forestry investments.

BALANCING ECONOMIC CONSIDERATIONS AND OTHER FOREST VALUES

Figure 9-3: Harvesting on steep terrain affects both skidding and road construction costs. In addition, extensive measures (BMPs) are needed to prevent soil erosion. This translates into higher logging costs which mean lower stumpage returns to the landowner.

There are many benefits from owning and managing forests. Stocks and bonds are usually purchased for the sole purpose of making money, and their financial performance is judged on that basis alone. But forests are more than mere collections of trees, and landowners benefit from a wide array of non-timber goods and services like berries and mushrooms, recreational enjoyment, aesthetics, water quality, and wildlife. Some of these are traded in the marketplace, for example income from leasing hunting rights, but most are not, and there is no easy way to determine their value to the landowner. These non-market benefits can have significant value though, as evidenced by the prices paid for forestland. Even land that is a long distance from a population center and has no unusual attractions, such as lakes or streams, will typically be bought and sold for much more than its value for timber production alone.

Investment analysis that focuses only on costs and returns from timber production will ignore important non-market benefits, and will provide an incomplete measure of total investment performance. In theory, it would seem easy to incorporate non-market benefits into the calculations, but in reality it is often difficult even for economists to value such benefits. Valuing non-market and market benefits are often referred to as ecosystem service valuation. Ecosystem services are, in simplest terms, ecosystem functions that interact with humankind. These services are divided into four basic categories (see Table 9-1).

Every forest management decision has embedded within it trade-offs and choices where certain aspects of ecosystems and ecosystem outcomes are favored over others. This is true whether the management context is strictly economic in nature (e.g., timber, recreation, income and economic development, etc.), more ecological in nature, or as is increasingly more common a combination of monetary and non-monetary goals.

The number and nature of ecosystem services and the vast areas that provide those services make direct measurement of ecosystem services difficult. Instead, proxy measurements called indicators are often used to estimate ecosystem services. For example, the amount of forestland cover may serve as a measurement of the amount of timber production.

ECOSYSTEM SERVICE CATEGORY	EXAMPLES OF ECOSYSTEM SERVICES	POSSIBLE MEASURABLE INDICATORS
1 **Provisioning Services**	• Food • Fiber and wood • Fuel • Water • Other services that create things for humans to use	• Agricultural land area • Forestland area • Stream water flow
2 **Regulating Services**	• Carbon storage • Water storage and flood control • Other services that regulate the environment	• Land cover • Wetland area • Soil water content
3 **Cultural Services**	• Recreation • Spiritual • Aesthetics • Other services that provide human social well-being	• Distance to recreation sites • Use of recreation sites
4 **Supporting Services**	• Primary production • Soil creation • Water cycle • Nutrient cycles • Services that allow other ecosystem services to exist	• Biomass • Soil tests • Litter layer depth

Table 9-1: Ecosytem Service Categories and Examples

ECONOMIC COMPARISON EXAMPLE

Family forest owners purchase and manage their woodland properties for a number of reasons including hunting, recreation and generating income. A timber harvest provides landowners with the opportunity to generate income as well as opportunities to improve fish or wildlife habitat, develop recreational trails, or improve the quality and quantity of wood that comes from the land. Sustainable forest management is managing woodlands to provide for multiple uses of the forest by balancing a diversity of both present and future needs. It is a process of informed decision-making that takes into account resource needs, landowner objectives, site capabilities, existing regulations, economics, and the best information available at any given time. Let's consider the case of two landowners managing similar 40-acre aspen stands. These stands are mature and ready for harvest. We will assume, for simplicity sake, that markets for aspen are competitive and that stumpage prices are the same. However, one landowner is interested in managing for wildlife habitat and wants to maintain the aesthetics of the stand while the other is interested in generating income.

LANDOWNER A

The primary objective of this landowner is economic. This landowner wishes to maximize the potential income from their property while maintaining its productivity and the ability to generate income at regular intervals in the future. However, focusing solely on generating income could limit potential water quality, fish and wildlife habitat, forest health, and aesthetics benefits the landowner would also receive. This landowner chooses to implement a simple coppice harvest that will maximize economic returns. Assuming a gross yield of 40 cords per acre and stumpage price of $28 per cord, this landowner would receive $44,800 for the timber.

LANDOWNER B

The primary objective of this landowner is to improve wildlife habitat. This individual is looking to harvest timber as part of an overall plan to improve wildlife habitat and recreation opportunities while maintaining the aesthetics of the property. By focusing on improving wildlife habitat and maintaining the aesthetics of the woodlands, this landowner is willing to accept a reduced economic benefit. The landowner chooses to implement a coppice with standards (reserve trees) harvest that will leave approximately 15 percent of the stand. These trees will be left on the site as individuals and in small groups and will not be harvested. Assuming a gross yield of 34 cords per acre and stumpage price of $28 per cord, this landowner would receive $ 38,080 for the timber.

Each of the landowners in this example is practicing sustainable forest management and is managing their lands to meet their individual goals and objectives. The difference in the income each landowner received provides a simple way to evaluate the cost of investing in wildlife habitat. Landowner B was willing to forgo $6,720 in income to improve the wildlife habitat and maintain the aesthetics of their woodland property. It could also be said that Landowner A was willing to forgo $6,720 of wildlife habitat and aesthetic benefits to maximize the income from their woodlands. Another way to look at this is that it would take approximately $6,800 in tax relief or supplemental payments to encourage Landowner A to manage for improved wildlife habitat and enhanced aesthetics that would directly benefit society but would not help Landowner A meet their goals.

BASIC FOREST MANAGEMENT AND ECONOMICS: THREE THINGS EVERY LANDOWNER SHOULD KNOW

1. How to Increase the Returns from Forestry Investments

The purpose of management is to meet the landowner's objectives, whether they are for wildlife habitat, recreation or timber production. There are a number of management strategies that can improve economic returns. For more details on factors that influence timber prices for landowners, please refer to the *Forestry Fact Sheet* from UW Extension at: ***https://forestandwildlifeecology.wisc.edu/forestry-facts/***.

PROTECT AND UTILIZE THE SITE FULLY

It is important to maximize the production potential of a given site. Simply said, an acre will grow about the same volume of wood, regardless of the number of trees on it, as long as there are enough to occupy the site fully. All things being equal, the fewer the number of trees, the larger they are likely to be; the greater the number of trees, the smaller they will be in diameter. Interestingly, height growth is largely independent of stocking levels except at extremes. This ability to focus diameter growth on fewer trees is the underlying principle behind many forest management treatments.

Stocking charts (see Chapter 16: Intermediate Silvicultural Treatments) have been developed to identify the relationships between diameter growth and various levels of stand density. If a landowner is interested in increasing the stand's value for sawlog production, careful attention should be paid to thinning periodically. Periodic thinnings will keep residual basal area densities at the recommended levels, maximize diameter growth, and concentrate growth on high quality trees with the greatest potential for grade increase (see Figure 9-4). Thinning can also maintain vigorous, healthy trees that can defend themselves from insect and disease attacks.

MANAGE FOR QUALITY

Higher quality products bring higher prices. Tree diameter is an important determinant of product value and tree quality, particularly in the case of sawlogs. Pulpwood is ground up and reconstituted into paper, flake board, and other similar products. Sawtimber, on the other hand, is cut into solid boards, making it necessary for trees to be of a certain minimum **diameter at breast height (DBH)**. Normally a nine to 11 inch DBH is required (depending on the species) to have any sawlog value at all. Tree grade also relates directly to DBH. The current U.S. Forest Service minimum DBH for grades 1, 2 and 3 trees are 16 inches, 13 inches, and 10 inches, respectively.

The typical product progression from pulpwood to sawlogs to veneer logs is based largely on size and quality, and this translates into a price function with dramatic increases as trees reach the specifications for different products (see Figure 9-5, page 9-7).

DIAMETER RESPONSE TO THINNING IN NORTHERN HARDWOODS

Thinning does not increase total volume produced, but thinning "frees up" resources for the residual trees, thereby concentrating growth on the remaining trees, improving their diameter, quality and value. One study conducted on the Argonne Experimental Forest in northeastern Wisconsin to measure the growth response of second growth northern hardwoods at different residual stocking levels had these results:

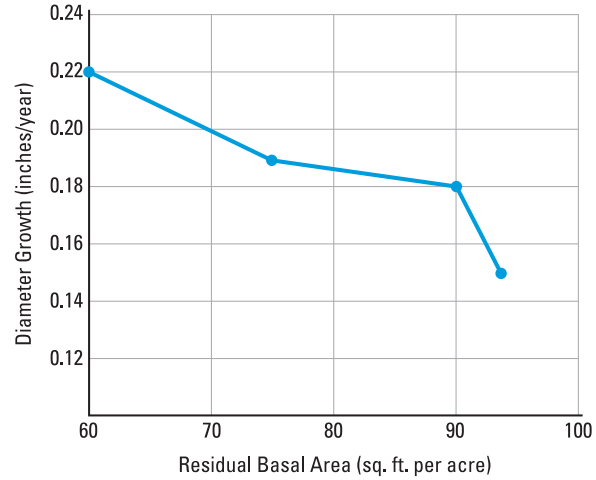


Figure 9-4: Periodic annual sawtimber diameter growth rates in relation to residual stocking for northern hardwoods. (Erdmann and Oberg, 1977)

Numerous researchers have reported that timely thinning can also improve tree quality in northern hardwoods, sometimes by as much as one grade.

Figure 9-6 further illustrates the impact of grade change on tree value. Notice that early internal rates of return are particularly dramatic as a tree passes from pulpwood to sawlog size. This is a function of both the large difference in product value (pulp versus lumber), and the minimal current investment. As a tree gets larger and produces higher grade logs, it experiences its largest increases in absolute value, even though internal rates of return decline due to the higher investment in growing stock being carried. As trees reach their maximum grade potential, whether that be prime veneer or one of the lower grades, the value increases come only from the additional volume produced. As a result, absolute value increases decline, dramatically reducing the internal rates of return, even though overall individual tree value is at its peak. Since the butt log (the lowest, or "first log") normally makes up such a large percentage of a trees total value, its grade potential is particularly important when evaluating whether to harvest a particular tree, or let it continue to grow.

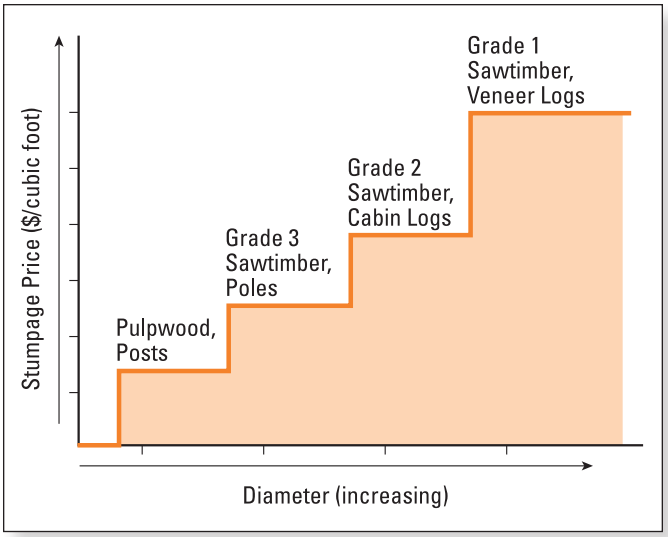


Figure 9-5: Schematic representation of the increase in stumpage price for timber as diameter increases. Note that very small diameter trees have no product value.

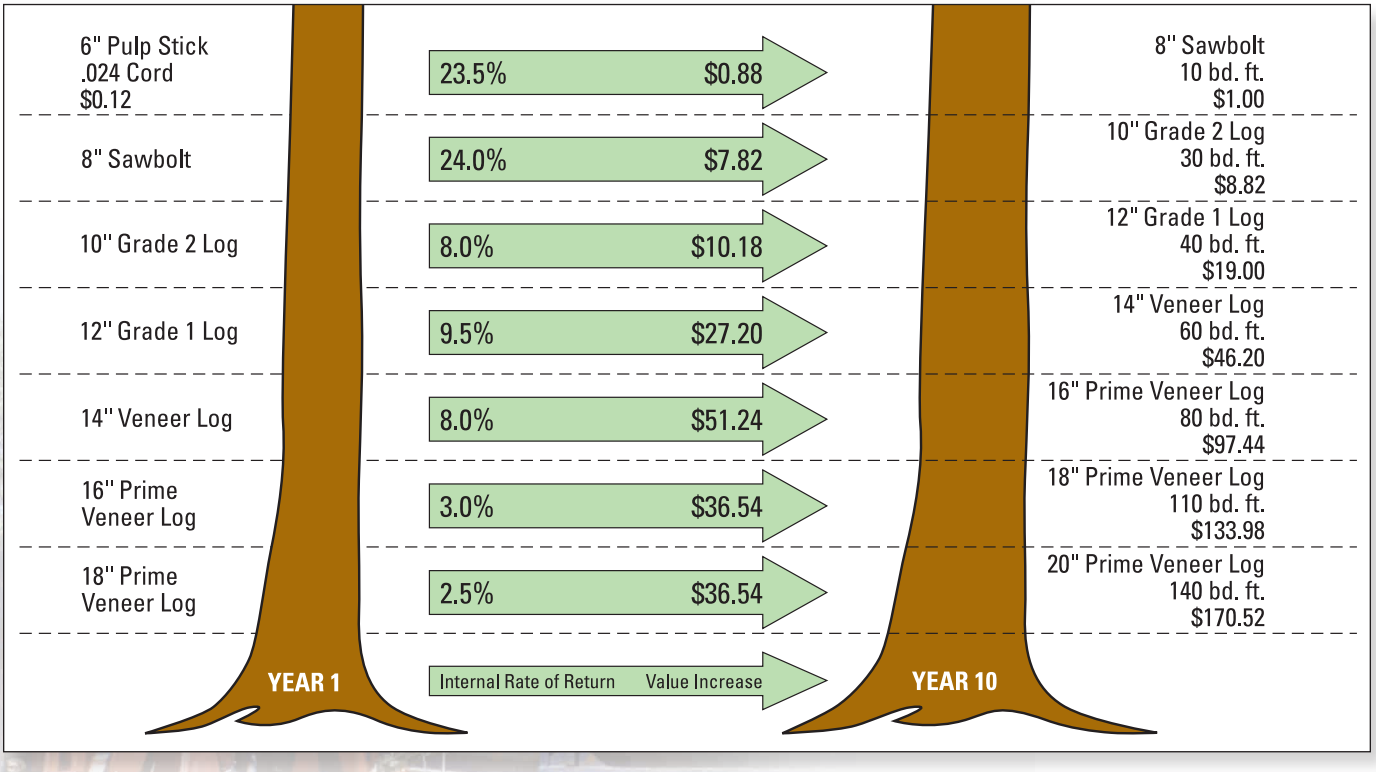


Figure 9-6: Relationship between grade change, volume growth, value increase and Internal Rate of Return for red oak. The volumes and values used in this example are based on one 100 inch pulp stick, or eight foot sawlog and are intended only to illustrate relative changes as trees increase in size and/or grade. For purposes of this example, red oak stumpage prices were estimated as follows: pulpwood $5/cord; sawbolts $25/cord; grade 3 logs $122/MBF; grade 2 logs $294/MBF; grade 1 logs $475/MBF; veneer logs $770/MBF; prime veneer logs $1,218/MBF.

DIVERSIFY AND GROW MULTIPLE PRODUCTS

Trees can be grown and marketed for many different products, and the relative value of these products is reflected in their prices. For example, pine can be grown for sawtimber, which is more valuable than pulpwood, but trees in the sawtimber size class can also be used for utility poles or cabin logs. On a per unit volume basis, these products can be even more valuable than sawlogs. Researchers report that utility poles are the most valuable products that can be produced from red pine, and that trees that qualify for poles sell for twice their value as sawtimber. Utility poles can be produced from trees 10 inches to 16 inches in diameter, but trees need to have minimal sweep and few knots, especially in the bottom portion of the pole. Some stands will yield a few trees that qualify for utility poles by happenstance, but not all sites are capable of growing poles.

Involve a forester early in your decision-making relative to your product goals. Management practices for producing poles, for example, differ from those for more typical pulpwood-sawtimber products, so landowners need to consider what their final product objectives are carefully from the very start. Some early management decisions can limit later opportunities.

Planting too few red pine seedlings per acre, for example, could result in too many knots and too much taper to qualify trees for utility poles when they are harvested decades later. A forester can help landowners think through management objectives.

EARLY INVESTMENTS AND RETURNS

Forestry is a long-term venture, and as a result, the financial returns from forestry investments are greatly influenced by interest rates. Costs incurred at the start of a project reduce profitability on a dollar-for-dollar basis, whereas costs that can be delayed until later in the life of the project are discounted significantly and do not weigh as heavily in the calculations.

Early investments can often be reduced by matching goals with the capability of the site (see Chapter 2: Generally Accepted Silvicultural Principles). Not "fighting mother nature," but rather growing those forest types best suited to a site can minimize the need for costly intensive site preparation, and non-commercial intermediate treatments.

On the other hand, early revenues start earning interest sooner. Early thinnings, followed by regular follow-up thinnings, also have the benefit of increasing diameter growth, and shortening the time until higher value products are produced.

Figures 9-7 and 9-8: These tall straight red pines, having little taper, will make high quality utility poles and generate excellent financial returns to the landowner.

2. How Forest Products Are Sold

- Forest products are normally sold on the basis of their **stumpage value**, which is the value of a tree still standing on the stump. This value is lower than the price a logger receives when the cut logs or pulpwood are delivered to the mill. The price difference is a result of the sawing, bucking, skidding, road building, hauling, and other costs of production incurred by the logger, as well as the need to make a profit. Different stumpage prices are established for each different type of cut product – pulpwood, posts, poles, sawlogs, cabin logs, and veneer logs. Stumpage prices also vary by species. In a few cases, products are cut, skidded, and piled along the road by the landowner, and sold as **cut products**. Since much of the production cost is borne by the landowner, prices for cut products are higher than the normal stumpage price, but still lower than a delivered price. The price paid for cut products is normally negotiated on a case-by-case basis by product and/or grade.

- Stumpage can be sold on a "lump sum" or "scaled" basis. In the case of **lump sum sales**, the buyer submits one bid for all the stumpage available on the sale. A single payment or series of partial payments are normally made depending on the size of the sale, before any harvesting is done. In the case of a **scaled sale**, the buyer submits a bid based on a unit of volume (piece, cord, or board foot) by species, product, and sometimes grade. The products are paid for as they are removed, based on a scale (actual measurement of the cords and/or board feet removed) by the landowner or a cooperating mill. Each method of sale has advantages and disadvantages relative to the time and expertise required to establish the sale, and administer the cutting operation.

3. How to Get Fair Market Value for Your Timber

If you want to get the best price for your timber, you need to do your homework, and that includes developing a rough idea of what it might be worth and why.

- The first step is to investigate stumpage price levels in your area. There are several sources of information on stumpage prices for Wisconsin timber.

  The Wisconsin DNR collects stumpage price information under the Forest Crop Law and Managed Forest Law programs. The stumpage rate schedule is posted on the Wisconsin DNR Division of Forestry's private forestry website. The schedule is updated annually. Stumpage prices are reported for each of 13 regions to provide more localized information.

  County, state and national forests can also provide stumpage price information on the timber they sell, and in some instances, these data might also be applicable to nearby private lands.

  Consulting foresters operating in your area are also a valuable source of stumpage rate information. Some firms even produce detailed reports on stumpage prices. An example would be Prentiss & Carlisle, which publishes the *Timber Mart North Price Report*©. It is available separately for Michigan, Minnesota and Wisconsin on a subscription basis at a modest cost, and is published twice annually. Wisconsin statewide average prices are reported, as well as for each of three regions within the state. Information is available by product and species, and for stumpage as well as for delivered cordwood and sawlogs.

- Regardless of the source, the next step is to adjust average price information to reflect the specific "production factors" associated with each timber stand:
  - **Felling and Bucking:** This step involves severing the tree from the stump and cutting it up into products. Felling and bucking costs are affected by the volume to be removed per acre, average diameter, and the number of pulp sticks or logs per tree, thinning versus clearcut, limbiness, and slash control needs. In general, stands with more removable volume per acre, larger trees, with fewer limbs command a higher stumpage value.

- **Skidding:** Skidding involves moving the cut product from the stump to a landing or roadside for hauling. Skidding costs are affected by hilliness, wetness, the amount of residual stand to work around, sale design, skidding distance, and any equipment restrictions that might be required. Timber stands on flat, dry land with few residual trees or clumps to work around, and with shorter skidding distances bring a higher price.
- **Road Construction and Maintenance:** Normally road construction costs are borne by the contractor, so the length of roads, rockiness, soil type, wetness, need for extensive BMP work, and stream crossings needs, all factor into a contractors stumpage bid.
- **Hauling:** Distance to the nearest mill, road quality, and seasonal road restrictions, as well as distance to the nearest available mill, will also affect the cost of getting the products to market, and therefore, what a buyer can afford to pay for a stand of timber.
- **Marketability:** Each species normally commands a different price. In addition, seasonal fluctuations in price may result from supply and demand and/or weather patterns. If every farmer has a pile of pulpwood behind the barn following a winter with unusually good access to lowland stands, it might be best to hold off selling your black spruce for a while, likewise if the local sawmill is full of logs from a recent windstorm.
- **Quality:** The amount of defect, crook and quality affect the value of both pulpwood and sawtimber. The quality premium is usually much higher for hardwood species than for softwoods. For example, the price of delivered grade 2 hardwood sawlogs in Wisconsin is typically 150 to 200 percent the price of grade 3 logs, and grade 1 logs bring a similar premium compared to grade 2 logs (George Banzhaf & Company, 2002). Since it costs about the same to cut a log out of a tree and deliver it to the mill regardless of the log grade, quality differentials for logs can translate into big differences in the value of standing trees.

The evaluation of these production factors requires a lot of local knowledge as to what is "average" in a given area. Some above-average factors may offset the impact of below-average factors. A forester can be a great help to a landowner trying to assess how the particular timber and harvesting factors for their situation will affect the value of their timber.

COMPETITIVE BIDDING CAN MAKE A BIG DIFFERENCE

The competitive bidding process is an important tool a landowner can use to ensure a realistic, fair price for their timber. Values offered for timber may vary for a number of reasons. Contractors do not all have the same equipment. Some may be very busy when you want to sell while others are looking for work. Some may have markets for specific products. Stumpage appraisal based on production factors is not an exact science. For these and many other reasons, try to get as many bids on your timber as possible.

Several studies report both increased income and satisfaction from competitively bid sales. One of the studies that analyzed 164 lump sum timber sales in Massachusetts found that the average difference between the high and low bid on sales that had two or more bids was $11,000. (Kittredge, D. B. and W. Halsam, 2000).

The example below shows the difference in prices offered in 1999 for one Wisconsin landowner's stumpage involving 107,980 board feet of sawtimber, and 260 cords of hardwood pulpwood. The actual submitted total bids were $42,077, $42,948, $48,262 and $65,044.

The forest owner hired a consulting forester to handle this sale. The consultant charged $4,590 for services. In addition to securing top value through competitive bids, the forestry consultant marked the timber, planned best management practices to protect water quality, assembled the bid packet, advertised the sale, negotiated the timber sale contract, collected harvest payments, and monitored contract compliance. Professional attention to these timber sale details help maximize returns, and minimize expenses over the long-term.

In addition to the bid price, remember that it is important to select a contractor that will do a quality job in a timely manner!

SOME SPECIES ARE MORE VALUABLE THAN OTHERS

The unique wood properties and characteristics of different tree species govern their suitability for specific uses. Size, structural strength, appearance and "workability" are important considerations. Red oak sawlogs, for example, command a higher lumber price than weaker, plainer, less workable basswood. Red pine and jack pine, with their longer fibers, command a higher price for pulpwood than shorter fiber aspen. The straightness, strength and the amenability to preservative treatment makes pine more valuable for posts and poles, while white pine, with its traditional appearance, commands top prices for cabin logs. Relative prices may change as a result of technology, consumer preferences, and availability, but in general, products that require larger diameter trees, and lend themselves less to substitution tend to bring higher prices, and increase in real price over time. On the other hand, many of the more valuable species are only suitable for a limited number of sites, and require higher establishment and maintenance investments, which may offset some of their increased value.

Figure 9-10: High quality hardwood trees should be carefully bucked to maximize the yield of high value veneer and sawlogs.

Figure 9-9: All the production factors involved in getting timber from the stump to the millyard affect its stumpage value.

SOFTWOOD LOG GRADES

Veneer Grade	• Logs must be 16" or larger, 8'8" or longer. Surface clear.
No. 1 Grade	• Logs must be 12" or larger, 8' or longer, with a net scale after deduction for defect of at least 50% of the gross contents of the log, 6" trim. • Three faces surface clear. • Maximum knot size 3", or no larger than 1/6 scaling diameter. • No black knots allowed.
No. 2 Grade	• All logs must be 10" or larger, 8' or longer, and a net scale after deduction for defect of at least 50% of the gross contents of the log. 6" trim, 3" maximum knot size or 1/6 scaling diameter.
No. 3 Grade	• Logs must be 9" or larger, 8' and longer. 50% of gross scale. Maximum knot size 4", 6" trim.

Table 9-2: Softwood Logs Grading (see also Tables 9-3 and 9-4, page 9-12)

NOTE: Tables 9-2, 9-3 and 9-4: Official Grading Rules for Northern Hardwood and Softwood Logs and Tie Cuts, Updated June 15, 2016. (Adopted and published by the Great Lakes Timber Professionals Association)

HARDWOOD VENEER LOG GRADING RULES

GRADE FACTORS	Prime Veneer	Veneer
Min. Diameter	14″	12″
Log Length	8′8″ to 10′6″ (prime veneer) 8′8″ to 14′6″ (veneer); other lengths specified; 8″ trim allowance.	
Surface Defects	None	• 8′8″; one allowed. • 17′6″; two if one falls in each half of the log. • Two defects allowed as one if perfectly in line. • Knots not to exceed 3″. • Bark distortion considered as surface defect. • Seam straight and tight up to 4′ considered as one standard defect. • 10′ and 12′; two defects in line. • 14′ and 16′; two defects if one in each half.
End Defects	• Small amounts of well-centered doze and holes individually or in combination allowed. • 12″ and 13″ diameter up to 2″ 14″ diameter up to 3″ • Logs must be free of mineral, ring shake and heavy bird peck. • One worm hole allowed in one end. • 50% heart allowed in hard maple. • Starred hearts, bark pockets, ring shakes, and fluted butts will not be accepted.	
Straightness	• Logs 13″ or under must be straight. • 14″ and up allowable sweep is 1/6 the diameter of the small end of the log.	
Grain Direction	• No wavy, curly, figured, or cross grain logs accepted. • Spiral grain allowed only if not more than 1″ in 12″ of length.	
Additional Notes	• Variations of this standard should be agreed upon by both buyer and seller. • Veneer logs graded on four faces.	

Table 9-3: Hardwood Log Grading Rules

HARDWOOD SAWLOG GRADES FOR STANDARD LUMBER

GRADE FACTORS	Grade 1	Grade 2	Grade 3
Minimum Diameter	12″	10″	10″
Minimum Length* (including trim)	8′8″	8′8″	8′8″
Clear Cuttings (on the three best faces)			
Length *(minimum)*		3′	2′
12″-15″ Diameter**	7′		
16″-19″ Diameter**	5′		
20″+ Diameter	3′		
Number on Face *(maximum)*	2		No Limit
8′-11′		2	
12′+		3	
Yield in Face Length (minimum)	5/6	4/6	3/6
Sweep and Crook Deduction (maximum)	15%	30%	50%
Cull Deduction, Including Sweep (maximum)	40%	40%	50%

Sound End Defects, Area (maximum)
Specific end defects such as bird peck, worm holes, spot worm holes, stain, mineral spots or streaks and unsound defects as grub holes and bark pockets are considered when in the quality section. When these defects occur in the quality section in three faces of the log at one end, or two faces at both ends, a log Grade 1 or Grade 2 shall be dropped one grade.

Exceptions
- Grade 2: 10″ d.i.b. must be one grade surface quality.
- Grade 2: 11″ d.i.b. limited to two cuttings.
- Sweep and crook allowance reduced 1/3 in logs with more than 1/4 diameter in sound end defects.
- 60% cull deduction permitted in Grade 2 if otherwise of Grade 1 quality.
- 60% cull deduction permitted in Grade 3 if otherwise of Grade 2 quality.

* Unless mill requires more trim.
** Grade 1: 8′ long logs must be 5/6 clear (6-2/3′) in one cutting on three best faces. Two cuttings 3′+ admitted to logs 20″ and up in diameter.

Table 9-4: Hardwood Sawlog Grades for Standard Lumber

EMERGING MARKETS

CARBON MARKETS

Societal interest in reducing the concentration of carbon dioxide in our air has opened the door for an additional economic opportunity and benefit from managed forests.

Economic markets have developed to exchange the value of the carbon stored in forests to offset carbon dioxide emissions from generating power, industrial activity and other fossil fuel use. These voluntary carbon markets connect those who own forests that are storing carbon with individuals and businesses interested in reducing their net carbon dioxide emissions. The interested individual or business enters into a contract to compensate the forest owner for the amount of carbon their forest is storing and that storage is measured and audited according to a system defined in the contract, usually referred to as a protocol. These contracts are legally binding, and commonly have language that requires third party forest certification and a long-term commitment to manage the forest to sequester carbon. It is recommended that landowners work with a consulting forester specializing in forest carbon to measure the carbon stored in their forest and negotiate the terms of any customer purchase agreements.

BIOMASS MARKETS

Wisconsin has seen an increased interest in wood-based bio-energy such as wood pellets and bio-diesel. Woody biomass offers Wisconsin woodland owners and timber producers a potential new market for previously underutilized products – small diameter trees and the branches, tops and limbs of harvested trees.

Harvesting woody biomass typically removes more woody material from forests than traditional harvest methods. The emergence of this new market raised concerns about sustainability including the potential loss of soil nutrients, reduced wildlife habitat, and compaction of forest soils. The Biomass Harvesting Guidelines, developed at the request of the Council on Forestry, provide guidance to help ensure that woody biomass harvests do not compromise the long-term productivity of Wisconsin's forestland, and that woody biomass can be a sustainable, reliable forest product for landowners and timber producers.
https://councilonforestry.wi.gov/Pages/WoodyBiomass/Overview.aspx

(HVS Advertising, Jerry Horen)


(HVS Advertising, Jerry Horen)

Figures 9-11 and 9-12: Woody biomass being processed by a chipper (in-woods) and being loaded into a chip trailer for transport to a wood energy facility. These fuel chips can be used for electricity generation, manufacturing process heat, building heating, or a combination of these uses.

ADVANCED FOREST ECONOMICS: AN INVESTMENT ANALYSIS PRIMER

The successful operation of a forest property requires the integration of business methods, and technical knowledge in the management of a complex biological entity – a forest – to achieve a desired result. A forest landowner is continually faced with choices:

- **To plant or not to plant?** How would an investment in growing trees compare with the rate of return on savings bonds or other investment opportunities (see Example 1, page 9-16)?
- **Do it now, or do it later?** Would it be better to invest some money up front, or wait and later spend a little more on projects needed to ensure tree survival and enhance future growth and quality (see Example 2, page 9-17)?
- **To cut or leave?** Which tree should be marked for harvest (see Example 3, page 9-18)?

There are many such questions, but they all revolve around the relationship between inputs and outputs. **Forest financial analysis** is a particular form of investment analysis conducted from the perspective of the forest landowner. It takes into account the costs and revenues that the landowner expects to realize as a consequence of implementing a proposed action.

While a financial analysis can provide useful guidance, it must be remembered that the future is never certain, and management decisions should be flexible enough to adjust to changes in conditions over time. Forest management is a long-term proposition. For example, a stand regenerated this year may not be ready for final harvest (and subsequent regeneration) for 100 to 200 years. Projecting long-term financial performance is an inexact science based in part on historical information, but it requires a lot of assumptions about forest health, interest rates, costs, revenues, rate of inflation, and socioeconomic conditions.

All investment analyses require information about 1) the physical **inputs and outputs** associated with a project, 2) the **expenditures and revenues** these inputs and outputs generate, and 3) the timing when each will occur. In addition, an appropriate **discount rate** must be selected as well as **investment performance criteria**.

For more details on calculating economic rotation please refer to the Economic chapter in the Wisconsin DNR *Silviculture Handbook, 2431.5*, which can be found at: ***dnr.wi.gov – keyword "silviculture."***

INPUTS AND OUTPUTS

Inputs and outputs are the physical resource flows that the project entails. Inputs might include such things as hours of labor or machinery rental, number of seedlings planted, and the amount of fertilizer or pesticide spread. Outputs in most cases will be the volumes of timber produced, but can also include non-timber forest products such as berries, nuts, mushrooms, hunting leases, or recreational user fees.

In some cases, it is possible to bypass estimating the units of physical resource used. For example, it is common to use an average per acre cost for mechanical or chemical site preparation, without going through the process of estimating the actual hours of machinery use, chemicals and labor that determine the cost.

Figure 9-13: The rate of return on initial investments, like tree planting, can be weighed against later timber revenues by conducting a financial analysis.

EXPENDITURES AND REVENUES

Expenditures and revenues are the monetary costs, and incomes, associated with the physical inputs or outputs. Landowners who invest their own labor in forestry projects should include the cost of their labor if they want to get a true picture of the financial soundness of their investment. In practice, though, many landowners derive significant recreational or other benefit from such work, and do not consider it a cost at all. If no earnings are forfeited when working in the forest, the landowner's personal labor cost can be excluded from the analysis.

Since most investment analyses involve estimating incomes and costs at some future date, it is necessary to project what they will be in **nominal** (also called market or current dollar) or **real** (also called constant dollar) terms. Nominal prices and costs contain inflation; real prices and costs have the inflation removed. The long-term rate of inflation over the period 1926 to 2000 was approximately three percent, which also happens to be what it averaged during the decade of the 1990s. Either real or nominal values can be used so long as they are used consistently throughout the analysis. It is usually easier to work with real values, though, and all examples in this chapter will be presented in real terms.

THE DISCOUNT RATE

The discount rate is similar in concept to an interest rate. Interest is the "rent" one pays (or gets paid) for the use of capital. The discount rate represents the rate of return on money invested.

Financial analysis involves adjusting expenditures and revenues for the effects of interest over time. Interest is **discounted** (subtracted), or **compounded** (added) as needed to reflect the value of revenues and expenditures at the same point in time. For example, the present value of a dollar to be received 10 years from now after being invested at five percent interest is only $0.61 (see Table 9-5), while the future value of one dollar invested for 10 years at five percent interest is $1.63 (see Table 9-6).

A very quick way to obtain a rough estimate of the effect of compounding and discounting is based on "the rule of 72." This rule states that the time it takes money to double when compounded (or halved when discounted) at a fixed interest rate is given by dividing the interest rate into 72. For example, money invested at 10 percent interest will double in just over seven years; at five percent, it will take about 14.5 years.

Years in Investment Period	INTEREST RATE				
	3%	4%	5%	6%	7%
10 Years	$0.74	$0.68	$0.61	$0.56	$0.51
20 Years	$0.55	$0.46	$0.38	$0.31	$0.26
30 Years	$0.41	$0.31	$0.23	$0.17	$0.13
40 Years	$0.31	$0.21	$0.14	$0.10	$0.07
50 Years	$0.23	$0.14	$0.09	$0.05	$0.03
60 Years	$0.17	$0.10	$0.05	$0.03	$0.02
70 Years	$0.13	$0.06	$0.03	$0.02	$0.01
80 Years	$0.09	$0.04	$0.02	$0.01	$0.00
90 Years	$0.07	$0.03	$0.01	$0.01	$0.00
100 Years	$0.05	$0.02	$0.01	$0.00	$0.00

Table 9-5: Discounted value of one dollar for different interest rates and time periods.

Years in Investment Period	INTEREST RATE				
	3%	4%	5%	6%	7%
10 Years	$1.34	$1.48	$1.63	$1.79	$1.97
20 Years	$1.81	$2.19	$2.65	$3.21	$3.87
30 Years	$2.43	$3.24	$4.32	$5.74	$7.61
40 Years	$3.26	$4.80	$7.04	$10.29	$14.97
50 Years	$4.38	$7.11	$11.47	$18.42	$29.46
60 Years	$5.89	$10.52	$18.68	$32.99	$57.95
70 Years	$7.92	$15.57	$30.43	$59.08	$113.99
80 Years	$10.64	$23.05	$49.56	$105.80	$224.23
90 Years	$14.30	$34.12	$80.73	$189.46	$441.10
100 Years	$19.22	$50.50	$131.50	$339.30	$867.72

Table 9-6: Compounded value of one dollar for different interest rates and time periods.

• EXAMPLE 1 •

Can I get a 5% or greater rate of return on a $250 per acre investment to plant a stand of trees, if I expect an income of $450 per acre to be generated by a thinning at age 30, and an additional $2,025 per acre to be generated in the final harvest at age 50 (assume there are no other costs or revenues, and all values are in real terms)?

ACTIVITY	YEAR OCCURRED	COSTS	REVENUES	YEARS IN INVESTMENT PERIOD	DISCOUNTING FACTOR[1]	CURRENT VALUE[2]
Planting	0	$250/acre		1	1.00	$250/acre
Thinning	30		$450/acre	30	0.23	$103.50/acre
Harvest	50		$2,025/acre	50	0.09	$182.25/acre

1 Discounted value of one dollar at five percent interest rate; from Table 9-5, page 9-15 • 2 Actual value of all costs and revenues in year one.

Since, in this example, the total revenues ($285.75) exceed the total costs ($250), this investment would yield a rate of return greater than 5%. Note that if the final harvest was put off until year 60 (only another 10 years), the value of the final harvest would only be $101.25 (assuming no change in the type of product harvested), and the total revenue ($204.75) would no longer exceed costs, which means the rate of return would be less than 5%.

INVESTMENT PERFORMANCE CRITERIA

A number of criteria can be used to evaluate the financial performance of forestry investments. Net present value, internal rate of return, and payback period, are normally used when deciding whether or not to make a specific investment. When analyzing the relative merits of a number of alternative actions, however, the criterion might simply be which alternative offers the greatest expected rate of return. See the Wisconsin DNR *Silviculture Handbook, 2431.5* for a more detailed discussion of these and other investment criteria. The handbook can be found at: ***dnr.wi.gov – keyword "silviculture."***

(WDNR, Jeff Martin)

Figure 9-14: The planting of trees is just one of a number of forestry investments that can be evaluated using investment analysis techniques.

• EXAMPLE 2 •

You plan to replant a poor quality mixed hardwood stand with oak following a harvest. You expect quite a bit of competition from the brush and red maple sprouts on the site, and feel something might need to be done to ensure the new oak seedlings are not shaded out. One option would be to spray the area with a herbicide prior to planting, but you are not sure it is absolutely necessary. Another option would be to wait 10 years, and then hand cut the competing brush and sprouts if necessary. The first option would be much less expensive, but it will be a wasted investment if it turns out not to be needed. Should you go ahead and spray now, and not take a chance on having to do the more expensive treatment later? You expect to make the final harvest in the stand at age 80, and whichever option you choose, you want a 5% rate of return on your investment.

ACTIVITY	YEAR OCCURRED	COSTS	YEARS IN INVESTMENT PERIOD	COMPOUNDING FACTOR[1]	FUTURE VALUE[2]
Herbicide Release	0	$70/acre	80	49.46	$3,469.92
Hand Release	10	$110/acre	70	30.43	$3,347.30

1 Compounded value of one dollar at five percent interest rate; from Table 9-6, page 9-15

2 Actual cost of the investment at the end of the time of final harvest in year 80.

In this case, it would make more financial sense to wait and conduct the hand release later, if it is needed. The reduced interest charged on the shorter investment period associated with the hand release (70 years versus 80 years) more than offsets the increased cost of the treatment. If it turns out the treatment is not necessary, even more money will have been saved. Finally, it is important to remember that trying to forego needed investments, such as the ones illustrated in this example, is really false economy, since the entire initial investment in planting may well be lost.

This analysis only tells us which of the two release options has the lowest overall cost over the entire investment period. In order to evaluate the rate of return on the entire planting project, revenues would also have to be estimated and included in the analysis, as in Example 1. (The long-time intervals and the risk and uncertainty involved in forestry investments also help explain why governmental cost-sharing programs can be helpful incentives to motivate some landowners to engage in forest management activities.)


(WDNR, Jeff Martin)


(WDNR, Jeff Martin)

Figures 9-15 and 9-16: Conducting a site preparation treatment before planting to ensure survival of planted trees versus a more costly herbicide release operation later, are typical of economic investment choices faced by forest landowners.

• EXAMPLE 3 •

One-third of Wisconsin's forests are northern hardwoods. Most stands were once or still are even-aged, but many landowners are converting them to uneven-aged stands. Long-term studies conducted on the Argonne Experimental Forest showed that the single-tree selection system with a medium level of residual basal area (75 square feet per acre) economically outperformed both unmanaged stands, and stands that had been subjected to a diameter limit harvest.

A landowner who is practicing uneven-aged management asks a consultant forester to mark trees for harvest under the selection system, and to administer the timber sale. The forester does not expect that the stand will be ready for another harvest until 10 years have passed. As the forester begins marking the stand, she decides that one of two sugar maple trees needs to be removed in order to meet the stocking guidelines. Both trees are 15 inches in diameter, have two merchantable logs, and a volume of 135 board feet worth $50 today. Both trees are also of comparable risk and vigor (see Chapter 2: Generally Accepted Silvicultural Principles).

Each of the two trees is expected to add two inches of diameter growth over the next 10 years, if the other one is removed to provide extra growing space. Both trees will therefore have a volume of 180 board feet in 10 years if they are left to grow, but tree 2 will improve its butt log to grade 1, whereas in tree 1 the butt log will remain grade 2. The estimated value 10 years in the future is $68 for tree 1 and $90 for tree 2.

Which tree should the forester mark for removal?

Even without doing any calculations, it is pretty obvious that tree 2 is the better investment, and makes the better crop tree. The actual rate of return for each tree is as follows:

TREE 1

$$\frac{\text{Discount}}{\text{Factor}} = \frac{\text{Future Value}}{\text{Present Value}} = \frac{\$68}{\$50} = 1.36$$

3% Rate of Return over a 10-year investment paid (see Table 9-6 page 9-15)

TREE 2

$$\frac{\text{Discount}}{\text{Factor}} = \frac{\text{Future Value}}{\text{Present Value}} = \frac{\$90}{\$50} = 1.80$$

6% Rate of Return over a 10-year investment paid (see Table 9-6 page 9-15)

Cutting tree 1 and leaving tree 2 makes the most economic sense, and also illustrates the powerful influence that quality has on timber value. This situation also demonstrates how many times what makes the most sense from a silvicultural viewpoint can also makes good economic sense. Of course, this will not always be the case, but economics is all about making trade-offs.

TAX AND RECORD-KEEPING CONSIDERATIONS

Forestry is subject to numerous risks and uncertainties, most of which are beyond the control of the owner. But one factor that can either contribute to or detract from financial success is under the direct control of the owner/manager – income taxes. There are a number of sound business practices that landowners should consider relative to taxes:

- **Have a forest management plan.** A management plan, complete with projections of future growth and yield, and associated anticipated costs and revenues, provides strong evidence that you are treating your forestland as a business, should you be questioned by tax authorities.
- **Build tax planning into your management,** including estate tax considerations.
- **Utilize the tax advantages available to forest landowners.** Tax advantages, such as the reforestation tax treatment and amortization provisions of the federal income tax code, can reduce the after-tax cost of early investments. Similarly, cost-sharing programs provide help with the costs of a wide range of forestry practices.
- **Keep good financial records,** not just because they are required by the IRS, but also because it is good business practice. It is hard to determine if past management and investment decisions were sound if you have no information with which to evaluate them. The difference between financial success and failure often depends directly upon whether adequate records have been kept to document expenditures and deductions, and the best place to start keeping good records is when you first acquire forestland assets.

The Original Basis: A Key Tax Consideration

One of the first important tasks a new landowner should undertake is the establishment of the **original basis**, or value, of all land and merchantable timber at the time of acquisition. Later, when income is received from a timber harvest, the adjusted (updated) basis for that portion of the timber sold can be claimed as a depletion allowance when computing income tax. Timber sale income can also qualify for more favorable capital gains tax treatment if the sale is structured correctly, and other requirements, such as the length of the holding period (typically one year), are met. Capital gains are also exempt from self-employment (Social Security) tax.

CALCULATION OF THE ORIGINAL BASIS

Exactly what constitutes the basis depends upon how the assets were acquired, for example, whether they were purchased, inherited, or received as a gift. Since the details of the tax code are complicated, no general discussion can be sure to cover the specifics of an individual landowner's situation.

In most cases, however, the original basis of assets purchased is their acquisition cost, plus any additional expenses directly associated with the purchase, such as legal and accounting fees, closing costs, recording fees, costs of surveys, and even real estate taxes, if they are not otherwise deductible. The important point is that **the basis usually includes more than just the purchase price**.

The basis should be established when the assets are acquired, but often landowners do not become aware of this requirement until some time later. The cost basis can be established at a later date in certain situations, but it is more difficult, and could invite closer scrutiny by the IRS than if it were done at the time of acquisition. When considerable time has passed since the acquisition occurred, it simply might not be worth the bother trying to establish the original cost basis, because it will cost more than will be saved in taxes.

ALLOCATION OF THE BASIS

The procedure for establishing the initial or original cost basis each of the assets included in the acquisition is called **allocating the basis**.

Essentially, it involves allocating the total acquisition costs among the assets in proportion to their fair market value on the date of acquisition relative to the total fair market value of all the assets acquired. For example, if on the date of acquisition the fair market value of land represents 50 percent of the total fair market value of all the assets acquired, then 50 percent of the total original cost basis of the assets should be allocated to the land (see Example 4).

• EXAMPLE 4 •

Mr. and Mrs. Jones just purchased a 40-acre parcel of forestland. It is stocked with an average of 3,000 board feet per acre of hardwood sawtimber. A barbed wire fence surrounds the property. The Jones' paid $55,000 for the parcel. Closing costs were $250, and they also paid their attorney $270 to review the paperwork.

The estimated fair market value of the timber on the date of acquisition, if sold as stumpage, is $275/mbf, the bare land is worth $500/acre, and the fence has a value of one dollar per linear foot.

STEP 1: DETERMINE THE TOTAL COST OF THE ACQUISITION, THE ORIGINAL BASIS.

ASSETS ACQUIRED	**ACQUISITION COST**
40 Acres of Forestland	$55,000
Attorney's Fees	$275
Closing Costs	$250
Total Acquisition Costs (Original Cost Basis)	**$55,525**

STEP 2: ESTIMATE OF FAIR MARKET VALUE OF THE THREE ASSETS ON THE DATE THEY WERE ACQUIRED.

ASSET	AMOUNT	UNITS	FAIR MARKET VALUE PER UNIT	TOTAL FAIR MARKET VALUE	PROPORTION OF TOTAL FAIR MARKET VALUE
Land	40	Acres	$500	$20,000	34.3%
Timber	120	MBF	$275	$33,000	56.6%
Fence	5,280	Feet	$1.00	$5,280	9.1%
				$58,280	**100.0%**

NOTE: It is very common for the total acquisition cost to be different from the fair market value of the assets. Markets are not always perfect, and the fair market value could be greater or less than the acquisition costs.

STEP 3: ALLOCATE THE ORIGINAL COST BASIS AMONG THE THREE ASSETS.

ASSET	AMOUNT	UNITS	PROPORTION OF TOTAL FAIR MARKET VALUE	ORIGINAL COST BASIS	ORIGINAL COST BASIS PER UNIT
Land	40	Acres	34.3%	$19,045	$476.12
Timber	120	MBF	56.6%	$31,427	$261.89
Fence	5,280	Feet	9.1%	$5,053	$0.96
			100.0%	**$55,525**	

As timber volumes increase over time, Mr. and Mrs. Jones will need to update their records by calculating the **adjusted cost basis** of the timber, as shown below.

Initial Timber Volume	120 MBF	Original Cost Basis	$31,427
Adjustment for Growth	80 MBF	**Adjusted Cost Basis Per Unit**	**$157.14/MBF**
Adjusted Timber Volume	**200 MBF**		

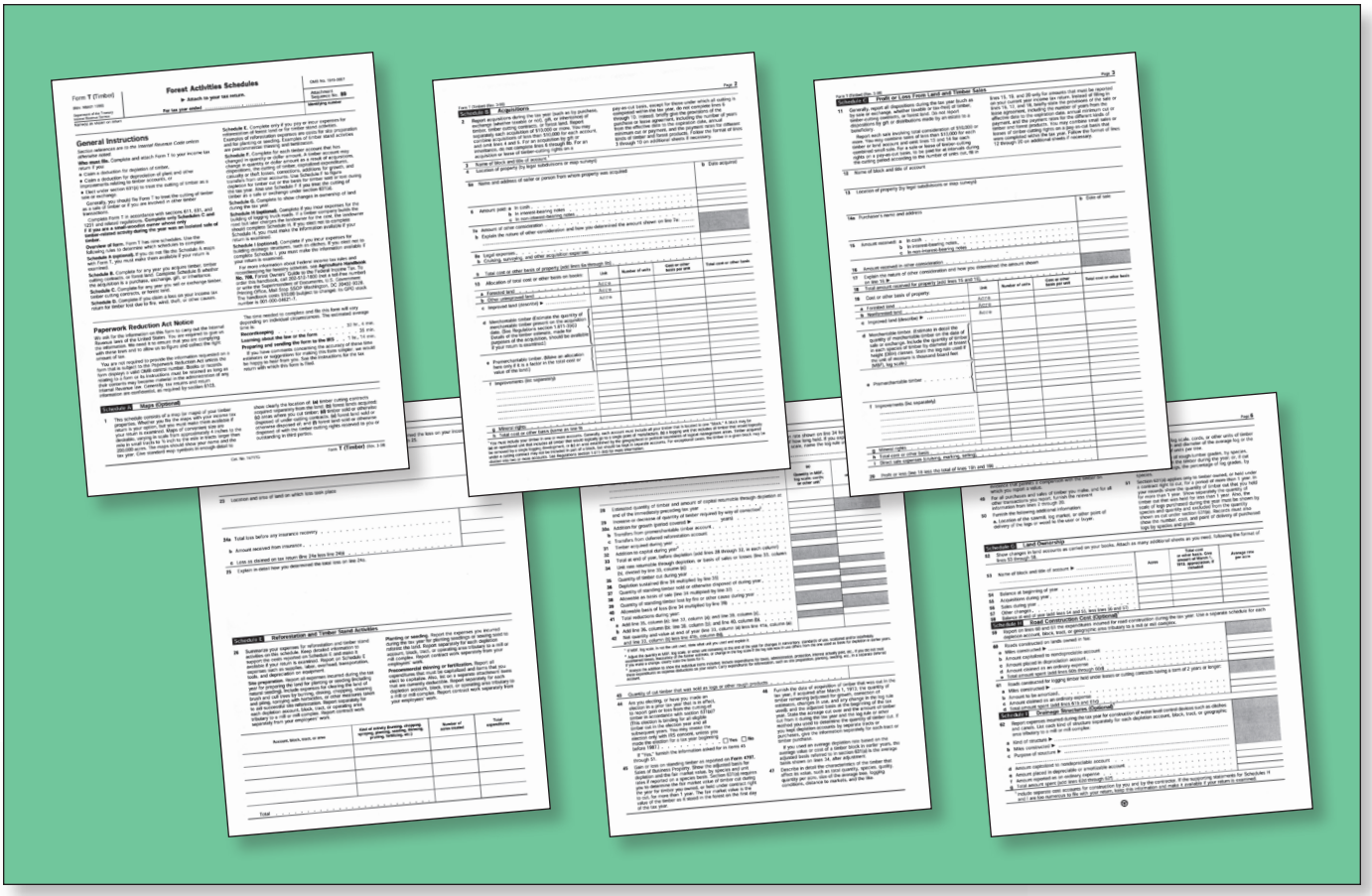


Figure 9-17: Complete and accurate records are key to managing a successful forestry business. IRS Form T categorizes the types of records that are critical.

THE IRS DOES NOT SPECIFY WHAT KIND OF BOOKKEEPING SYSTEM A TAXPAYER MUST USE

At a minimum, however, your records should include accounts with the amounts and cost basis of land, merchantable timber volume, and merchantable timber value. In Example 4 (see page 9-20), the landowners should also maintain a depreciation account to keep track of the cost basis of their fence, and how it changes as the depreciation allowances are claimed.

Perhaps the best guide to what kinds of records are useful is **IRS Form T: Forest Activities Schedule** (see ***www.timbertax.org*** for a copy of Form T). While not all items of information on Form T will be needed by all landowners, the form is a good guide both to the kinds of information larger forestry businesses must document, and how the information is used when filing tax returns.

Forestry-related Tax Deductions

- Timber is subject to **damage and loss** as a result of tornadoes, ice storms, fire, and even theft. The basic rule under the income tax code, however, is that if a taxpayer cannot demonstrate a cost basis in the damaged asset, no income tax deduction will be permitted. The deduction is the lesser of the decrease in value caused by the loss or the basis in the timber depletion account. A competent appraisal is required.
- One of the most beneficial provisions of the federal tax code relates to the **reforestation tax credit and amortization**. You can deduct outright the first $10,000 per year per qualified property. The amortization provision permits expenses to be recovered over eight tax years.

Exactly which forest management expenses may be deducted when calculating taxable income depends on how the forestry operation is structured. An active business is the best option, but many landowners do not meet the IRS requirements for "active participation," and instead participate only passively or treat their forestland as an investment. Others fall into the "hobby farm" category. Each of these situations has different implications under the tax code for how income and expenses can be treated (for more information, see the references listed in the Resources for Additional Information section on page 9-23).

AMORTIZING REFORESTATION EXPENSES

In 2009, a landowner spends $20,000 on reforestation. In 2009, the landowner can deduct outright $10,000 ($5,000 for married couples filing separately), plus 1/14th of the remaining $10,000. The amortization for each subsequent tax year is calculated by applying an annual amortization factor to the remainder. The calculations are illustrated below.

YEAR	DEDUCTION FOR AMORTIZATION (FRACTION)	DEDUCTION FOR AMORTIZATION (AMOUNT)
2009	1/14th	$712
2010	1/7th	$1,429
2011	1/7th	$1,429
2012	1/7th	$1,429
2013	1/7th	$1,429
2014	1/7th	$1,429
2015	1/7th	$1,429
2016	1/14th	$712
Total		**$10,000**

Figure 9-18: Forest management plans are often modified by natural disturbances like this major wind storm in a northern Wisconsin hemlock stand.

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

CASUALTIES, THEFTS AND INVOLUNTARY CONVERSIONS: SOME INCOME TAX TIPS FOR WOODLAND OWNERS

Casualties, Thefts and Involuntary Conversions: Some Income Tax Tips for Woodland Owners. Stier, J. C., University of Wisconsin-Madison, Department of Forest and Wildlife Ecology, Forestry Fact Number 16, 8 pages, 2001.

DETERMINE YOUR BASIS…AND KEEP MORE TIMBER INCOME

Determine Your Basis…and Keep More Timber Income. Martin, J., University of Wisconsin-Madison, Department of Forest and Wildlife Ecology, Forestry Fact Number 71, 4 pages, 1994.

ESTATE PLANNING FOR FOREST LANDOWNERS: WHAT WILL BECOME OF YOUR TIMBERLAND

Estate Planning for Forest Landowners: What Will Become of Your Timberland. Siegel, W. C., Haney, Harry L., and Greene, J. L., U.S. Department of Agriculture Forest Service General Technical Report SRS-112, *General Technical Report SRS-112*, 2009.
www.srs.fs.usda.gov/pubs/gtr/gtr_srs112.pdf

FOREST LANDOWNERS' GUIDE TO THE FEDERAL INCOME TAX

Forest Landowners' Guide to the Federal Income Tax. Haney, H. L., Jr., Hoover, W. L., Siegel, W. C., and Greene, J. L., U.S. Department of Agriculture Forest Service Agricultural Handbook 718, 2001.
www.timbertax.org/publications/aghandbook

NATIONAL TIMBER TAX WEBSITE

This website was developed to be used by timberland owners, and for accountants, attorneys, consulting foresters and other professionals who work with timberland owners by answering specific questions regarding the tax treatment of timber related activities.
www.timbertax.org

WHAT WILL A FOREST TREE EARN?

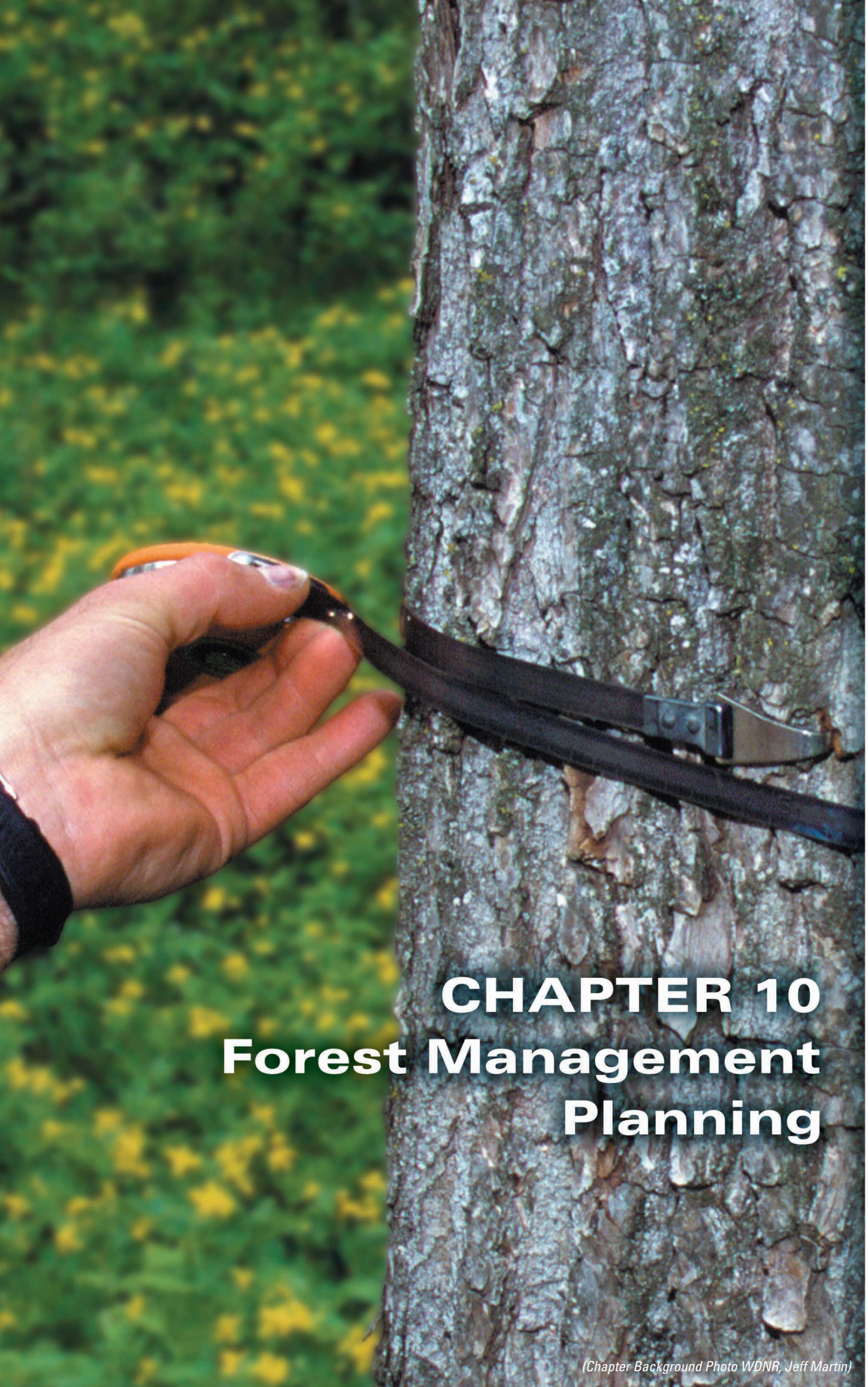
What Will a Forest Tree Earn? Stier, J. C. and A. J. Martin, University of Wisconsin-Madison, Department of Forest and Wildlife Ecology, Forestry Fact Number 38, 3 pages, 1988.

WHAT'S A FOREST TREE WORTH?

What's a Forest Tree Worth? Stier, J. C. and A. J. Martin, University of Wisconsin-Madison, Department of Forest and Wildlife Ecology, Forestry Fact Number 39, 5 pages, 2003.

WHEN TO HARVEST TIMBER – NOW…OR LATER?

When to Harvest Timber – Now…or Later? Martin, J. University of Wisconsin-Madison, Department of Forest and Wildlife Ecology, Forestry Fact Number 53, 8 pages, 2003.



10

CHAPTER 10
Forest Management Planning

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 10
FOREST MANAGEMENT PLANNING

FOREST MANAGEMENT PLANNING

A forest management plan is a written document that helps guide a landowner's management decisions and identifies actions to meet and achieve their goals and objectives. A professional forester can help a landowner prepare their management plan and implement practices included in their plan. At a minimum, forest management plans should address and include the following:

- Property ownership – who owns the property?
- Property description – where is the property located?
- A statement about the landowner's management goals and objectives and what they plan to achieve
- A description of resource conditions and concerns
- Recommended management activities and schedule
- Map(s) – property maps, soil maps, etc.
- Resources and information – publications, permits, professional assistance contact information

Incorporating Sustainability Into Forest Management Plans[1]

In many cases, developing a forest management plan requires an understanding of how the forest interacts with other surrounding vegetative communities on the landscape, and responds to disturbances including management activities. The concept of sustainable forestry practices was introduced in Chapter 2: Generally Accepted Silvicultural Principles, and will be further explained in the following steps.

STEP ONE: IDENTIFYING LANDOWNER GOALS

Landowners may not have well-defined goals and objectives for managing their forestland, or may not be aware of the management opportunities on their land. Foresters must be able to help the landowner identify and understand their long-term goals, and clearly articulate to the landowner how they can achieve them.

Figure 10-1: Frequent communication between the forester, landowner and other resource professionals helps insure management objectives are fully achieved.

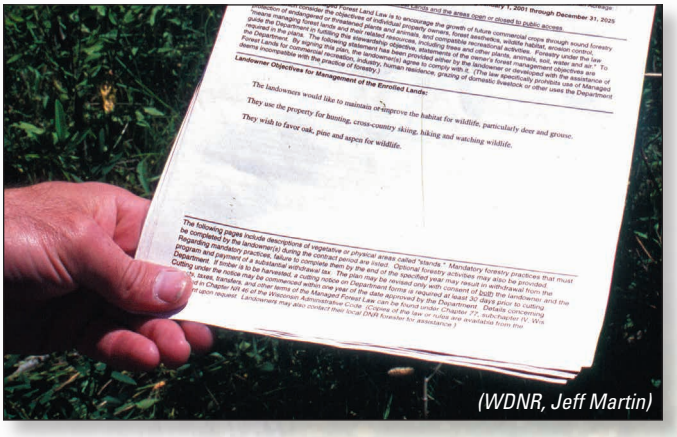


Figure 10-2: An important first step in developing a management plan is to identify the landowner's specific objectives, and list them in the written plan.

By involving the landowner in the development of their plan, the forester can help the landowner better understand the recommendations included in their plan, and ensure that they are in line with the landowner's goals. Foresters should carefully consider the objective statement provided by the landowner, and help refine it, if necessary, with the landowner's involvement.

Some example goals may include: 1) create habitat for a wide range of wildlife species; 2) maximize income from wood production; or 3) provide the best possible deer habitat.

1 *This section is adopted from Kotar, J. 1997. Approaches to Ecologically Based Forest Management on Private Lands. University of Minnesota Extension Service, publication NR-604.*

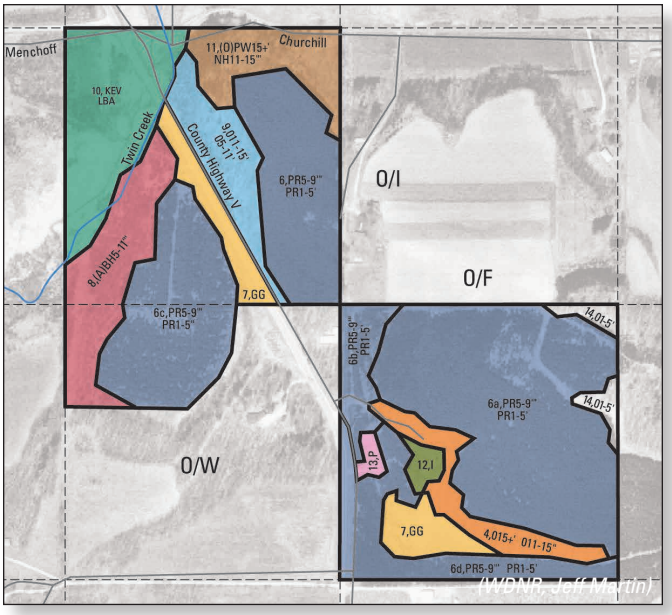


Figure 10-3: An important step in planning is to identify site types, delineate individual stands, and prepare a map of the property.

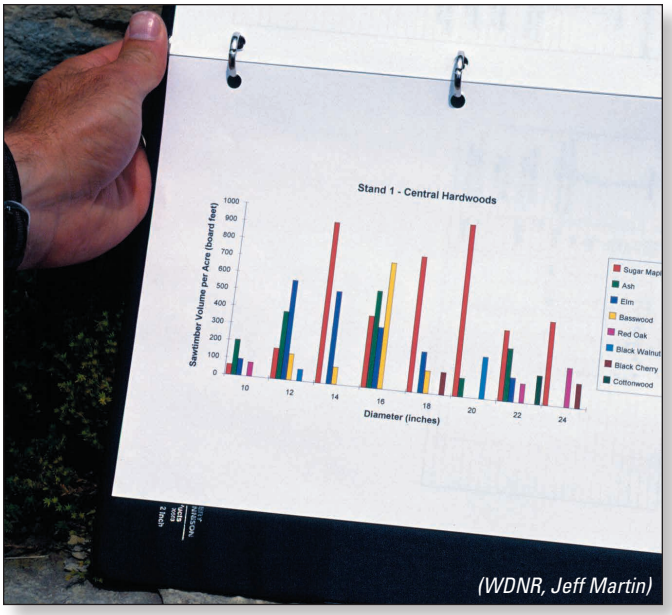


Figure 10-4: An inventory of each stand will provide basic information to guide management decisions. The chart in this photo indicates the board-foot volume per acre by species and diameter for a specific stand.

STEP TWO: ASSESS RESOURCE CONDITIONS AND CONCERNS

Secure aerial photographs, topographic maps, soil surveys, Natural Heritage Inventory (NHI), cultural heritage, and other available resources to gather background information about the property and help prepare for the visit. Much of this information is available from federal, state and local county offices: Soil and Water Conservation District (SWCD), USDA-Natural Resource Conservation Services (NRCS), Department of Natural Resources (DNR), and county land departments.

Conduct an on-the-ground evaluation of the land. It is important to understand existing resources, conditions and concerns on the land before recommending any type of management activity. Evaluate soil conditions to determine tree species, preferred seasons of operation, site preparation and regeneration requirements. Identify important resources, features and site conditions that may require special attention (e.g., water resources, steep slopes, rock outcrops, invasive species, and wildlife impacts). Assess the presence of cultural and historic resources, threatened and endangered species, or species of special concern.

Other important factors to consider when planning forest management activities include maintaining aesthetic quality and the location and design of roads.

Delineate site types (see Chapter 2: Generally Accepted Silvicultural Principles). A site is a portion of land characterized by factors that affect ecosystem properties (e.g., tree species composition). These factors can influence a tree species' ability to grow, reproduce, and compete include soil depth, texture and chemical properties, and position on the landscape (such as north or south slope aspect, ridge or valley, etc.). An ownership may have more than one site type.

STEP THREE: IDENTIFY STANDS

A stand (see Chapter 2: Generally Accepted Silvicultural Principles) is a group of trees in the same area with similar species composition, age, condition and stage of development. A forester may elect to divide a site type into more than one stand in order to apply a range of management treatments (or passive management) to meet a variety of landowner objectives.

STEP FOUR: IDENTIFICATION OF SILVICULTURAL AND ECOLOGICAL ALTERNATIVES FOR EACH STAND

The way in which a stand develops over time, in terms of compositional and structural changes, is relatively predictable. The current development trend of the stand, however, are not necessarily the only ecologically acceptable pathways, and may not meet the landowner's goals. Before deciding on the most viable management option, a forester should identify other ecological alternatives.

Properly delineated, each stand can be expected to respond uniformly to a given natural disturbance or management action. Although there are limitations due to site, stand composition and availability of seed sources, there is almost always more than one ecologically sound silvicultural alternative available. All too often, regenerating the existing tree cover type is the only option considered. Such a choice may not always be ecologically desirable, nor meet the landowner's goals.

By identifying viable ecological and silvicultural alternatives, more management options can be offered to the landowner. Considering the following factors when developing management alternatives:

- **Age structure of the stand.** Species and age structure are two fundamental properties of any forest stand. They must be taken into account in any management consideration.
- **Successional role of each species comprising the current stand (overstory and understory).** This information is essential for planning changes in stand composition and regeneration techniques.
- **Relative growth potential of each species on the identified site type.** This may be the most important information for any management decision because growth potential relates not only to economic outputs, but also strongly affects forest dynamics.
- **Presence of advance regeneration.** Presence of advance reproduction to a large extent dictates the type of regeneration techniques that will be applied. Also, advance reproduction may or may not be of the desired species.

Figure 10-5: Having a trained forester collect inventory data for each stand on the property is necessary before prescriptions can be developed.

- **Anticipated response of advance regeneration to different types of stand manipulation.** If advance regeneration is of mixed species, different growth rates can be expected with different degrees of canopy removal. Seedlings of most species benefit from complete canopy removal, but some shade-tolerant species respond best to gradual canopy removal.
- **Anticipated response of competing vegetation after opening of the canopy.** Understory plant species respond differentially to removal of the forest canopy, and present different degrees of competition to tree seedlings. Response of competing vegetation also varies among site types. Generally, the more mesic the site, the stronger the understory competition. However, potential competing species are not necessarily present in every stand. Some nonnative invasive plants are very competitive and can limit regeneration and growth (see 3.1, 3.3 and 4.3).
- **Potential for inducing advance reproduction of each canopy species.** Regeneration requirements vary greatly with species. Some conditions are more difficult to meet artificially than others.
- **Existing and potentially-damaging agents.** Some species are more susceptible to specific damaging agents (e.g., deer herbivory, insects, pathogens, frost, windthrow) in certain regions or on specific site types.

STEP FIVE: EVALUATE LANDOWNER GOALS AND OBJECTIVES TO IDENTIFY MANAGEMENT OPTIONS

- **Landowner's Resource Constraints:** Some silvicultural and ecological opportunities identified previously may not meet an owner's financial expectations, or may exceed their commitment of time.

- **Regional and Landscape Ecological Issues and Concerns:** Management practices that are ecologically sound on a site or local ecosystem level may not address landscape and regional concerns. However, resource professionals working with private owners should be aware of such issues, and bring them to the owner's attention when preparing management plans. Such issues vary greatly from region to region, and cannot be addressed comprehensively.

  The following are examples of regional ecological considerations:
  - Lack of large contiguous blocks of specific habitats to accommodate wide-ranging animal species, or those that do not thrive in edge habitats.
  - Need for special wooded corridors to accommodate movement of some animal species between suitable habitat patches.
  - Loss of certain vegetation types (and accompanying fauna) due to changes in natural disturbance regimes (e.g., loss of oak savannas or pine forests due to suppression of wild fires).
  - Shortage of mature stages of forest development.
  - Reduced compositional and structural diversity of forest communities.
  - Lack of tree regeneration and reduction of shrub/herb density and diversity due to high deer populations.
  - Management of invasive insects or diseases such as the emerald ash borer or beech bark disease.

  Additional information for ecological considerations can be found in landscape-level documents like the *Ecological Landscape Handbook* and the Wildlife Action Plan (see the Resource Directory for more information).

- **External Socioeconomic Constraints:** Certain activities may be constrained by zoning laws, local and regional land use plans or forest practice regulations, while others may simply conflict with the attitudes of neighbors or the general public. While the latter doesn't bind an owner, a conscientious resource professional will keep landowners informed in order to minimize potential future conflicts.

- **Socioeconomic Incentives:** Socioeconomic constraints often can be balanced by incentives. These may include lower property taxes on managed forestland, income tax deductions for forest management investments, government cost-sharing for management practices, and others. Some practices may also engender greater public acceptance than others without compromising a landowner's goals.

BMPs: Invasive Species

The following are Forestry BMPs for Invasive Species (IS-BMPs) to consider when preparing a forest management plan.

- 3.1 Include a strategy for managing invasive species.
- 3.3 Consider the need for action based on: 1) the degree of invasiveness; 2) severity of the current infestation; 3) amount of additional habitat or hosts at risk for invasion; 4) potential impacts; and, 5) feasibility of control with available methods and resources.
- 4.3 Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.

STEP SIX: DEVELOP MANAGEMENT OBJECTIVES FOR EACH STAND

The previous steps identify ecologically sound management options for individual stands, and eliminate from consideration those that do not align with the landowner's goals or available resources. Based on these options, both the landowner and the forester must select the management (or silvicultural) objectives for each stand (i.e., what to grow and how to grow it, as explained on page 2-35).

STEP SEVEN: PREPARING THE MANAGEMENT PLAN

Only when management objectives have been defined through this type of process should the management plan (i.e., the "action plan") be developed. The management plan is a written document that summarizes all of the previous information, and then clearly prescribes management activities and a timeline for accomplishing them.

Detailed silvicultural prescriptions are not part of the initial management plan – these are developed immediately prior to a scheduled management practice in order to take into account unique stand conditions. For example, a timber harvest or tree planting project should have a detailed project plan with specific instructions or performance criteria.

A suggested process to develop management options is depicted in Figure 10-7. It should be emphasized that this is a process (i.e., a sequence of steps to consider) and not an outline of items to be specifically included in actual management plans.

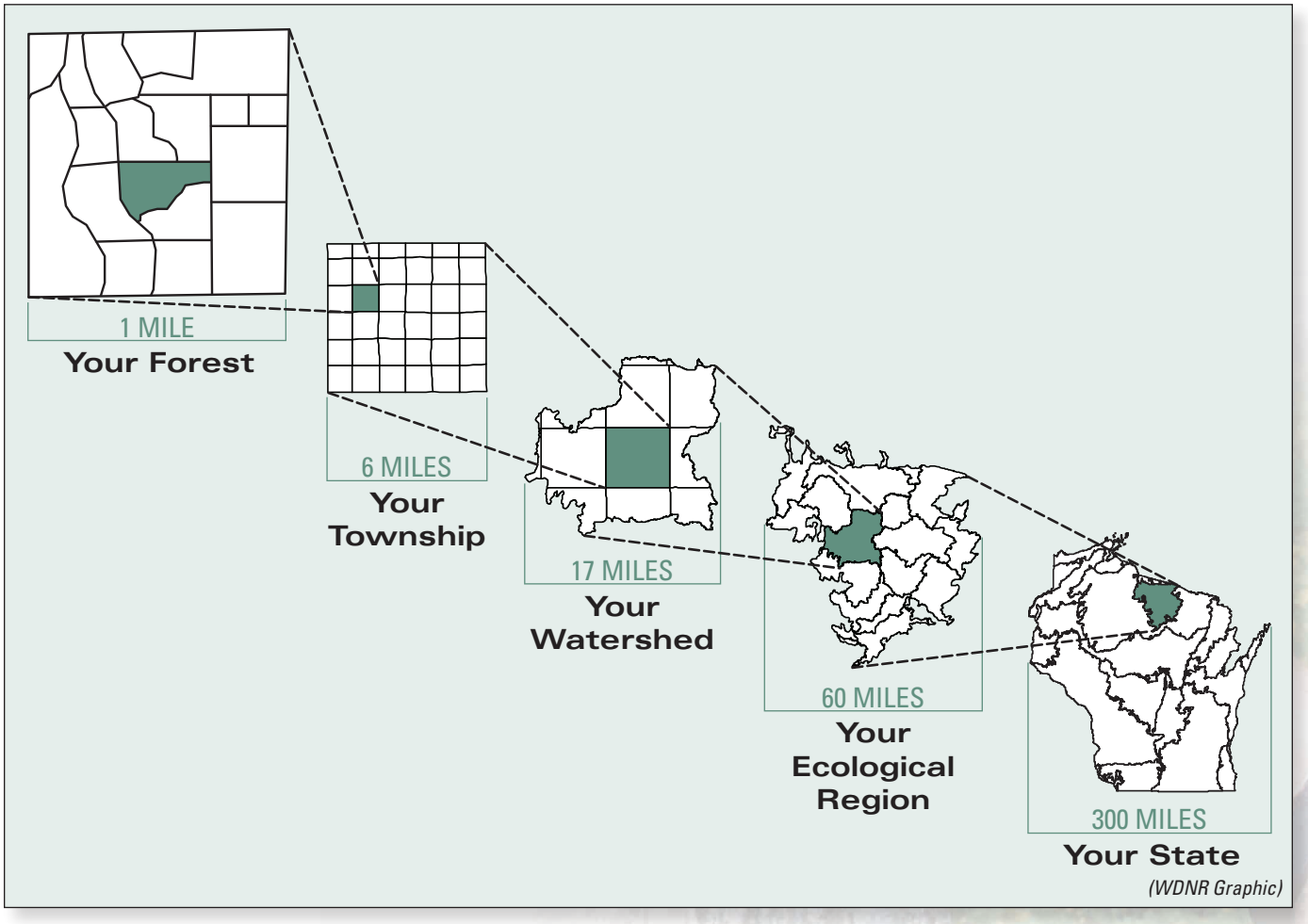


Figure 10-6: Understanding how your property is connected can help to understand how management locally impacts the resources in the township, watershed, state and beyond. Some landscape level tools are identified in the Resource Directory.

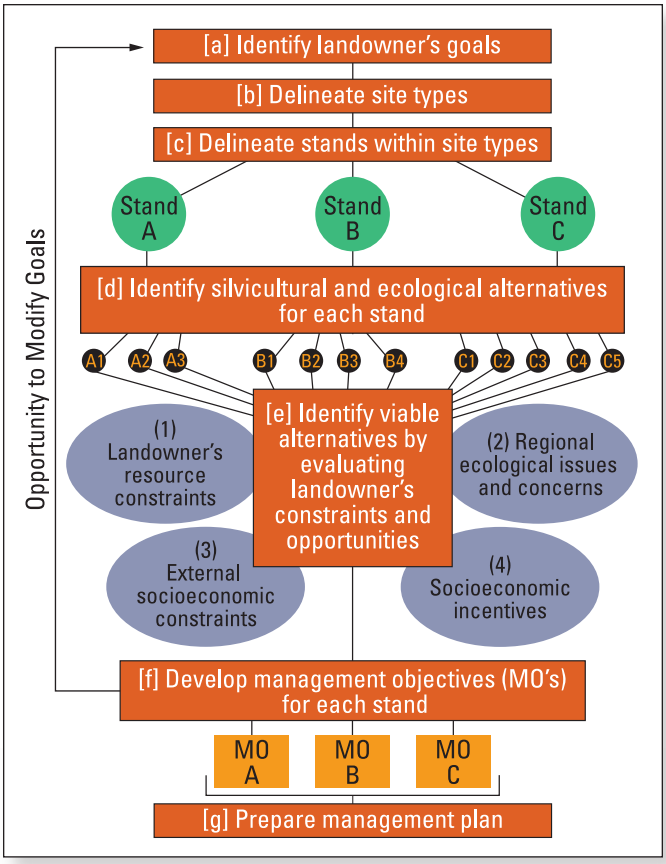
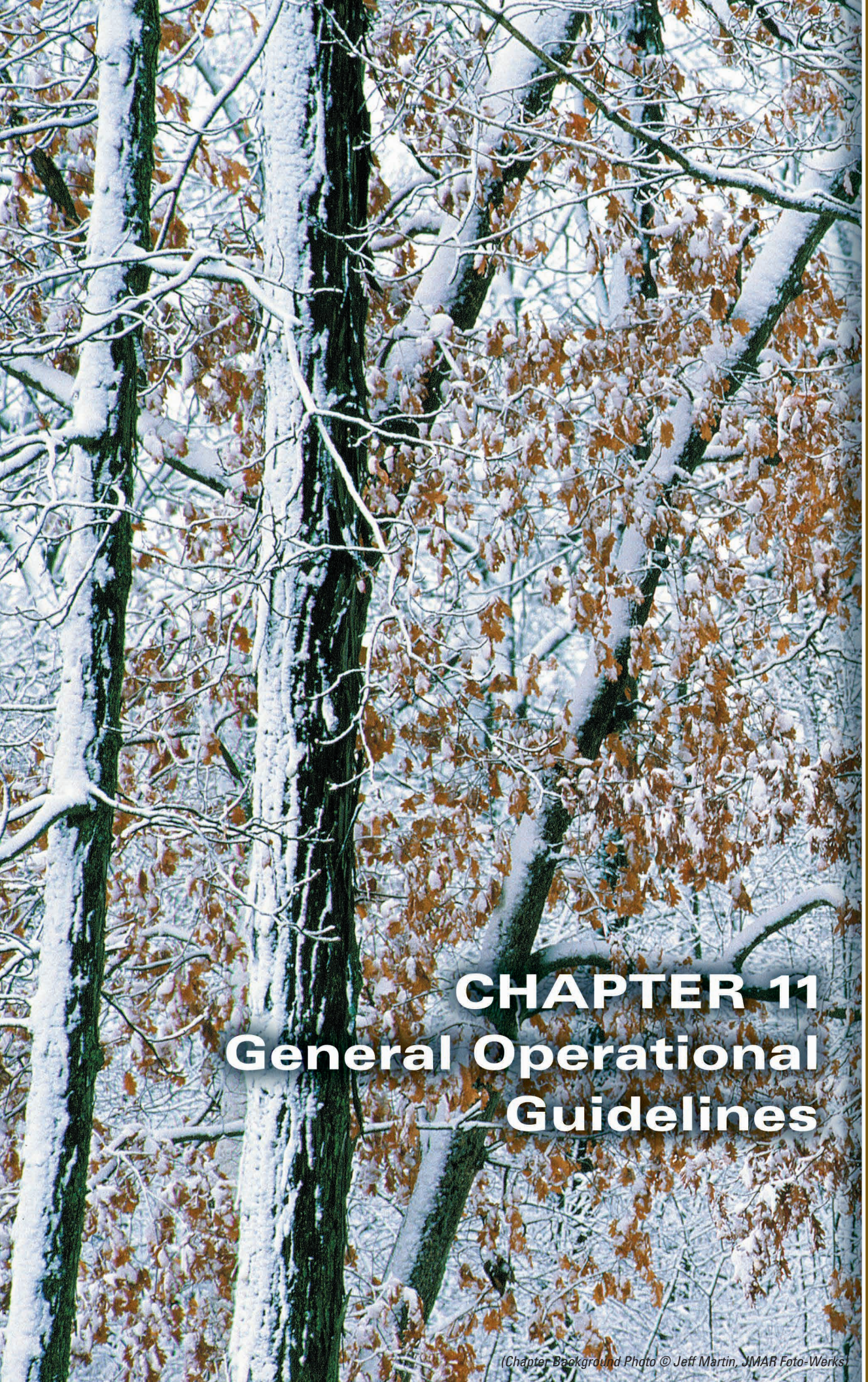


Figure 10-7: Model of an approach to the development of ecologically sound forest management plans.
(Figure adapted from Kotar, page 14)

Types of Forest Management Plans

While this chapter describes how to develop a more comprehensive management plan, there are other types of plans that a forester can write based on a landowner's interest and readiness to take action on their property. A forest management plan can range from being quite brief to detailed depending on its purpose. For state and federal programs in Wisconsin, forest management plans usually fall into these categories:

- **Practice Plans:** Practice plans provide detailed information about how to implement an individual practice. Practice plans may stand alone or may supplement a more comprehensive plan.
- **Basic Plans:** Basic Plans outline (a) general management practice(s) for a property and may be in the form of a letter or summary of management prescriptions. They are used most often as a follow-up to initial contact with a new landowner to support verbal recommendations, and lay the groundwork for further action in the future. A Basic Plan might not meet the plan standard requirements for cost-sharing or forest tax programs, but should still incorporate the sustainable forestry principles described in the first section of this chapter.
- **Comprehensive Plans:** Comprehensive Plans such as Forest Stewardship Plans (FSPs) are more complete than Basic Plans, and can qualify landowners for different financial incentives, such as cost-sharing and tax law programs. They incorporate sustainable forestry principles and may go into some detail to identify and describe activities to enhance or protect soil, water, aesthetic quality, recreation, timber, water, and fish and wildlife resources based on the landowner's objectives for the land.



11

CHAPTER 11
General Operational Guidelines

(Chapter Background Photo © Jeff Martin, JMAR Foto-Werks)

CHAPTER 11
GENERAL OPERATIONAL GUIDELINES

OPERATIONAL CONSIDERATIONS

Timing and Coordination of Activities

Timing forest management or recreational activities can be constrained by 1) pre-existing conditions, regulations, or limitations such as road load limits, forest access limitations, risk of introducing and spreading invasive species and forest fire hazard conditions, and 2) seasonal conditions that specify appropriate times for such activities as herbicide treatments, tree planting and road construction.

- Conduct forest management activities when soil conditions are firm enough to support the type of equipment being used, in order to protect soil productivity and minimize damage to any cultural resources that may be present.
- Plan for removal of equipment and cut material from wetland areas prior to thawing at the end of the winter season, or leave it until the next winter.

TIMING AND COORDINATION OF ACTIVITIES TO REDUCE NOISE AND VISUAL IMPACTS

- Avoid management operations during periods of peak recreational use whenever possible.
- Reduce noise in early morning, late evening and other appropriate times when possible.
- Selectively restrict use of recreational facilities to avoid conflict with management activities.
- Temporarily relocate recreation trails away from management activity areas.
- Inform and educate recreational users regarding management issues, limitations and timing prior to, during and after management activities.
- Time management activity with consideration for public-use patterns.
- Minimize direct conflict with forest recreational users during peak use and special event periods.

Figure 11-1: Winter harvesting is one example of timing forest management activities to protect soils, especially in lowland areas such as this black spruce stand.

- In wetlands, plan to conduct forest management activities when soil is frozen or firm enough to support equipment being used. Evaluate the site based on weather conditions to ensure adequate support for equipment to prevent or minimize rutting. Examples of weather conditions that could be cause for concern include heavy rain, flooding, significant snow before frost, and three consecutive nights above freezing after frost has been established.
- Plan to conduct all activities during the preferred operating periods for site and soil conditions. Preferred operating periods for a site may vary due to local and seasonal climatic conditions, equipment being used, operating techniques, and presence of invasive species (see 3.4).
- Combine and integrate forest management activities where appropriate to reduce or eliminate the need for multiple entries by heavy equipment. For example, full-tree skidding may be used for preparation of jack pine seed beds, eliminating the need for additional site preparation.
- Consider timing operations to minimize the risk of introducing or spreading invasive insects and diseases, for more information refer to Table 8-1A through 8-1H, pages 8-9 through 8-18 or additional resources in Chapter 8: Threats to Forest Health.
- Protect reserve areas and structural habitat components retained in previous stand treatments.

Figure 11-2: The new leaves of buckthorn emerge beside the berries from last year.

Designing Operations To Fit Site Conditions

Operational considerations should take into account individual site conditions as they vary across the landscape. Characteristics such as soil type, topography, access, climate conditions, and the presence of invasive species or cultural resources should be evaluated and planned for.

- Avoid unwanted impacts to a site by determining the preferred operating season, as well as the costly process of moving equipment from a site, or shutting down operations if negative impacts are occurring.
- Take into account that the preferred operating season may vary for any one site depending on soil characteristics, local climatic conditions, equipment being used, and operating techniques. The use of low ground pressure (LGP) equipment and such operating techniques as using slash mats to drive on, can extend operating seasons on low-strength soils.
- Identify occurrences of invasive species, and evaluate their levels of threat to the regeneration of forest or other desirable vegetation, as well as human health and safety.
- Moving equipment from site to site may aid in the spread of invasive plants or vegetative parts that can take root in the new location. Equipment may need cleaning before it is moved from an infested site into an area that is free of problem invasives (see 3.2, 3.3, 4.4, and 4.5).
- To help prevent spread of invasive plants, monitor, control and treat infestations prior to and after completion of forest management activities (see 4.2).
- To help prevent introducing or spreading invasive insects and diseases, follow guidance pertinent to the forest type. For more information, refer to Table 8-1A through 8-1H, pages 8-9 through 8-18 or additional resources in Chapter 8: Threats to Forest Health.
- Soil susceptibility to compaction, rutting and puddling is primarily dependent on soil texture and moisture content. Use caution when operating heavy equipment on sites whenever adverse soil impacts are likely, especially during the following times:
  - During spring and early summer months.
  - Immediately following heavy rains.
  - During the period between when transpiration ceases in the fall and before freeze-up occurs.

Managing and Minimizing Infrastructure

In the context of forest management activities, infrastructure is defined as the network of access roads, approaches, trails, and landings used to move equipment onto and around a forest management site. Any reduction in the total amount of area occupied by such infrastructure reduces the impact on soil productivity, as well as potential impacts to cultural resources, residual trees through wounding, riparian areas, and wildlife habitat.

- Consider future management activities that use common infrastructure for management of adjacent stands or ownerships. Develop or plan infrastructure accordingly.
- Examine existing access routes to determine if they are appropriate. Consider whether relocation would provide a better long-term access route.
- Where appropriate, limit direct trafficking of sites to the smallest area needed when planning management activities such as harvesting and site preparation. As a general rule, no more than 15 percent of the harvest area should be occupied by roads, landings and skid trails. Of this 15 percent, no more than three percent of the harvest area should be occupied by permanent roads.

Figure 11-3: At the end of a forest operation, a simple earthen traffic barrier may be satisfactory for preventing unwanted vehicle traffic.

MANAGEMENT ACTIVITY PLANNING CHECKLIST

- ☐ Develop a forest management plan with management objectives for your property.
- ☐ Make a list of site-specific Forestry BMPs for Water Quality (WQ-BMPs) needed to protect water quality. Include in your timber sale contract, timber harvest plan, and forest management plan.
- ☐ Investigate cost-share options for implementing WQ-BMPs.
- ☐ Plan management activities to protect water quality by considering site conditions.
- ☐ Plan management activities to ensure that habitat of any endangered or threatened plant or animal species is protected.
- ☐ Review the Natural Heritage Inventory for threatened or endangered species prior to beginning any activity associated with timber harvesting.
  dnr.wi.gov – keywords "public portal"
- ☐ Prepare a map of your property with sensitive areas and other important features identified to use during forest management activities.
- ☐ Reference mapping resources and confirm site conditions in the field when identifying sensitive areas.
- ☐ Obtain necessary permits and file needed notices before beginning any timber harvesting. Appendix E contains more permit information. Information on permits can also be found in *Wisconsin's Forestry BMPs for Water Quality Field Manual* including a list of contacts by county.
- ☐ Stabilize any bare soils as soon as possible to prevent erosion. Critical areas to protect include steep slopes, erosion prone sites, riparian management zones, wetland filter strips and stream crossings.
- ☐ Have a spill containment and clean-up kit on-site whenever equipment is present.
- ☐ Investigate and address invasive species concerns (see Chapter 8: Threats to Forest Health).

Table 11-1: This checklist can be used when planning forest management activities.

PROTECTING CULTURAL RESOURCES

Figure 11-4: To be effective, gated road closures must be located properly. Otherwise, vehicle traffic will simply go around as they have on this forest road.

Some types of cultural resources are protected by federal or state law (see Chapter 6: Cultural Resources).

- When feasible, avoid management activities within cultural resource areas. Delineate such areas with flagging, signs or temporary fencing, and make sure that loggers and equipment operators understand that there is to be no work in the marked area.
- When it is not feasible to avoid cultural resource areas during forest management activities, protect resources by one of the following measures:
  - Temporarily brace walls and board up windows and doors of historic buildings.
  - Avoid felling trees onto historic buildings, structures or surface features of archaeological sites.
- For cultural resources that cannot be protected from damage, consider data recovery (professional excavation of archaeological sites or documentation of above-ground cultural resources).
- If a human burial site is accidentally discovered during operations, cease operations immediately in the vicinity of the discovery. Contact the Burial Sites Preservation Office at the Wisconsin Historical Society (**800-342-7834** or **608-264-6493**), and your local law enforcement agency.
- For the accidental discovery of other types of cultural resources such as archaeological artifacts, temporary suspension is recommended but not required. Suspending operations in the immediate vicinity allows time to contact a cultural resource professional.

FUELS, LUBRICANTS, WASTE, AND SPILLS

Fuels, Lubricants and Waste

Logging, road building and other forest activities require motorized equipment. Antifreeze, fuels and lubricants used in machinery can potentially pollute lakes, streams, wetlands, and groundwater. Planning for forestry operations should include practices to handle solid and liquid wastes generated in the field.

Spills

Report all hazardous substance spills immediately to the Wisconsin DNR by calling the **24-hour Emergency Hotline number at 1-800-943-0003**.

Spills of fuel, lubricants or pesticides during forest management operations can occur as a result of fueling, hydraulic hose breaks, mechanical damage, or vandalism. All spills of hazardous substances that adversely impact or threaten to adversely impact public health, welfare or the environment must be 1) immediately reported to the Wisconsin DNR and 2) cleaned up. In some instances, small quantities of petroleum products and agrichemicals do not require reporting to the Wisconsin DNR. During timber harvesting operations, reporting a spill is not necessary for a gasoline spill less than one gallon, or for a diesel or hydraulic fluid spill less than five gallons, as long as there is no threat to the environment. However, the spill still needs to be cleaned up.

For more details on spill reporting guidelines or cleanup, contact your local Wisconsin DNR Regional Spill Coordinator:

Northern 715-392-7822
Northeast..... 920-662-5165
South Central..... 608-275-3303
Southeast 414-263-8524
West Central..... 715-684-2914, Ext. 117

NOTE: Proper equipment maintenance will prevent many spills.

BMPs: Spills

The following Forestry BMPs for Water Quality (WQ-BMPs) are general guidelines for spills of fuel and lubricants used in forestry field operations. These practices complement specialized training given to persons using pesticides or other hazardous materials.

- **Maintain a spill-containment and cleanup kit appropriate for the materials on the operation.** At a minimum, a kit for petroleum products should include:
  1) Plugs and clamps to control a hydraulic line break
  2) A container to catch leaking fluid
  3) A shovel
  4) Oil absorbent sheets, sawdust or other material to absorb fluid

- **If a spill should occur, do the following:**
  1) **Protect yourself and others.** Wear protective clothing and use equipment appropriate for any hazardous materials on the operation. Avoid coming in contact with any toxic drift or fumes that may be released.
  2) If you are able, **control the spill**; **stop the leak**.
  3) If you are able, **contain the spill**; **keep it from spreading**. Shovel a dike around the spill. Use absorbent material such as sawdust or loose soil to soak up fluid. Place a bucket under a hydraulic hose break. Keep the spill from flowing into lakes, streams or wetlands.
  4) Isolate the spill material.
  5) **Report all hazardous substance spills immediately to the Wisconsin 24-hour Emergency Hotline at 1-800-943-0003**.
  6) **Contact your local Wisconsin DNR regional office** for disposal guidance.

POST-OPERATIONAL ACTIVITIES

Figure 11-5: Honeysuckle is a prevalent invader of many Wisconsin woodlands.

- Consider closing roads after operation completion if they will provide access to a cultural resource.
- Remove flagging, signs or other markings that identify a cultural resource when a forest management activity is completed.
- Restore watercourses to approximate their natural condition by removing temporary drainage structures and stabilizing the soil along the banks.
- Stabilize bare soil areas and install water diversion devices and erosion control barriers where appropriate, to prevent or minimize erosion and sedimentation from roads, skid trails and landings into surface water and cultural resource areas.
  - Fill in ruts as necessary, weighing the benefits of filling in ruts on skid trails against the potential for additional impact to soil productivity as a result of equipment used to eliminate ruts.
  - Inspect erosion control measures periodically and maintain or remove as needed.
  - Seed and fertilize as appropriate. Do not use nonnative invasive plants or seed mixtures that are not certified weed-free (see 6.1 through 6.4).
- Place traffic barriers where appropriate to prevent vehicles from disturbing recently stabilized areas. Barriers should be visible and well-marked, and they should not present a safety hazard.
- Conduct follow-up visits to areas where structures (e.g., culverts or waterbars) or other protection measures (e.g., seeding of bare areas) are used to minimize impacts on water quality and wetlands. Such visits can help assure that protection measures remain functional.

BMPs: Nonpoint Source Pollution Prevention

The following Forestry BMPs for Water Quality (WQ-BMPs) will help prevent nonpoint source pollution from fuels, lubricants and wastes during forest management activities.

- **Use biodegradable lubricants whenever practical.** Biodegradable lubricants are less toxic than other lubricants, but still need to be disposed of properly.
- **Maintain equipment regularly.** Check hoses and fittings to prevent leaks or spills.
- **Designate specific areas for equipment maintenance and fueling.** Locate these areas on level terrain, a minimum of 100 feet from all streams and lakes.
- **Collect all waste lubricants, containers and trash.** Store them in leak-proof containers until they can be transported off-site for recycling, reuse or disposal at an approved site. **NOTE: It is illegal to dump fuel and lubricants on the land or in water in Wisconsin.**
- **Separate all fluids and materials, and keep in different labeled containers** to avoid creating "hazardous waste" and expensive waste disposal. Call your local Wisconsin DNR regional office to determine if a waste is hazardous, and for disposal guidelines.

(Best Management Practices for Maine: Protecting Maine's Water Quality)

Figure 11-6: Store empty containers of lubricants and other waste in leak-proof containers until transported off-site.

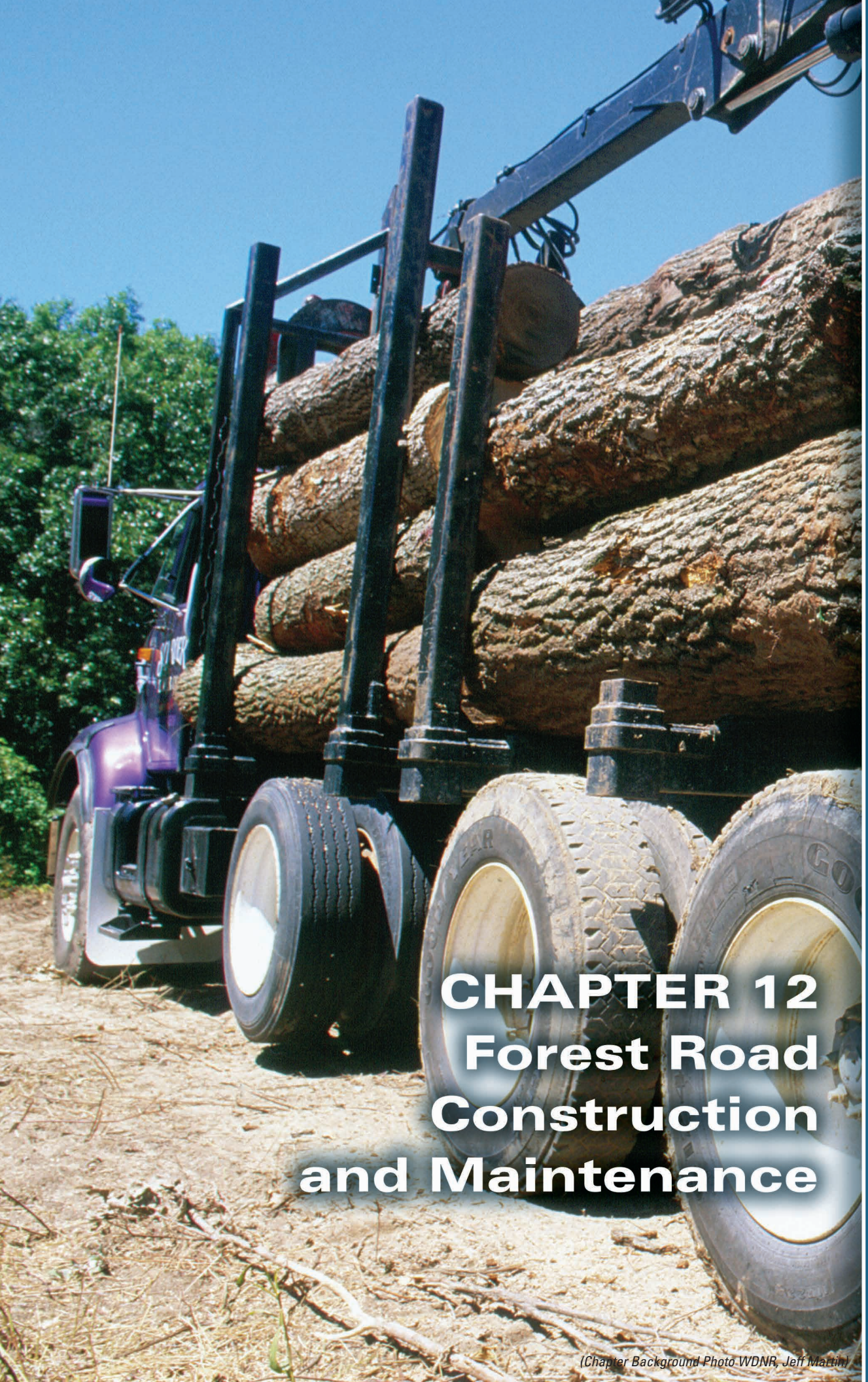
BMPs: OPERATIONAL ACTIVITIES

BMPs: Invasive Species

The following are Forestry BMPs for Invasive Species (IS-BMPs) that should be considered when carrying out stewardship practices.

- 3.2 Prior to implementing management activities, scout for and locate invasive species infestations, consistent with the scale and intensity of operations.
- 3.3 Consider the need for action based on: 1) the degree of invasiveness; 2) severity of the current infestation; 3) amount of additional habitat or hosts at risk for invasion; 4) potential impacts; and, 5) feasibility of control with available methods and resources.
- 3.4 Plan management activities to limit the potential for the introduction and spread of invasive species.
- 4.2 If pre- or post-activity control treatments are planned, ensure that they are applied within the appropriate time window.
- 4.3 Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.
- 4.4 Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.
- 4.5 Take steps to minimize the movement of invasive plants, insects, and diseases to non-infested areas, during forest stewardship activities.
- 5.4 Where site conditions permit, allow natural revegetation of the roads, skid trails, and landings to occur. If seeding or planting is necessary to minimize the threat of highly damaging invasive species from spreading, use native seed or non-invasive cover crops for revegetation.
- 6.1 Limit the introduction and spread of invasives during reforestation or revegetation site preparation activities.
- 6.2 Revegetate or reforest as quickly as feasible after site disturbance (see also 5.4).
- 6.3 When consistent with site conditions and goals, allow natural revegetation of the ground layer to occur. If seeding or planting is necessary to minimize the threat of highly damaging invasive species from spreading, use native seed or non-invasive cover crops for revegetation (see also 5.4).
- 6.4 Select plant materials that are site appropriate to favor establishment and vigor.

Figure 11-7: Cleaning equipment to prevent the spread of annosum propagules.



12

CHAPTER 12
Forest Road Construction and Maintenance

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 12
FOREST ROAD CONSTRUCTION AND MAINTENANCE

Roads, skid trails and landings comprise a forest transportation system. Skid trails are used to get forest products from the woods to a landing, A landing is used to stockpile timber for loading onto logging trucks. Forest roads connect the landings to existing public roads. Forest roads can also provide access needed for improving fish and wildlife habitat, fighting fires, and providing recreation. This chapter focuses on forest roads. Timber harvesting, skid trails and landings are discussed in Chapter 13: Timber Harvesting.

There are three types of forest roads: temporary, permanent seasonal, and permanent all-season. During the planning stage, identify the type of road system that is needed to meet both forest management and landowner objectives.

Temporary roads are the most common type of forest road. They are designed and constructed for short-term use during a specific project, like a timber harvest. These roads are used only when the ground is frozen or firm. When the project is done, the temporary road is closed, all stream crossing structures removed, and the road revegetated.

Permanent seasonal roads are maintained as part of the permanent road system, but are designed to be used only when the ground is frozen or firm. These roads are generally narrower than all-season forest roads and are built to lower engineering standards. Seasonal roads will generally have little to no surface gravel.

Figure 12-1: Seeding can be as easy as spreading grass seed by hand as this landowner is doing on his freshly-graded woods road. Use non-invasive species and certified weed-free seed.

Permanent all-season forest roads are designed for year-round use, but may have use restrictions at various times of the year, such as spring break-up. These roads are built to higher standards than the others and usually have gravel surfaces. All-season roads can be the most expensive to build and maintain.

Integrated Resource Management Considerations

Well-planned and well-built forest roads make sense both economically and environmentally. The largest contributor to nonpoint source pollution from forest management activities is forest roads that are poorly located, constructed and maintained. Roads over steep slopes, erosion prone sites, streams, and wetlands hold the greatest potential for degrading water quality. Road construction may alter the flow of water over and through the ground. Heavy road use may expose soil, making it vulnerable to erosion. Stream crossings can change the hydrology of streams. All of these factors pose risks to waterbodies; however, water quality impacts can be avoided by properly designing, constructing and maintaining forest roads. Following the Forestry BMPs for Water Quality (WQ-BMPs) for forest roads can:

- Extend the road's season of use
- Reduce road wear and maintenance costs
- Enable trucks to haul heavier loads
- Lower truck maintenance costs
- Reduce travel time, and
- Protect water quality before, during and after timber harvests

Forest roads also provide an opportunity for nonnative invasive species to move into areas, either on equipment constructing or maintaining the road, or on vehicles or footwear of road users. Servicing as many acres of forest with as few roads as possible is a sound method of reducing impacts of roads on forest resources.

FACTORS IN DECISION-MAKING

- The number, size and design of forest access roads will be influenced by the frequency of access, amount of anticipated traffic, seasons during which access is required, and safety concerns.
- Distribution of necessary management activities will affect the number and location of access roads.
- Choices regarding road construction standards and maintenance activities will be influenced by site characteristics, and the value of the resources served. Culverts and ditches may be necessary with any road construction technique.
- Access roads may inadvertently serve as a means for spreading nonnative invasive plants, whether by human activity or wildlife (see 5.1 and 5.2).
- Surfacing can be the major cost of low-volume road construction. Alternatives should be evaluated according to expected use and potential impact on sediment load. Where grades make the potential for surface erosion significant, the road should be surfaced with materials such as crushed rock, compacted gravel, or sod that will minimize potential water quality and soil productivity impacts (see 5.5).

MINIMIZING THE IMPACTS OF ROADS

- Visual impacts and excessive noise can result from poor design, construction and maintenance of forest access roads. Take into account the following considerations when planning to reduce noise and visual impacts associated with the design and use of forest access roads:
  - Noise from traffic, especially large trucks and heavy equipment.
  - Potential increased costs of building forest access roads to accommodate visual quality concerns, and potential increased costs of using existing roads that require traveling greater distances.
  - The limited road construction season that generally coincides with the tourist season.
  - Traffic during wet periods that can increase maintenance needs, and create unsightly ruts and mudholes.
- Visual impacts and noise impacts created by gravel pits are not compatible with recreational user sensitivities. Take into account the following considerations when planning to reduce noise and unsightliness related to gravel pits:
  - Local sources of gravel are necessary for efficient, cost-effective road building and maintenance.
  - Recreational use of gravel pits may cause conflicts.
- Site-specific soil, topographic and forest inventory information (including invasive species) will assist resource managers or landowners in planning road location and layout. For more information, see the Resource Directory.
- Because roads take soils out of production, effort should be made to keep the length and width of roads to a minimum without sacrificing safety.
- To minimize road mileage and reduce costs, coordination with adjacent landowners may be desirable.
- The greatest potential for soil erosion occurs immediately after construction. Disturbed areas should be shaped and stabilized as soon as possible to minimize erosion potential (see 5.4).

MAINTENANCE NEEDS

- The purpose of maintenance procedures is to ensure measures taken to minimize impacts on forest resources are working, and continue to work into the future. Surfacing materials and the amount of use determine the level of maintenance required.
- Roads that are open for use require more maintenance than roads that are closed to vehicular traffic. Inactive roads (roads currently not in use) whether closed temporarily or permanently, require occasional work to reduce potential impacts on water resources.
- Road layout, construction methods, and access control all contribute to the longevity, utility, safety, and maintenance cost of roads.
- Monitor for nonnative invasive species, control their spread, and eradicate them if possible. Clean equipment as needed (see 4.3 and 4.4).

REDUCING VISUAL IMPACTS OF ROAD CLEARINGS

- Utilize merchantable timber within road clearings.
- Burn, screen or bury road-clearing debris such as stumps, rocks and boulders, so it is not visible from travel routes or recreation areas.
- Move cleared debris outside of the travel route right-of-way so it is minimally apparent.
- Avoid creating a corridor of debris.
- Do not leave jackstrawed or overturned stumps in the immediate foreground.
- Reduce the height of dozed clearing debris during road construction.

REDUCING VISUAL IMPACTS DUE TO ALIGNMENT AND LOCATION OF ROADS

- Minimize the number of roads approaching travel routes or recreation areas.
- Locate roads and trails to minimize visibility from nearby vantage points such as scenic overlooks, streams and lakes.
- Minimize total road mileage and ground disturbance required to meet landowner objectives and anticipated traffic loads.
- Avoid tracking mud onto highways by using appropriate road surface material.
- Reduce visual penetration with appropriate curves in road alignment.

REDUCING NOISE AND VISUAL IMPACTS OF GRAVEL PITS AND BORROW AREAS

- 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.
- Rehabilitate pits upon completion of use.
- Reduce noise in early morning, late evening and other appropriate times whenever possible.
- Develop gravel or borrow pits from the back to the front of pits (moving toward the predominant view or vantage point).

Figure 12-2: Road maintenance activities spread garden forget-me-not along this access road. If it were identified prior to grading, it could have been avoided or controlled to minimize its spread.

PROTECTING WATER QUALITY AND WATER FLOW

- Following WQ-BMPs when designing, constructing and maintaining roads can minimize the potential impact of roads on water quality in lakes, streams and wetlands, as well as minimize alterations to normal water flow patterns.
- Effective road construction techniques minimize the disturbance to the natural flow of water over the landscape, and ensure the structural integrity of the road embankment.

The goals are to provide a simple road structure of adequate strength to support heavy vehicle traffic, and provide drainage structures to pass water through the road corridor.

UPLAND FOREST ROADS

BMPs: Planning, Location and Design

Decisions made at the planning stage will affect a road's construction costs, long-term maintenance needs, service life, and the amount of nonpoint source pollution it causes. Foresters, loggers, and landowners should plan, locate and design the road system together.

- Plan road systems that minimize the number, width and length of roads to limit the total area of the site disturbed. Remember to:
  - Consider future uses of the road system.
  - Coordinate development with adjoining landowners when possible.
  - Use temporary roads where practical.
- Use existing roads when they provide the best long-term access. Consider relocating existing roads if access can be improved and environmental impacts lessened. Reconstruct existing roads to the extent necessary to provide adequate drainage and safety. Do not disturb stable road surfaces.
- Select road locations that allow for drainage away from the road.
- Where possible, locate roads on well-drained soils.
- Minimize the number of stream, dry wash, and wetland crossings.
- Locate roads outside riparian management zones and wetland filter strips except at crossings. For more information, see Chapter 5: Riparian Areas and Wetlands (see page 5-9).
- Road grades should not exceed 10 percent. If road grades greater than 10 percent are necessary, limit grade length to minimize erosion, or break the grade using drainage structures. Graveling the road surface on steep grades can also help to maintain stability. NOTE: Optimum roads grades should be less than five percent (see Figure 12-3).
- Locate roads to follow natural contours and to minimize cut and fills. Balance cut and fills to minimize the need for fill and removing excess fill material (see Figure 12-4).

- 5.2 Avoid constructing new roads, skid trails, and landings in areas infested with invasive species where possible.
- 5.3 Avoid spreading seeds and other propagules from infested to non-infested areas during road maintenance, reconstruction, new construction, and closure.

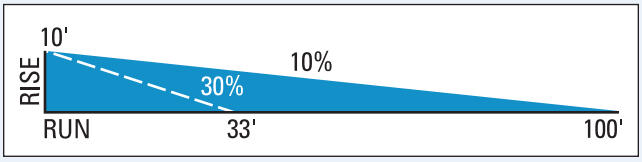


Figure 12-3: Road Grade % = Rise ÷ Run x 100
(Figure Credit: WDNR)

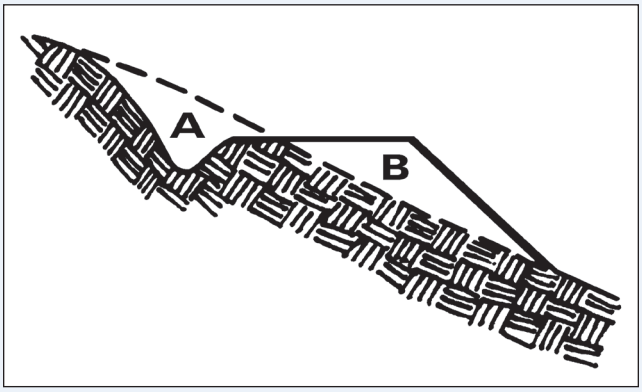


Figure 12-4: A side-hill cross-section illustrating how cut materials (A) equals fill materials (B).
(Figure Credit: WDNR)

STREAM CROSSING DESIGN AND CONSTRUCTION

Many stream crossings, especially culverts, can significantly affect streams if WQ-BMPs are not used to minimize impacts with proper design, installation and maintenance. Poorly designed, installed or maintained, crossings can change the physical characteristics of a stream – its speed, depth and channel shape. Crossings can also create barriers for fish and other organisms trying to move upstream.

When planning a stream crossing, first determine whether there are other ways to access the parcel that would not require a new crossing. This could include contacting adjacent landowners for permission to cross their property for alternative upland access.

If the crossing is unavoidable, you will need to consider:

- the stream channel
- the stream banks
- the approaches to the crossing

The ideal location for a stream crossing is where the stream is straight and narrow with low banks and firm rocky soil. The road should approach the stream at the least gradient possible.

When stream crossings are necessary, select a stream crossing location before building and designing your forest road system. Stream crossing locations can be a fundamental driver on planning the layout of the timber harvest and the forest road system. Forest roads should meet at the optimal stream crossing location.

Figure 12-5: This stream crossing is undersized and perched, preventing fish movement upstream.

Building your forest roads prior to deciding where to locate a stream crossing often results in a sub-par location for a stream crossing – which can cause a Chapter 30 Stream Crossing Permit to be denied on navigable streams.

Factors in properly sizing a crossing include storm frequency, drainage area, and flow rates. Permit standards for crossings include information on how to size crossings. A properly sized crossing will reduce the likelihood of high water levels undermining or washing out the crossing. Washouts can also be avoided by providing a high water release as part of the approach. This high water release can be a dry culvert or dip in the approach.

A decision must be made as to whether or not a crossing should be permanent or temporary. The key factor in this decision will depend on the intensity of use. If the crossing will only be used during the course of a harvest, a temporary crossing could suffice. If the crossing will get continual use throughout the year, a permanent crossing may be more appropriate. Common temporary stream crossing designs used in forest management include portable bridges, timber mats and pole fords. For permanent crossings, bridges, culverts, and fords are often used.

The USDA Natural Resources Conservation Service, your local land conservation department, or a private consultant can assist with ford and culvert designs. To design a bridge, contact a private consultant or experienced contractor.

Figure 12-6: Timber mats provide an easy and cost-effective option for temporary stream crossings.

BMPs: Stream Crossings

The following WQ-BMPs provide general guidance on the design, installation, and maintenance of stream crossings. Permit requirements will include more detailed information on sizing and installing stream crossings. Be sure to refer to and understand permit requirements.

- Identify optimal stream crossing locations. Optimum locations are where the stream channel is straight and narrow with low banks and firm rocky soil. Roads should approach streams at the least gradient possible.
- Install stream crossing structures at right angles to the stream channel, where practicable.
- Use soil stabilization practices on exposed soil at stream crossings. Use seed and mulch, and install temporary sediment control structures immediately following construction to minimize erosion into streams. Maintain these practices until the soil is permanently stabilized (see Soil Stabilization, page 12-16).
- Design, construct and maintain stream crossings to avoid disrupting the migration or movement of fish and other aquatic life. Consider clear-span bridges, bottomless arch culverts and temporary stream crossings that retain the natural streambed.
- Install stream crossings using materials that are clean, non-erodible and non-toxic to aquatic life.
- Minimize channel changes and the amount of excavation or fill needed at the crossing.
- Limit construction activity in the streambed to periods of low or no flow. Keep use of equipment in the stream to a minimum.
- Use diversion ditches, broad-based dips or other practices on the road approached to prevent road runoff from entering the stream. Direct the runoff into undisturbed vegetation, preferably outside the riparian management zone (RMZ) (see Figures 12-7 and 12-8).
- Stabilize approaches to crossings with aggregate or other suitable material to reduce sediment entering the stream.

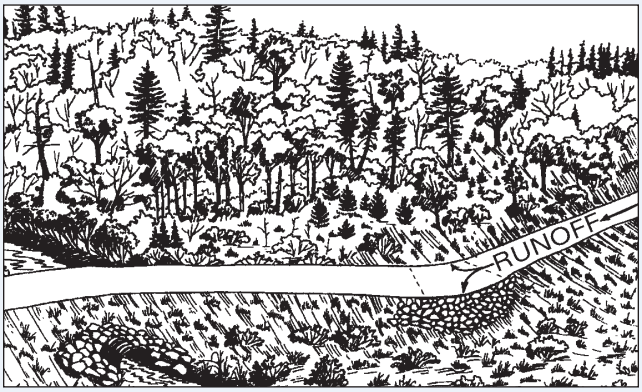


Figure 12-7: Use of fill when placing a culvert.
(Figure Credit: WDNR)

Figure 12-8: Example of a diversion ditch.

BMPs: Culverts for Stream Crossings

- Install culverts that extend at least one foot beyond the road fill.
- Install culverts that are large enough to pass flood flows. To avoid plugging, wash-outs, and upstream flooding, culvert should be a minimum of 18 inches in diameter.
- Install culverts so there is no change in the streambed elevation. Culverts should not cause dam or pool water (see Figure 12-11).
- Firmly compact material around culverts, particularly the bottom half. To prevent crushing, cover the top of culverts with fill to a depth of one-third of the culvert diameter or at least 12 inches, whichever is greater (see Figure 12-9).
- Use riprap around the inlet and outlet of culverts to prevent water from eroding and undercutting the culverts. Use filter fabric or a filter layer of gravel under the riprap (see Figure 12-10). Consider using flared-end culvert sections.
- Keep culverts clear and free of debris so that water can pass unimpeded at all times. This is especially important in areas where beaver are present. Consider using a bevel cut culvert to facilitate debris removal. A bevel cut requires a longer culvert than a flat cut.

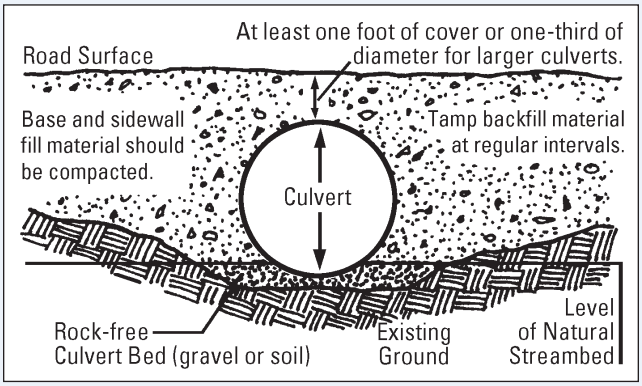


Figure 12-9: Installation of culverts. (Figure Credit: WDNR)

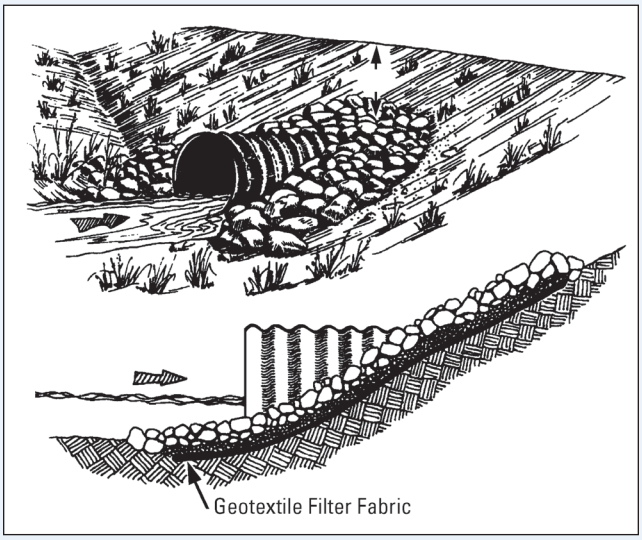


Figure 12-10: Use riprap around the inlet and outlet of culverts. (Figure Credit: WDNR)

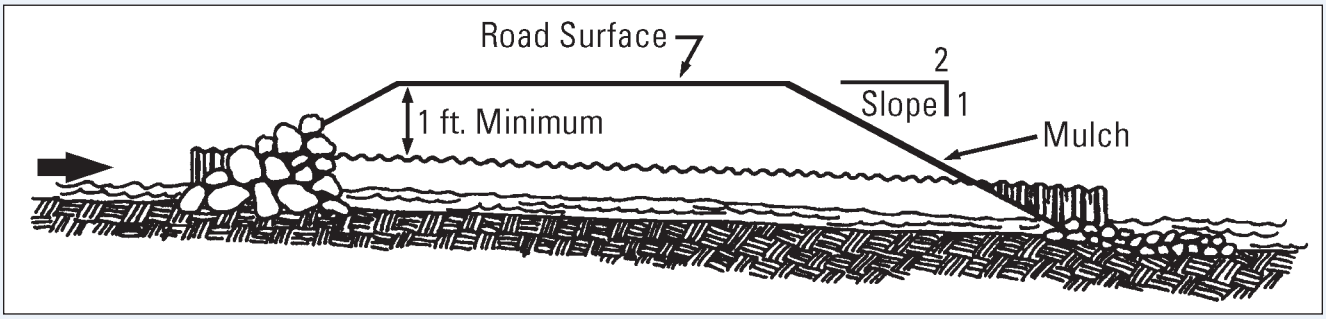


Figure 12-11: Install culverts so there is no change in the streambed elevation. (Figure Credit: WDNR)

BMPs: Fords

- Use fords for crossing dry streambeds or where fording would cause minimal water quality impacts.
- Locate fords where stream banks are low.
- Place fords in areas with a firm rock or gravel streambed. Install stabilizing material like reinforced concrete planks, crushed rock, riprap, or rubber mats on streambeds, if needed.

Figure 12-12: Fords are best suited to streams with a firm rock or gravel base.

BMPs: Temporary Stream Crossings

Figure 12-13: This temporary bridge provides access for forest management activities when a permanent crossing is not needed.

- Use temporary stream crossings such as temporary bridges, timber mats, pole fords or frozen fords when appropriate.
  - Timber mats can span the width of smaller streams and are easy to install with a skidder or forwarder. Timber mats can be used in any season.
  - Pole fords may be used in small streams by placing poles (or small logs) side by side on the streambed. Pole fords must be removed immediately after use. Remove any debris before the upstream end becomes clogged and impedes stream flow.
  - Frozen fords are used in small streams when ice is thick enough or the streambed is frozen enough to protect the streambed.
- Anchor temporary structures on one end with a cable or other device so they do not float away during high water. Install them so they can be easily removed when no longer needed, regardless of season.

ROAD CONSTRUCTION AND DRAINAGE

The key to constructing forest roads is to get water off the road and then away from the road. The road construction BMPs focus on the first part – getting water off the road. This will not only help to prevent erosion, but will also ensure that a high quality road system is in place. There are three common road profiles – out-sloped, in-sloped and crowned. In general, the slope of any road surface should be no more than two to six percent. More than that will make it difficult for vehicles to stay on the road in wet or icy conditions.

Road surfaces are normally crowned or sloped to remove surface water. Well-designed forest roads will change road profiles as needed, and have ditches and drainage structures to control runoff, prevent erosion, and ensure water quality.

IN-SLOPED ROADS

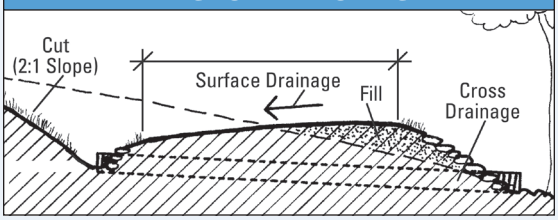


Figure 12-14: An In-sloped Road
(Figure Credit: Best Management Practices for Forestry: Protecting Maine's Water Quality)

Best Suited For:
- Single lane roads.
- Steep road grades (greater than 8%).
- Active roads.

Things to Keep in Mind:
- Ditches and drainage structures are needed to carry surface drainage away from the road.
- Regular maintenance of ditches and drainage structures is needed.

OUT-SLOPED ROADS

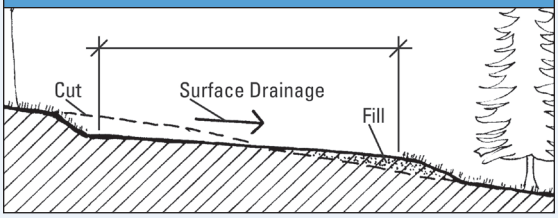


Figure 12-15: An Out-sloped Road
(Figure Credit: Best Management Practices for Forestry: Protecting Maine's Water Quality)

Best Suited For:
- Single lane roads.
- Flat or gentle road grades (8% or less).
- Seasonal and closed roads.
- Roads with light traffic.
- Situations where ditches or cut-slopes will be unstable and likely to erode.

Things to Keep in Mind:
- Surface should be kept smooth and rutting controlled.
- Vehicles can slide off in slippery or icy conditions.

CROWNED ROADS

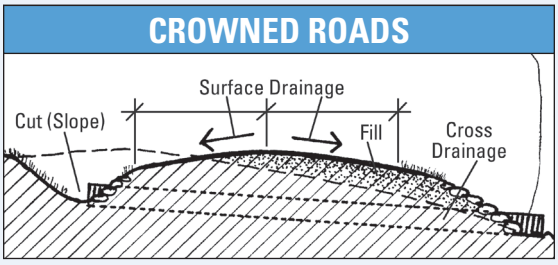


Figure 12-16: A Crowned Road
(Figure Credit: Best Management Practices for Forestry: Protecting Maine's Water Quality)

Best Suited For:
- Single and two lane roads.
- Flat or gentle road grades.
- Steep road grades if a single lane.

Things to Keep in Mind:
- Ditches and drainage structures are needed to carry surface drainage away from the road.
- Regular maintenance of ditches, crown and drainage structures is needed.

BMPs: Road Construction

- Design and construct roads to remove water from road surfaces to keep roads dry and structurally sound.
- Construct stable cut-and-fill slopes that will revegetate easily or stabilize these slopes with rock, seed and mulch or other methods to prevent erosion, if necessary.
- Do not bury debris in the road base. It causes uneven settling that can lead to erosion, frost-heaving, and mud holes.
- Compact the road base material or allow it to settle before using the road to reduce the amount of water that soaks into it. This will increase the road's carrying capacity, reduce road maintenance, and help to reduce erosion.
- Surface the road with gravel where steep slopes, erodible soils or high-traffic volume make the potential for surface erosion significant.
- Locate gravel pits outside RMZs using proper location, development and soil stabilization practices to minimize erosion from the pits.
- 5.2 Avoid constructing new roads, skid trails, and landings in areas infested with invasive species where possible.
- 5.3 Avoid spreading seeds and other propagules from infested to non-infested areas during road maintenance, reconstruction, new construction, and closure.

Figure 12-17: This waterbar, placed at the proper angle to the road, will intercept runoff water and direct it into the adjoining vegetation.

DRAINAGE STRUCTURES

BMPs: Drainage Structures (continued on page 12-13)

After the water is off the road surface, you then need to get it away from the road. If water is confined to ditches along the roadside, the roadbed could become saturated and would not be able to support heavy traffic. Also, as water accumulates in the ditches and gains speed, soil can erode from the ditch, road bed and road surface. These problems can be avoided by diverting water out of the ditches and dispersing it into the adjacent forestland. This will not only help to prevent erosion, but will also ensure that a high quality road system is in place. Placement of drainage structures is often dictated by the landscape; however, care should be taken to avoid directing runoff directly into lakes, streams, dry washes, and wetlands.

Road drainage structures include cross-drains and diversion ditches. Cross-drains are designed to move water from a roadside ditch on one side of the road to the other and include pipe culverts, open-top culverts, rubber belt diverters, broad-based dips, and waterbars. Diversion ditches direct water away from the road and disperse the water across the forest floor. Selection of structures will depend on road type, traffic volume and other considerations (see Table 12-1).

	INFRASTRUCTURE				LEVEL OF TRAFFIC			TOPOGRAPHY	
STRUCTURE	Permanent All-season Roads	Permanent Seasonal Roads	Temporary Roads	Skid Trails	High Traffic Volume	Low Traffic Volume	No Vehicular Traffic	Rolling to Steep Slopes	Flat to Gentle Slopes
Cross-drain Culvert	✓	✓	✓		✓	✓		✓	✓
Open-top Culvert	✓	✓	✓			✓	✓	✓	✓
Rubber Belt Diverter	✓	✓	✓			✓	✓	✓	✓
Broad-based Dip	✓	✓	✓	✓	✓	✓	✓		✓
Waterbar			✓	✓			✓	✓	✓
Diversion Ditch	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 12-1: Recommended Uses for Different Drainage Structures

BMPs: Drainage Structures (continued from page 12-12)

- Install drainage structures to remove water from the road surface and ditches. Drainage structure should be installed immediately above steep grades, below bank seepages, and where water will flow onto log landings or forest roads. Space these structures at intervals close enough to minimize runoff volume and speed, avoiding ditch erosion. As road grades increase, use more drainage structures (see Table 12-2).
- Install a berm at the inlet of drainage structure, if needed, to direct water into the structure. Use rock riprap, mulch, and/or seeding at the inlet to prevent water from eroding and undercutting the structure.
- Provide erosion protection for outflows of drainage structures to minimize erosion and disperse the water, allowing it to soak into the ground. Rock riprap, mulch and/or seeding may be necessary.
- Install drainage structures at grades of at least two percent more than the ditch grade and at a 30° to 45° angle to the road.
- Check drainage structures to ensure that they are not filling with sediment or other debris. Clean if needed.
- Install cross-drain culverts long enough to extend beyond the road fill. Size culvert cross-drains according to the size of the road and the area drained by the ditch. To avoid clogging, culverts should be a minimum of 12 inches in diameter.
- Install cross-drain culverts on a surface of compacted granular material. Firmly compact fill material around the culvert, particularly the bottom half. To prevent crushing, cover the top of the culvert with fill to a depth of one-third of the pipe diameter, or at least 12 inches (whichever is greater).
- Construct broad-based dips deep enough to provide adequate cross-drainage and wide enough to allow trucks and equipment to pass safely. On high volume roads, place a surface of crushed rock stone or gravel in the dip and on the mound to prevent rutting from occurring. On low volume roads and where traffic can be limited during wet periods, a vegetated surface may suffice.

ROAD GRADE (PERCENT)	MAXIMUM DISTANCE BETWEEN WATERBARS (FEET)		MAXIMUM DISTANCE BETWEEN ALL OTHER DRAINAGE STRUCTURES (FEET)	
	High Erosion Risk (Most Sandy and Silt Soils)	Low Erosion Risk (Most Rocky and Clay Soils)	High Erosion Risk (Most Sandy and Silt Soils)	Low Erosion Risk (Most Rocky and Clay Soils)
0 to 3	175	250	250	350
4 to 6	125	200	175	250
7 to 9	100	175	125	175
10 to 12	75	150	75	125
13 to 15	60	100	60	100
16 to 20	50	75	50	75
21 to 30	40	65	40	65
30+	30	50	30	50

NOTE: Broad-based dips generally become ineffective on slopes greater than 10 percent.

Table 12-2: Recommended Maximum Distances Between Drainage Structures on Forest Roads and Skid Trails

CROSS-DRAIN CULVERTS

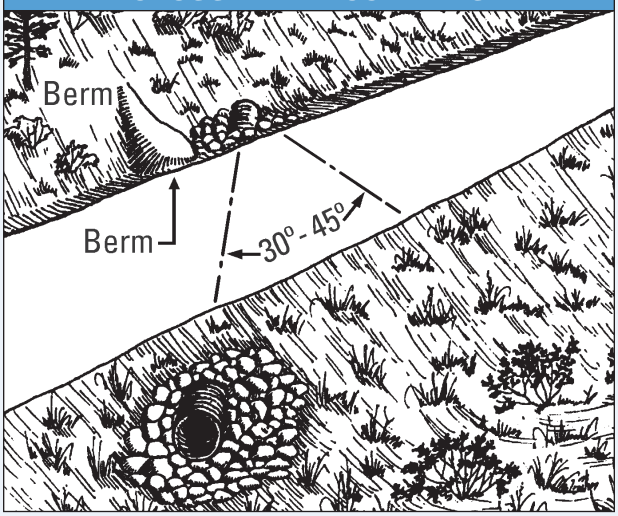


Figure 12-18: Cross-drain culvert. (Figure Credit: WDNR)

Best Suited For:
- Permanent roads.

Things to Keep in Mind:
- The road stays dry because water is diverted under the road.
- Cross-drain culverts can be expensive to install, but allow faster traffic speeds.
- They can become plugged by sediment and other debris, requiring frequent maintenance visits.
- They can be used on temporary roads, but should be removed when the road is closed.

OPEN-TOP CULVERTS

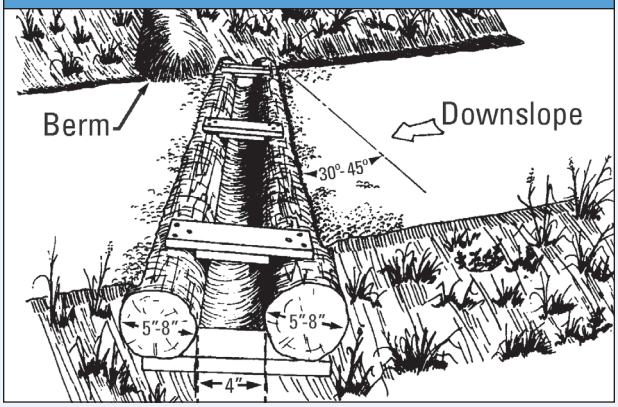


Figure 12-19: Open-top log culvert. (Figure Credit: WDNR)

Best Suited For:
- Low volume permanent and temporary roads.

Things to Keep in Mind:
- The road stays dry because water is diverted under the road.
- Open-top culverts are easy and inexpensive to install, but slow traffic speeds.
- They can be used on road with grades greater than 10%.
- They can become plugged by sediment and other debris, requiring frequent maintenance visits.
- Open-top culverts can be damaged by high volumes of traffic and heavy equipment.
- On temporary roads, they should be removed when the road is closed.

RUBBER BELT DIVERTERS

Best Suited For:
- Low volume permanent and temporary roads.

Things to Keep in Mind:
- They are easy and inexpensive to install, but slow traffic speeds.
- They can be used on steep roads without ditches.
- Rubber belt diverters can accumulate dirt, leaves and other debris and require cleaning.
- Rubber belt diverters can be damaged by high volumes of traffic and heavy equipment.
- Rubber belt diverters can be torn apart if logs are skidded over them.
- On temporary roads, they should be removed when the road is closed.

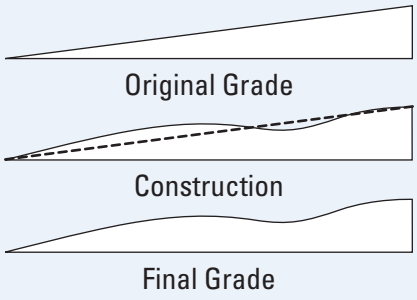
BROAD-BASED DIPS (GRADE DIPS)

Best Suited For:

- Permanent and temporary roads and skid trails.

Things to Keep in Mind:

- They can be used on active roads with or without ditches.
- They are most effective on roads grades less than 10%.
- Broad-based dips are difficult to construct on steeper roads.
- On high volume roads, gravel may be required on the road surface to prevent rutting. On low volume roads, a vegetated surface should suffice. Limiting traffic during wet periods will also help prevent deterioration of the road and drainage structure.
- Care is needed to ensure that the "dip" is not lost due to high traffic volumes and road grading.
- For high speeds and low clearance vehicles, the approaches should be longer and flatter. For low speeds and high clearance vehicles, the approaches can be shorter and deeper.



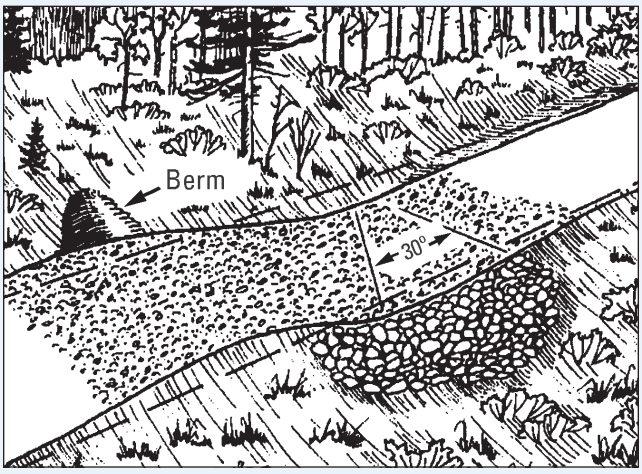


Figure 12-20: Broad-based dip (and cross-section). *(Figure Credit: WDNR)*

WATERBARS

Best Suited For:

- Closed roads and skid trails.

Things to Keep in Mind:

- They are easy and inexpensive to install.
- They can be constructed with soil, logs and/or slash.
- They are not intended to be driven over.
- They require minimal maintenance.

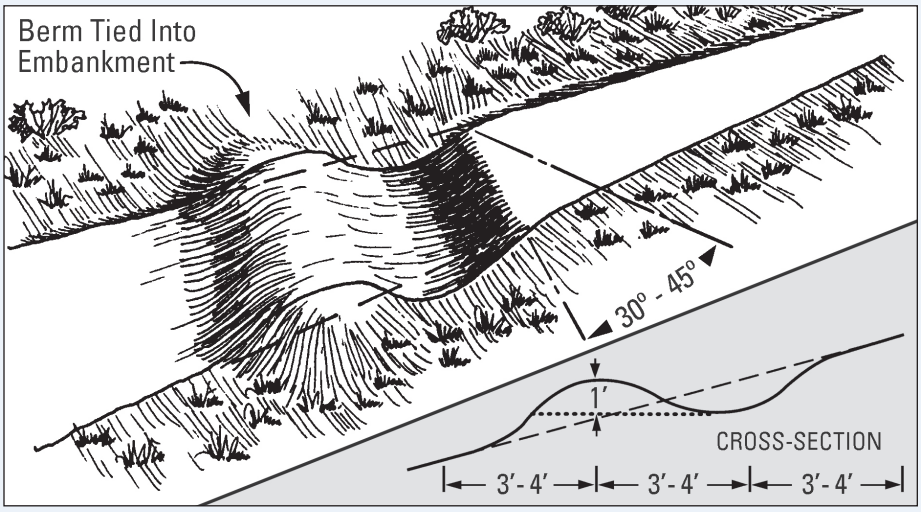


Figure 12-21: Waterbar *(Figure Credit: WDNR)*

SOIL STABILIZATION

Figure 12-22: Once recommended as a wildlife planting, multiflora rose has become quite invasive in many locations.

Soil stabilization practices are used where soil is exposed, and natural revegetation is inadequate to prevent soil erosion (the detachment of soil) and subsequent sedimentation (the movement of soil). Soil can be exposed during road construction, by heavy volumes of traffic, and when closing out roads and skid trails. Some practices are designed to hold the soil in place and to prevent it from eroding, such as seeding and mulching, while other practices are intended to slow and capture sediment once it has begun to erode, such as straw bales and silt fences. There are a multitude of practices available to select from, depending on grade, slope length and location. These practices are often used in conjunction with one another to ensure water quality protection.

It is always more efficient and cost-effective to prevent erosion than to repair damage after the fact.

Timing is critical when implementing soil stabilization practices. Steps should be taken to stabilize any bare soils as soon as possible after it is disturbed. In the fall, seed may not germinate until the following spring, so soil stabilization practices in addition to seed and mulch may be needed to hold the soil in place during fall rains and spring snowmelt until the vegetation becomes established. During winter harvests, temporary soil stabilization may need to be installed before spring break-up to prevent erosion and then permanent practices installed after the site has become dry enough for equipment to work on.

Soil stabilization is a critical aspect of limiting the introduction and spread of nonnative invasive plants. Disturbed soil acts as a germination bed if invasive plants exist in the area or if soil is brought that contains invasive plant propagules. Seed mixtures should include fast-growing species for quick soil protection, plus perennial species for longer soil protection until native vegetation returns to the site. Use certified weed-free seed (see 6.1, 6.2, and 6.5) instead of mixtures that contain aggressive or nonnative invasive plants (e.g., reed canary grass, birds-foot trefoil, crown/hairy vetch, tall fescue). For lists of seeds that should and should not be used, see pages 12-22 and 12-23, resources in Chapter 5: Riparian Areas and Wetlands, and Appendix H of *Forestry BMPs for Invasive Species: A Field Manual for Foresters, Landowners and Loggers*.

After the site has become stabilized by vegetation, temporary stabilization practices, like silt fences, can be removed. It may be necessary to seed and mulch in areas that are disturbed by the removal of the temporary structures.

BMPs: Soil Stabilization

- Use seed, mulch, and/or erosion control netting where necessary to minimize soil erosion into lakes, streams and wetlands.
- Install sediment control structures where necessary to slow the flow of runoff and to trap sediment until vegetation is established at the sediment source.
- Maintain, clean or replace sediment control structures until areas of exposed soil are stabilized.

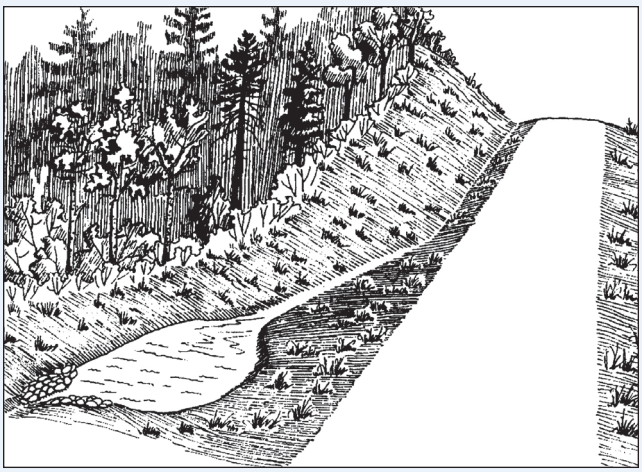


Figure 12-23: A sediment trap to slow runoff and trap sediment for channelized flow. *(Figure Credit: WDNR)*

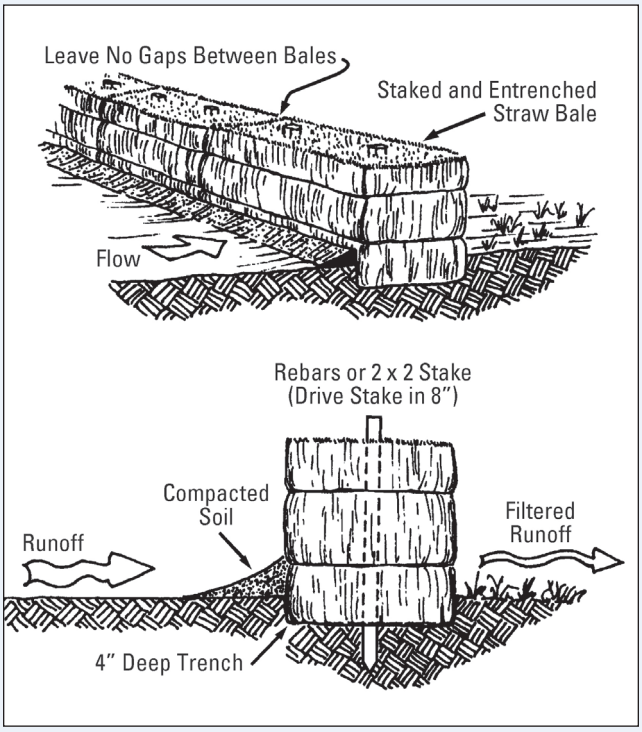


Figure 12-24: Straw bale fencing to slow runoff and trap sediment for sheet flow or channelized flow. *(Figure Credit: WDNR)*

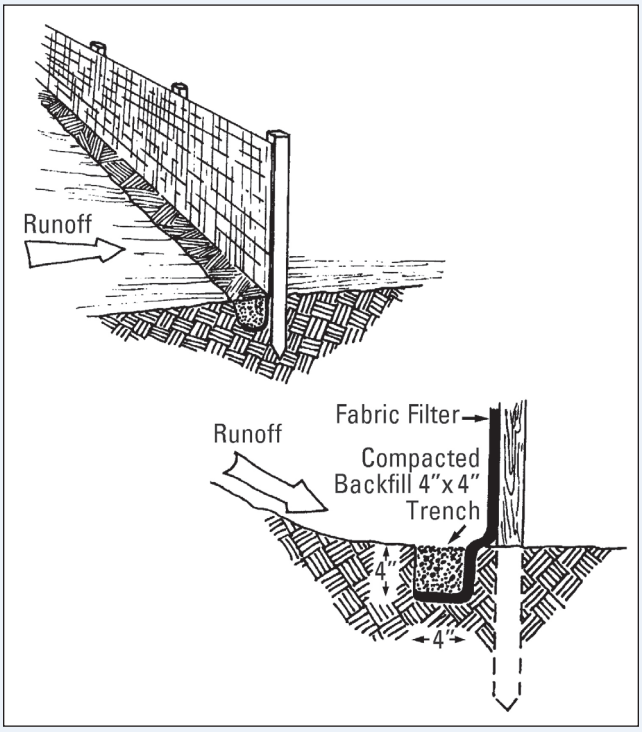


Figure 12-25: Silt fencing to slow runoff and trap sediment primarily for sheet flow, not channelized flow. *(Figure Credit: WDNR)*

WETLAND FOREST ROADS

BMPs: Wetland Roads, Skid Trails and Landings (continued on page 12-19)

Temporary roads, skid trails and landings in wetlands require firm or frozen ground. Any activities in wetlands must follow Wisconsin DNR and U.S. Army Corps of Engineers regulations. Roads must be built carefully to avoid restricting the natural water flow of the wetland under the road.

- Construct upland road approaches to wetlands so the surface runoff is diverted away from the road approach and does not enter the wetland (see Drainage Structures, page 12-12).
- If landings are necessary in a wetland, build them to the minimum size required for the operation and to achieve the landowner's objective.
- Whenever practical, avoid locating roads and landings in the wetland filter; otherwise use extreme caution. The wetland filter strip begins at the edge of the wetland and extends a minimum of 15 feet away from the wetland.
- Avoid operating equipment in areas of open water, springs or seeps.
- Provide adequate crossroad drainage to minimize changes to natural surface and subsurface flow in the wetland.
  - For permanent roads with fill, use permeable fill material for at least the first layer of fill. Install culverts or bridges a maximum of 300 feet apart and at all natural drainageways. Install at least one cross-drainage structure at each wetland crossing.
  - For temporary roads, provide adequate crossroad drainage at all natural drainage ways. Temporary crossing structures include timber mats, culverts, bridges and porous organic material such as corduroy or chunkwood. Temporary crossings should be removed promptly when work is complete. If organic material is used, remove as much as feasible, given site and material conditions.

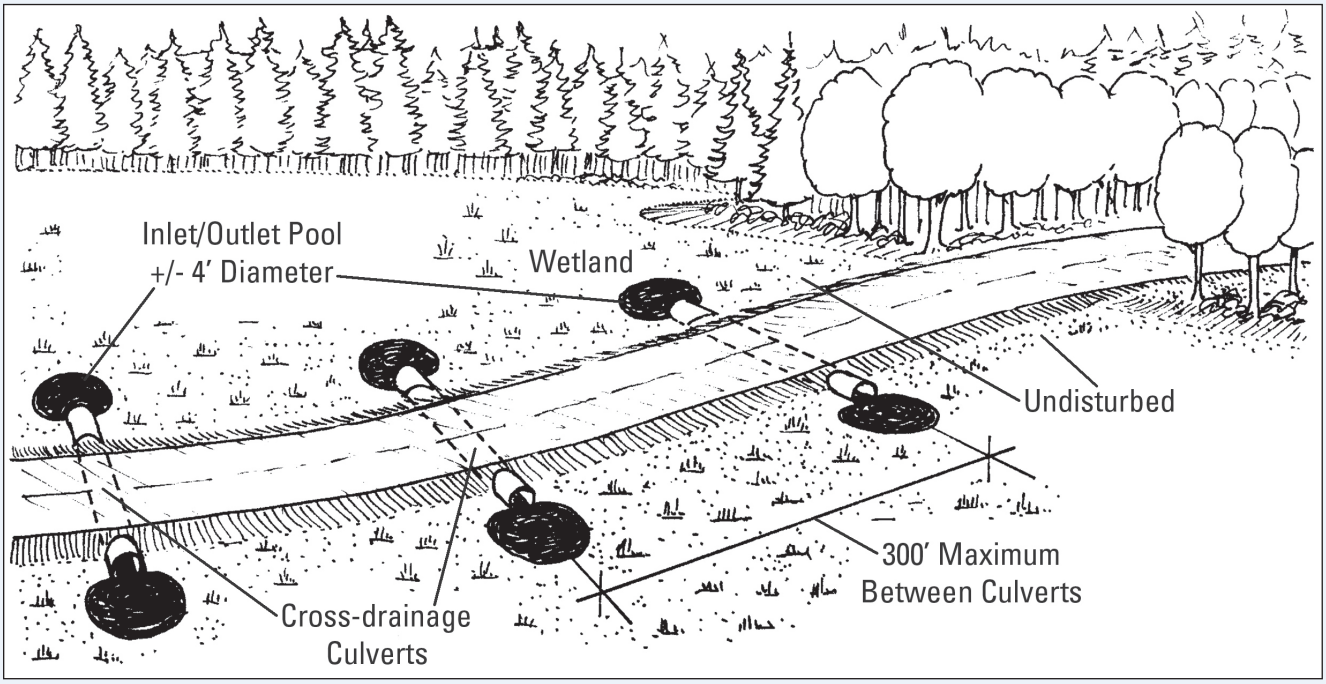


Figure 12-26: Cross-drainage structures should be no more than 300 feet apart in permanent wetland roads.
(Figure Credit: Best Management Practices for Forestry: Protecting Maine's Water Quality)

BMPs: Wetland Roads, Skid Trails and Landings (continued from page 12-18)

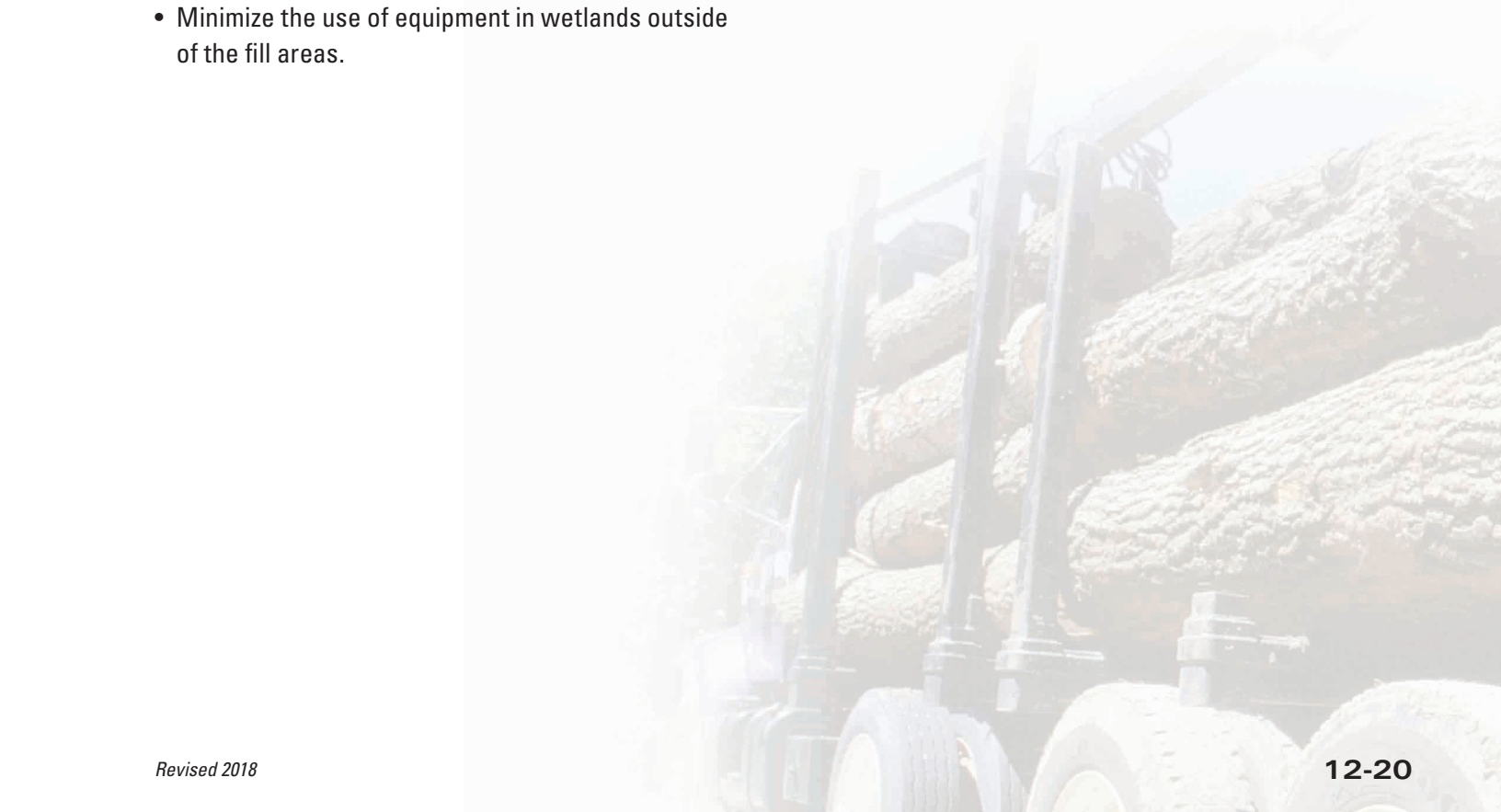
- Minimize rutting in wetlands by conducting forestry activities on firm or frozen ground that can support the equipment used. To achieve this:
  - Operate equipment on a day-to-day basis depending on weather conditions.
  - Consider using corduroy, slash, chunkwood or timber mats to improve the soil's ability to support traffic.
  - **In the Winter:**
    - To promote frost penetration, compact snow, grass, and brush.
    - Monitor air temperatures daily. As air temperatures rise above freezing, you may not be able to operate equipment beyond late morning without creating ruts. Soil frost begins to disappear when night temperatures stay above freezing for three or four consecutive nights.
  - **In the Summer:**
    - Operate equipment only when soils are dry enough to support equipment. Soils may become too wet after storms and extended wet spells.
- Cease equipment operations before rutting becomes excessive.
- Use low-ground pressure equipment, such as wide-tire or tracked equipment, if necessary to minimize rutting.
- 5.2 Avoid constructing new roads, skid trails, and landings in areas infested with invasive species where possible.
- 5.3 Avoid spreading seeds and other propagules from infested to non-infested areas during road maintenance, reconstruction, new construction, and closure.

Figure 12-27: By using log corduroy at this timber harvest, the loggers were able to safely extend their operating season without damaging the wetland.

FEDERAL REQUIREMENTS FOR FOREST ROADS IN WETLANDS

The following 15 federal BMPs are required for the construction and maintenance of forest roads to qualify for the silvicultural exemption from a federal section 404 permit. The silvicultural exemption for forest roads is only applicable when the primary purpose of the road is for silviculture. This list is written in lay language. For the exact language of the law, contact the U.S. Army Corps of Engineers program manager in your area.

- Avoid filling wetlands if practicable alternatives exist – especially in breeding and nesting areas for migratory birds and spawning areas for fish.
- Limit the number, length and width of forest roads and skid trails to the minimum necessary to accomplish the forest management goals, consistent with topographic and climatic conditions.
- Locate roads outside of riparian management zones (RMZs), except at stream crossings.
- Place bridges or culverts in road fill to prevent constriction of expected flood flows – other design methods may also be appropriate.
- Stabilize fill to prevent erosion and sedimentation – before, during and after road construction.
- Minimize the use of equipment in wetlands outside of the fill areas.
- Minimize disturbance of wetland and aquatic vegetation during the design, construction and maintenance of roads.
- Design, construct and maintain wetland crossings to avoid disrupting movement of fish and other aquatic species.
- Use fill from upland sources whenever feasible.
- Place fill so as to not affect any threatened or endangered species and to prevent any adverse modification or destruction of critical habitat for these species.
- Do not place fill near public water supply intakes.
- Do not place fill in areas of concentrated shellfish production.
- Do not place fill in National Wild and Scenic River Systems – in Wisconsin, these are portions of the Namekagon, St. Croix and Wolf Rivers.
- Use fill that is clean, non-erodible and non-toxic.
- Remove all temporary fill and restore disturbed areas to their original elevation.



ROAD MAINTENANCE

BMPs: Road Maintenance

Roads must be well maintained. If not, erosion control and drainage structure may quickly degrade and endanger water quality. For both active and inactive roads, follow BMPs in Soil Stabilization, page 12-16.

ACTIVE ROADS

Active roads are generally open to vehicular traffic. Depending on the landowner and type of road, this may include logging trucks, light trucks, automobiles, tractors, light utility vehicles, and ATVs. A road may be closed seasonally or may be closed to other users, but still considered an "active" road.

- Inspect the road system at regular intervals, especially after heavy rainfall, to detect problems and schedule repairs.
- Clear debris from culverts, ditches, dips, and other drainage structures to prevent clogging that can lead to washouts. Place the debris where it cannot be washed back into these structures or into open water.
- Keep traffic to a minimum during wet periods and spring breakup to reduce maintenance needs.
- Shape road surfaces periodically to maintain proper surface drainage. Fill in ruts and holes with gravel or compacted fill as soon as possible to reduce erosion potential.
- Remove berms along the edge of the road if they will trap water on the road.
- When dust control agents are used, apply them in a manner that will keep these compounds from entering lakes, streams, wetlands and groundwater. Consult a qualified road engineer from the County Highway Commissioner's Office or Wisconsin Department of Transportation for assistance in selecting the appropriate chemicals and amounts. NOTE: It is illegal to spread oil on roads, land or water in Wisconsin.

INACTIVE ROADS

When forest roads are inactive (not used by vehicular traffic) for extended periods, closing the system will help to protect the road surface and drainage structures. Consider erecting a barrier to traffic, such as a gate or berm, and post "closed" signs at the entrance of the road. If temporarily closed, state the length of time and/or reason for closure. Inviting acceptable uses may be helpful to assure compliance.

- Remove all temporary drainage and crossing structures.
- Shape all road system surfaces to maintain proper surface drainage, if necessary.
- Install waterbars where necessary (see page 12-15 and follow the recommendations in Table 12-1 on page 12-12).
- Inspect and maintain road surfaces, drainage structures, and crossings to minimize erosion.

Figure 12-28: Maintaining woods roads helps prevent erosion. This grader is shaping the road surface so that water runs off properly.

BMPs: Invasive Species

The following are Forestry BMPs for Invasive Species (IS-BMPs) that should be considered when constructing and maintaining forest roads.

- 4.3 Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.
- 4.4 Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.
- 5.1 To the extent practical, use existing roads, skid trails, and landings to reduce disturbance.
- 5.2 Avoid constructing new roads, skid trails, and landings in areas infested with invasive species where possible.
- 5.3 Avoid spreading seeds and other propagules from infested to non-infested areas during road maintenance, reconstruction, new construction, and closure.
- 5.4 Where site conditions permit, allow natural revegetation of the roads, skid trails, and landings to occur. If seeding or planting is necessary to minimize the threat of highly damaging invasive species from spreading, use native seed or non-invasive cover crops for revegetation.
- 5.5 Ensure, to the extent practical, that fill and gravel are free of invasive species and their propagules.
- 6.1 Limit the introduction and spread of invasives during reforestation or revegetation site preparation activities.
- 6.2 Revegetate or reforest as quickly as feasible after site disturbance.
- 6.5 Plan for post-planting management of invasive species.

INVASIVE SPECIES NOT RECOMMENDED FOR SEED MIXES

COMMON NAME	SCIENTIFIC NAME
Creeping Bent Grass	*Agrostis palustris*
Smooth Brome Grass	*Bromus inermis*
Crown Vetch	*Coronilla varia*
Quack Grass	*Elytrigia repens*
Tall Fescue	*Festuca arundinacea*
Flat Pea	*Lathyrus sylvestris*
Chinese Lespedeza	*Lespedeza cuneata*
Bird's Foot Trefoil	*Lotus corniculatus*
Big Leaf Lupine	*Lupinus polyphyllus*
Reed Canary Grass	*Phalaris arundinacea*

Table 12-3: These species were previously recommended for use in seed mixtures for revegetating bare soil but they have since been found to be invasive. These species should NOT be used in seed mixes.

NATIVE GRASS SPECIES RECOMMENDED FOR SEED MIXES

GRASS SPECIES		SITE CHARACTERISTICS					
Common Name	Scientific Name	Dry	Dry-Mesic	Mesic	Wet	Shady	Sunny
Big Bluestem	*Andropogon gerardii*	✓	✓	✓			✓
Fringed Brome	*Bromus ciliatus*			✓	✓	✓	
Kalm's Brome	*Bromus kalmii*		✓	✓			✓
Bluejoint Grass	*Calamagrostis canadensis*			✓	✓		✓
Broom Sedge	*Carex scoparia*			✓	✓	✓	
Fox Sedge	*Carex stipata*			✓	✓		✓
Tussock Sedge	*Carex stricta*			✓	✓	✓	✓
Brown Fox Sedge	*Carex vulpinoidea*			✓	✓		✓
Canada Wild Rye	*Elymus canadensis*		✓	✓	✓		✓
Bottlebrush Grass	*Elymus hystrix*	✓	✓	✓		✓	
Virginia Wild Rye	*Elymus vinginicus*		✓	✓	✓		✓
Reed Manna Grass	*Glyseria grandis*			✓	✓		✓
Dudley's Rush	*Juncus dudleyi*			✓	✓	✓	
Common Rush	*Juncus effuses*				✓		✓
June Grass	*Koeleria macrantha*	✓	✓				✓
Switch Grass	*Panicum virgatum*	✓	✓	✓	✓		✓
Little Bluestem	*Schizachyrium scoparium*	✓	✓				✓
Dark Green Bulrush	*Scirpus strovirens*			✓	✓		✓
Wool Grass	*Scirpus cyperinus*			✓	✓		✓
Indian Grass	*Sorghastrum nutans*	✓	✓	✓			✓
Needle Grass	*Stipa spartea*	✓	✓			✓	✓

Table 12-4: These grass species are native to Wisconsin and could be considered in seeding mixes used to revegetate bare soils. More detailed information on plant species, seed mixes and seeding rates can be found in Wisconsin's Forestry Best Management Practices for Invasive Species: A Field Manual for Foresters, Landowners and Loggers, *Appendix H: Species Recommended for Revegetation.*

NONNATIVE SPECIES RECOMMENDED FOR SEED MIXES

GRASS SPECIES		SITE CHARACTERISTICS					
Common Name	Scientific Name	Dry	Dry-Mesic	Mesic	Wet	Shady	Sunny
Oats	*Avena sativa*	✓	✓	✓			✓
Red Fescue	*Festuca rubra*		✓	✓			✓
Barley	*Hordeum vulgare*		✓	✓			✓
Alsike Clover	*Trifolium hybridum*		✓	✓			✓
Red Clover	*Trifolium pratense*		✓	✓	✓	✓	✓
White Clover	*Trifolium repens*		✓	✓		✓	✓

Table 12-5: These nonnative species are suitable for cover crops and will provide short-term erosion control until other plant species become established. This is not a complete list.

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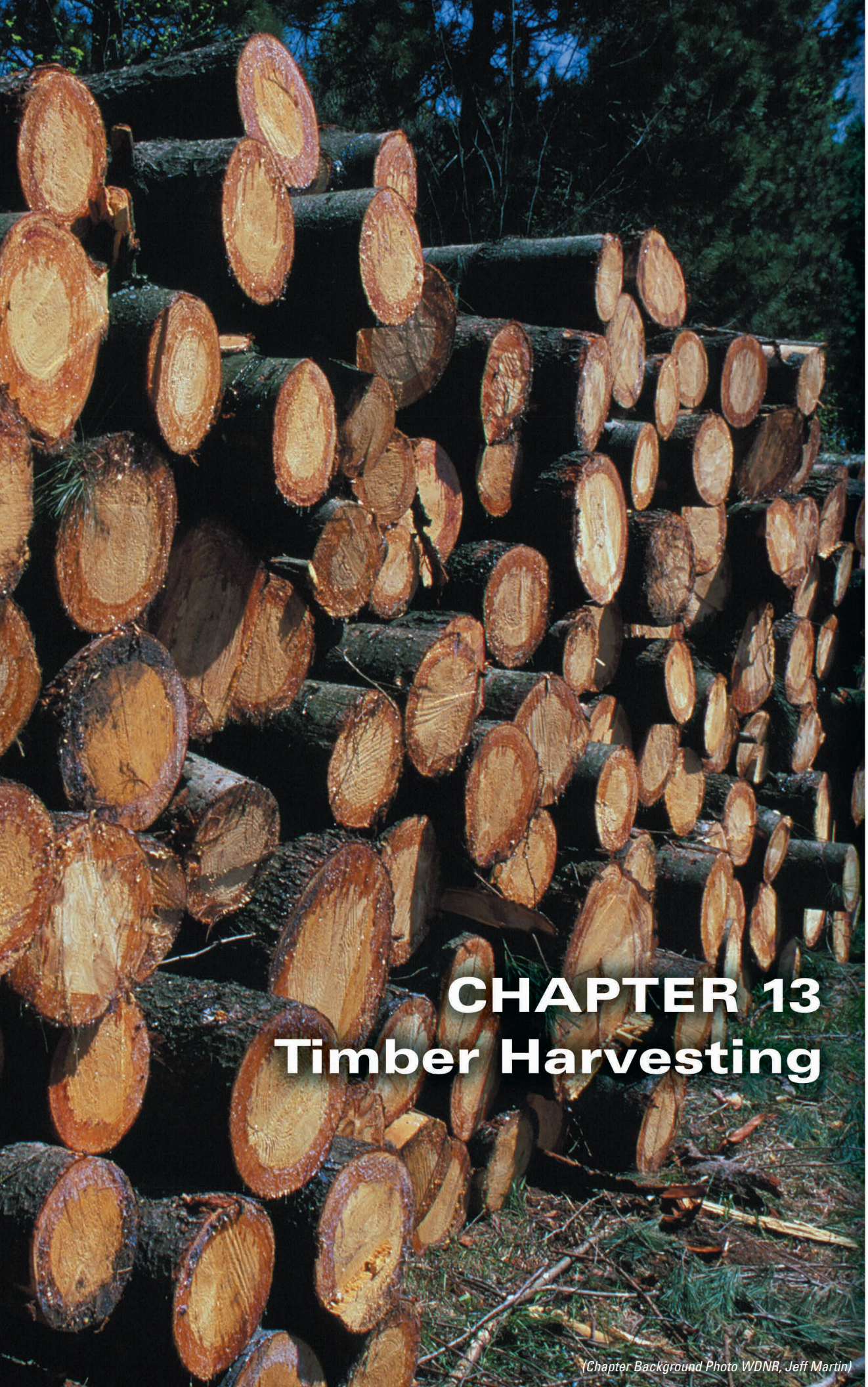


CHAPTER 13
Timber Harvesting

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 13
TIMBER HARVESTING

Timber harvesting involves: 1) cutting trees and moving them to a landing, 2) processing them into various products, sorting and loading, and 3) transporting these products to markets.

Integrated Resource Management Considerations

- Special soil conditions and topographic features make some areas of the state more sensitive than others to soil disturbance. Two primary examples of these localized sensitive areas are the red clay soils along Lake Superior, and the steep slopes in the driftless area in southwestern Wisconsin.
- If done incorrectly, harvesting activities can result in sediment, chemical, nutrient, and debris movement into streams, lakes, wetlands, seasonal ponds, and groundwater.
- Wetlands are highly productive sites for a variety of ecological functions, as well as for the enhancement of water quality. All forest management operations in or adjacent to wetlands should be planned and conducted in a manner that protects these functions.
- Visual sensitivity levels should be considered in determining the level of effort appropriate to minimize visual impact.
- The silvicultural system needed to regenerate a stand affects the visual impact of the harvest. In general, partial cutting has less impact in more aesthetically sensitive areas. The type of harvest (partial cut versus clearcut) also affects user perception of apparent size.
- The visual impact of a harvest and the timing of adjacent harvests will be affected by 1) the length of time needed to re-establish forest regeneration; and 2) the intensity of treatments required to assure survival of the new growth.
- Wildlife habitat quality is influenced by timber harvesting activities. Maintain or enhance the structural components of the stand (live trees, snags, woody debris, shrubs, and ground cover) needed by wildlife during a timber harvest.

Figure 13-1: An aerial view of part of the Northern Highland-American Legion State Forest where aesthetic management guidelines have been applied for many years to manage the visual impact of harvesting operations.

- The average life span of a species affects the frequency of regeneration harvests and the time available to complete a harvest before the trees begin to deteriorate. Upon reaching old age, short-lived species tend to lose vigor over a relatively short time period with entire stands suffering disease or insect mortality all at once. Long-lived species tend to lose vigor more slowly, and suffer mortality on an individual tree basis.
- Timber harvesting activities may affect the population of invasive species, particularly if these organisms are already present on the site or adjacent to the site. Proliferation of invasive species could threaten the ecological function of your forest. All forest management operations should be planned and conducted in a manner that limits the introduction and spread of invasive species to protect these functions.
- Timber harvesting activities can impact cultural resources if not identified and protected (NOTE: Not all such resources require protection).

PLANNING AND DESIGN

- A comprehensive, detailed plan is a critical part of any successful harvesting operation. In addition to what, where and how, the plan should consider follow-up regeneration needs and specific measures designed to address other important forest resources.

Soil Productivity

- Identify areas with special soil conditions and topographic features that make them more sensitive to disturbance than others, and design operations accordingly to minimize any adverse impacts.
- Minimize soil impacts by limiting the soil area impacted by infrastructure (roads, landings and primary skid trails) and by careful consideration of timing, equipment being used, and harvesting methods. Planning considerations should include careful determination of appropriate operating seasons for any given soil, as well as using harvest layouts, strategies, and equipment that minimize the surface area of a site that is trafficked. As a general rule, no more than 15 percent of the harvest area should be occupied by roads, landings and skid trails. Of this 15 percent, no more than three percent of the harvest area should be occupied by permanent roads and landings that remove forestland from production (see 3.4 and 4.3).
- Employ appropriate timber harvesting strategies and practices to ensure harvest operations do not reduce the productive capacity of forest soils through removal of nutrients or disruptions of nutrient cycles. Harvests of small diameter biomass should adhere to *Wisconsin's Forestland Woody Biomass Harvesting Guidelines* (see the resources at the end of this chapter). Biomass harvests should not occur on soil types with low nutrient availability. Where applied, biomass harvests should leave a portion of the logging slash on site.

Water Quality and Wetlands

Consider water quality concerns as harvest plans are developed:

- Include provisions for water protection in the timber sale contract.
- Avoid building landings, skid trails and roads in wetlands.
- Consider timing of harvest to minimize damage to wetlands, and to increase efficiency in timber sale operations.

See Chapter 5: Riparian Areas and Wetlands and Chapter 12: Forest Road Construction and Maintenance, for general BMPs related to wetlands and planning.

BMPs: Planning and Design

- Limit the length and number of skid trails, landings and stream crossings, to the minimum necessary to conduct the harvest operation and to meet the landowners objectives.

Invasive Species

(For more information, see Chapter 8: Invasive Plants, Insects and Diseases)

A comprehensive, detailed plan that considers invasive species is divided into two parts – property planning and activity planning. Property planning is intended to reduce the likelihood of invasive species introductions, mitigate the effect of invasive species that may arrive and manage species that are already present. Likewise, activity planning addresses practices that bring people and equipment into the forest (e.g., timber harvesting). Skillful execution of routine timber harvesting activities can help minimize or even reduce the threat of invasive species (see 3.2, 4.5, and 5.2).

- Consider guidance for timing of harvests to minimize the risk of introducing or spreading invasive insects and diseases.
- Consider guidance for treatment of conifer stumps to minimize the risk of introducing Annosum root rot.

Figure 13-2: Dame's rocket is a quickly spreading invasive plant that invades the edges and understories of woods. It is often mistaken for the native phlox, but is quite different in that it has four flower petals rather than five.

Figure 13-3: In visually sensitive areas, thought should be given to retaining selected long-lived trees until the new stand is fully developed.

Visual Quality

Wisconsin forests are composed of a wide variety of species. Some occur as pure stands, while others occur in association with each other in complex communities. Each species has a unique set of silvical characteristics, which result in different silvicultural requirements (see Chapter 2: Generally Accepted Silvicultural Principles). As a result of these differences, each species presents a different aesthetic management challenge. In order to most effectively reduce the visual impact of harvesting, it is necessary to carefully evaluate the specific biological requirements of each species as well as the physical and structural characteristics of the stands in which they occur. Elements that can be used to minimize or enhance visual impact must be identified and imaginatively employed. At the same time, alternative management strategies must be devised to overcome less favorable elements.

- When stands contain mixtures of short- and long-lived species, careful consideration should be given to the opportunities available to mitigate the visual impact of a harvest operation through retention of some portion of the long-lived species as individual trees or in scattered clumps.
- Tree selection criteria and residual density levels can be modified in more visually sensitive portions of a particular stand to foster a more natural appearance and/or enhance visual diversity.

SHORT-LIVED SPECIES

Aspen, Balsam Fir, Jack Pine, Paper Birch

MEDIUM-LIVED SPECIES

Hickory, Red Maple, Tamarack

LONG-LIVED SPECIES

Ash, Basswood, Beech, Cedar, Elm, Hemlock, Oak, Red Pine, Spruce, Sugar Maple, White Pine, Yellow Birch

Figure 13-4: In this jack pine clearcut, long-lived red pine trees were left in both clumps and as scattered individuals to minimize the visual impact of this harvest along a major recreational highway.

Figure 13-5: Residual trees were left in this clearcut as both "islands" and "fingers" to provide better wildlife cover and travel corridors.

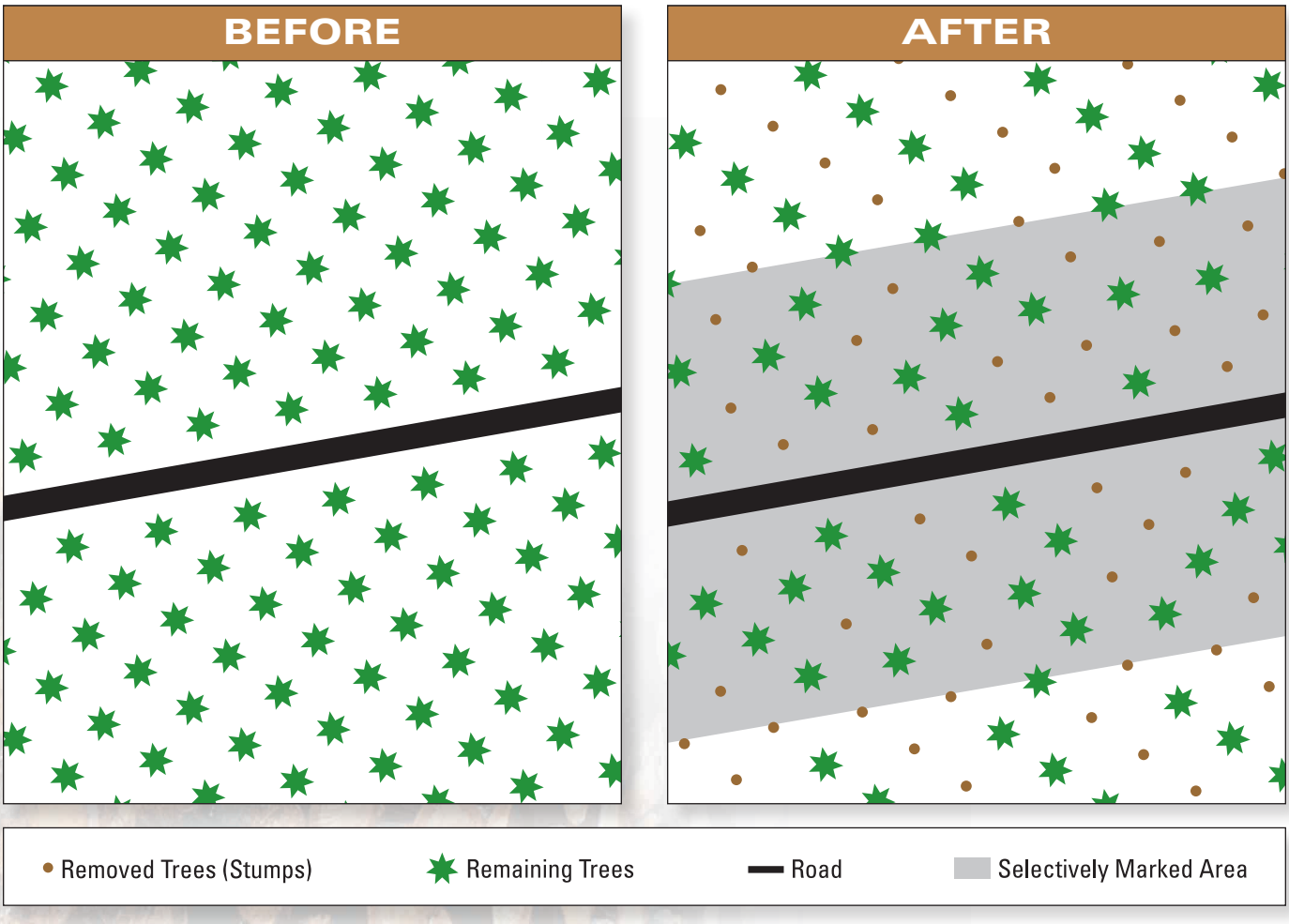


Figure 13-6: When plantations are established with the rows perpendicular to primary roadways, the appearance can be somewhat artificial. The first thinning in such plantations normally requires the removal of entire rows in order to allow harvesting machinery room to gain access, which creates an even more unnatural appearance. In this example, an area along the roadway was selectively thinned to create a more natural appearance. Harvesting entire rows in the remainder of the stand will make it possible to selectively thin the entire stand in subsequent thinnings.

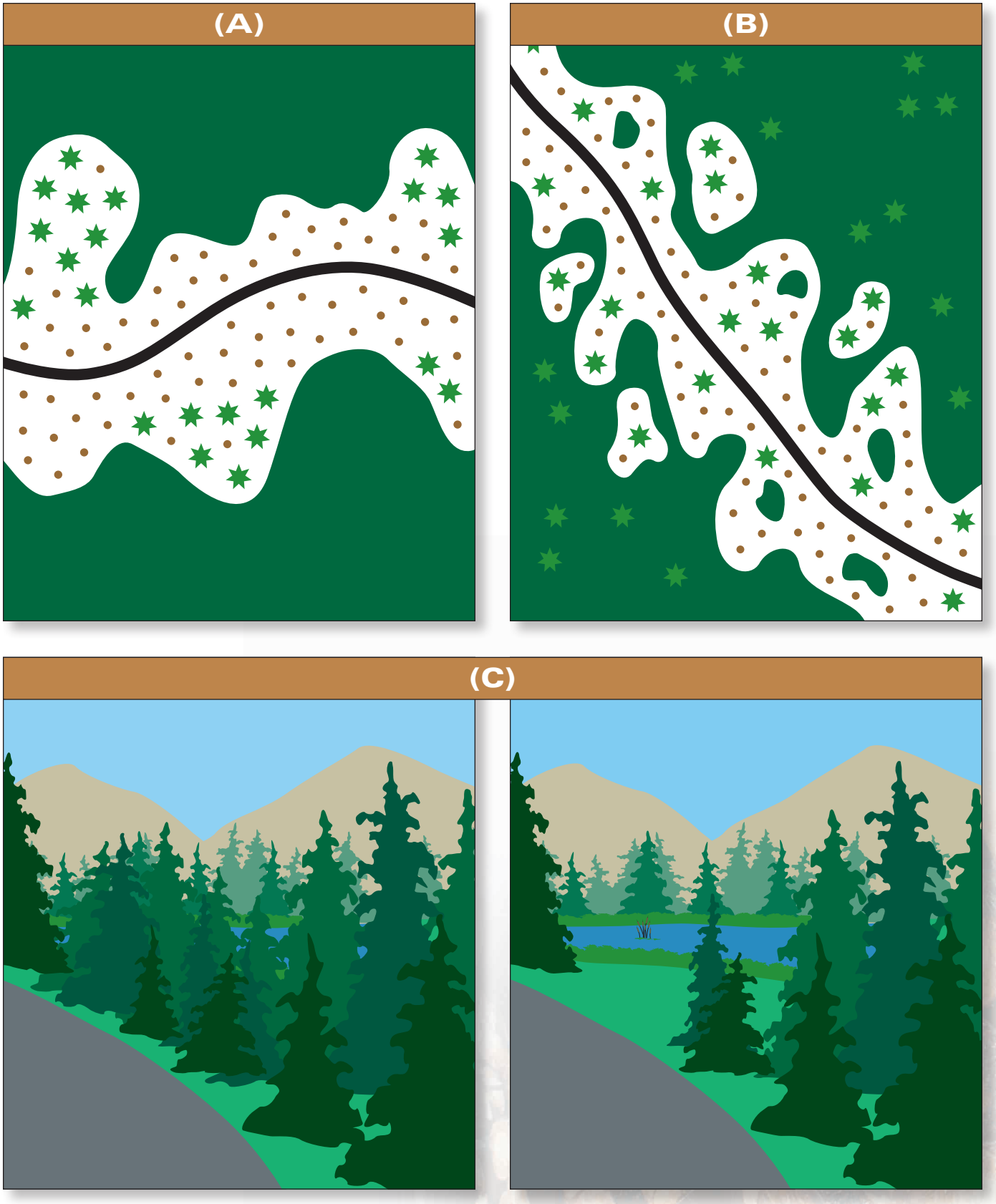


Figure 13-7: In the first of these examples, clumps of long-lived trees were retained along the roadside (A). In the second, individual trees were retained (B). In the third, a small vista was created through the judicious removal of selected trees (C). All of these treatments enhance visual diversity.

- As a stand of trees grows, it passes through a number of stages in its life cycle. Each of these stages presents differing degrees of aesthetic management value and flexibility. Harvesting strategies should reflect the positives and negatives of each.

Figure 13-8

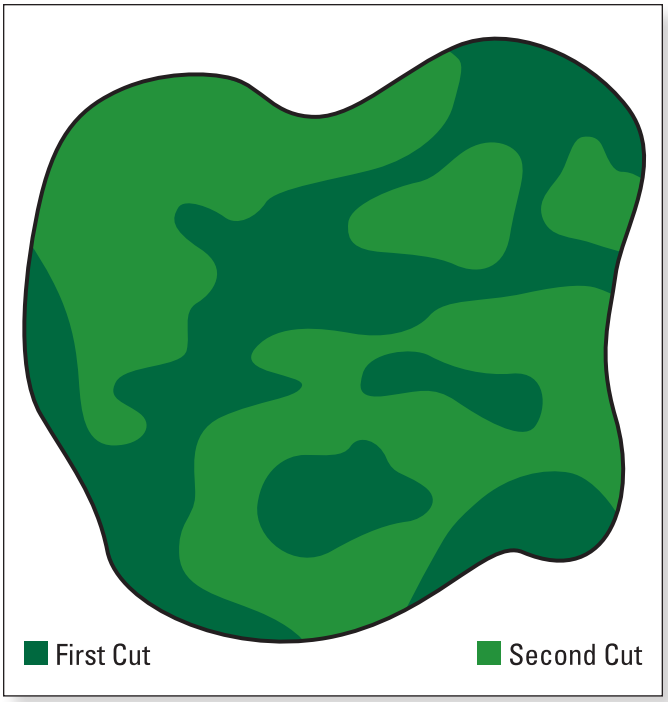


Figure 13-9: This stand of mature timber has been divided into two harvest areas to allow as much time as possible between harvests. Shape was used to reduce the visual impact. If this stand were younger, smaller blocks could be harvested separately over a longer period with a still greater reduction in visual impact.

Figure 13-10

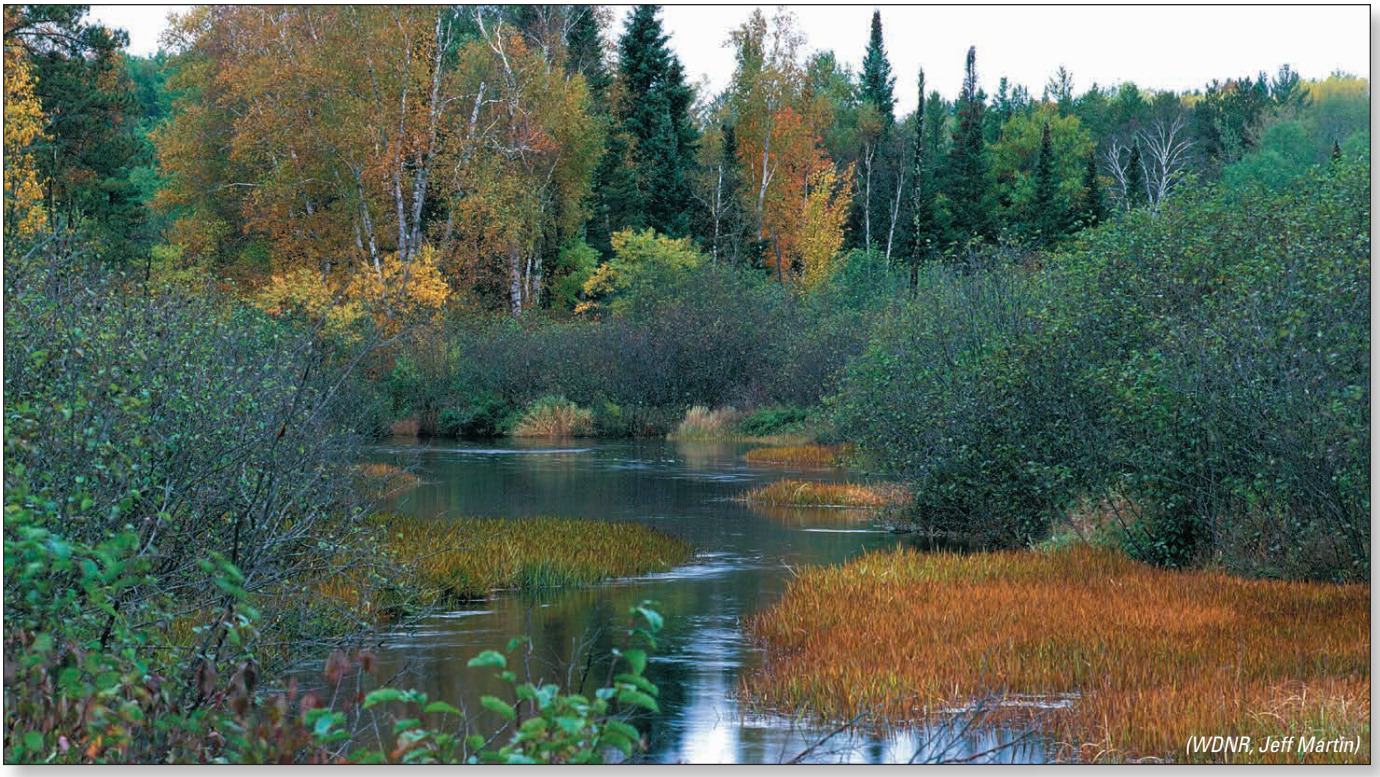
Figure 13-11

Figures 13-8, 13-10 and 13-11: These aerial and ground photographs show a mosaic of stands with different species, age classes, densities and shapes. They were developed over many years to reduce the visual impact of future harvest operations in what was once a large monotype.

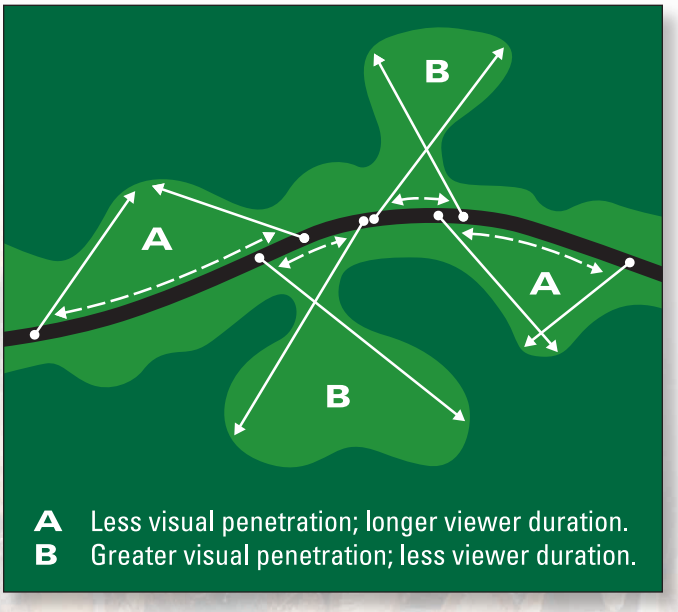
Figure 13-12: This even-aged, short-lived white birch stand occurs in a visual zone classified as "most sensitive." Creative integration of the understory and topography into the harvest design would be crucial for protecting visual quality during a timber sale. Seasonal harvesting restrictions, logging methods, road systems, slash treatment, and follow-up site preparation are also important considerations that could have an effect on visual objectives.

- The entire vegetative community occurring in a stand should be considered in the development of an aesthetic management plan – not just that portion being harvested. A well-developed understory can be used to great advantage in reducing the visual impact of a harvest operation.
- Use topography and other land features when possible to minimize the visual impact of harvest operations.
- Use natural features and avoid artificial patterns where possible. These natural features may correspond to changes in topography, soils, wetland interfaces, and timber types.
- When planning harvest boundaries in areas of high visual sensitivity, consider how the spatial design of the harvest area will impact how long a viewer can see the harvest and how far into the harvest they can see while passing by (see Figure 13-14 on page 13-9).
- Road layouts should consider visual quality as well as timber management needs. A good road system should:
  - Minimize the number of exits onto sensitive roadways.
  - Facilitate re-entry of deferred harvest areas.
  - Be compatible with follow-up management operations (firebreak needs, tree planting, timber stand improvement, etc.).

Modifications of a timber harvest for aesthetic concerns should weigh operational considerations that would significantly impact logging efficiency. Aesthetic modifications increase the cost for foresters to establish a timber sale, and for loggers to harvest it.



Figures 13-13: Stream corridors provide excellent opportunities for both visual screening and the protection of riparian areas. When used as a sale boundary, the need for stream crossings is also reduced.



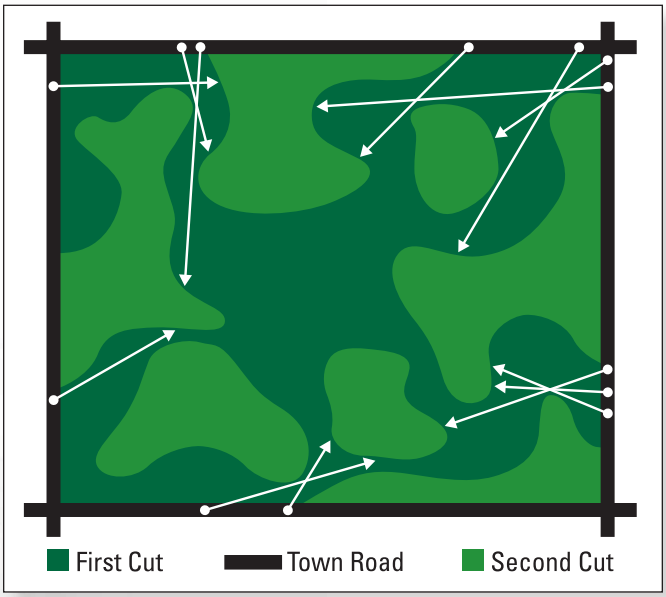


Figure 13-14: In these examples, the harvest area has been designed so that the longer a viewer can see an area (viewing duration), the shorter the distance they can see (visual penetration). The goal is to provide some visual diversity, while at the same time reducing the apparent size of the harvest area.

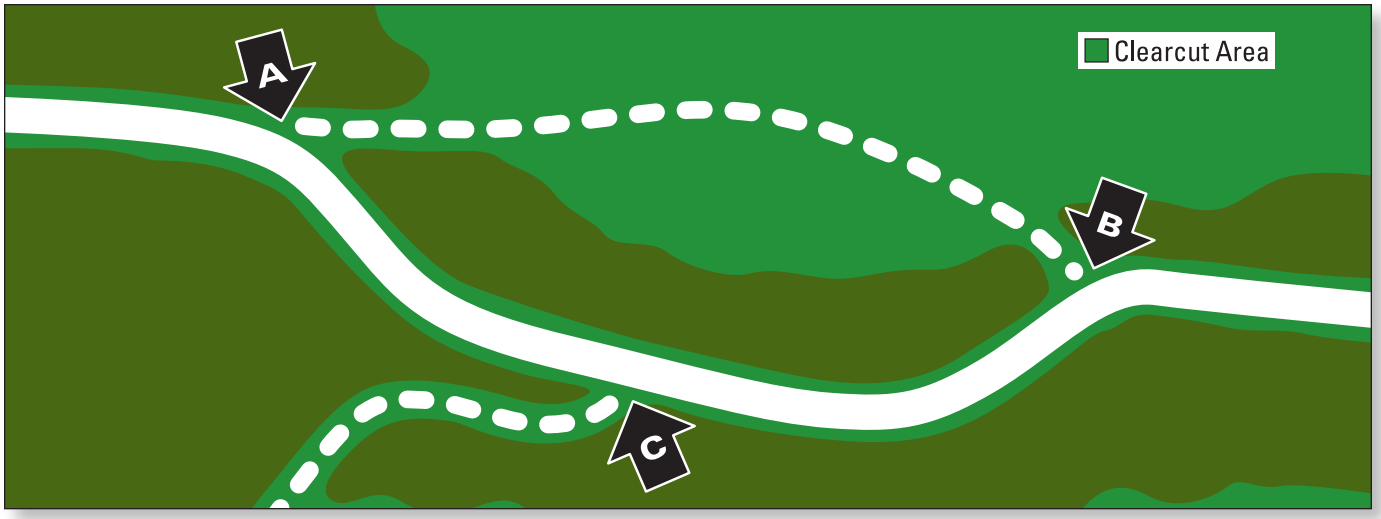


Figure 13-15: The logging road entrances at "A" and "B" permit excessive visual penetration directly into the harvest area. They also present a safety hazard by joining the main road on curves. A more preferred entrance location at "C" breaks the line of sight into the harvest area and also exits onto the main road at a 90° angle in a safe area.

Threatened and Endangered Resources

(For more information, see Chapter 3: Wildlife Habitat and Biodiversity)

Timber sale activities are subject to both Federal and Wisconsin laws protecting Threatened and Endangered (T&E) species. A review of the Natural Heritage Inventory (NHI) should be completed prior to beginning any activity associated with timber harvesting to discover the possible presence of T&E species on or nearby to any timber sale project. If T&E species are present, avoidance measures including modifications to the timber sale design and/or harvest season timing may be needed to avoid injuring or harming individuals of the species, and/or damaging their habitat. Go to the NHI Public Portal to complete an initial search at: ***dnr.wi.gov – keywords "public portal."***

Cultural Resources

If practical and feasible, protect cultural resource areas by:

- Excluding cultural resource areas from the timber sale area. No unauthorized soil disturbance of any kind is allowed in burial areas.
- Keeping roads, skid trails and landings away from cultural resource areas.

Slash Management

- Slash, or debris left on the land after timber or other forest products have been cut, is unavoidable when harvesting timber. Slash management plans should be developed prior to beginning the harvest, and also spelled out in the harvesting contract.
- Slash near lakes and streams, and in wetlands is subject to special regulations.
- Slash treatment has a definite cost.
- Slash falling onto the land of an adjoining landowner must be removed.
- Slash provides soil nutrients.
- Slash can provide shelter for wildlife.
  - If nonnative invasive plants are present on a harvest site or have the potential to invade the site, their control may be hindered by the presence of slash. Consider treating the invasive plants prior to a harvest (see 4.2 and 4.3).

Landings

- Landings are places where trees and logs are gathered in or near the forest for future processing or transport. The size and number of landings are affected by silvicultural considerations, the logging system used, sale size, and timber sale design.
- Proximity of harvest to sensitive travel routes or use areas can affect placement of landings.
- Topography can limit both the placement and number of landings.
- Proposed use of a landing area (e.g., as a parking area along a recreational trail or as a wildlife opening) can affect the size and placement of a landing.

Reserve Trees, Wildlife Trees, Coarse Woody Debris, and Snags

- Retain individual trees and/or groups of trees unharvested for reasons other than providing seed for regeneration of the stand (see Appendix A). Such reasons may include:
  - Provision of den and nest trees, food sources, cover, travel corridors, and special habitat needs for wildlife.
  - Reduce the unobstructed line of vision in clearcut areas, and provide additional diversity in future stands.
  - Retain selected high quality trees for additional growth and future harvest.
  - Reduce runoff and erosion in sensitive areas.
- Consider retaining coarse and fine woody debris for wildlife habitat purposes (see Chapter 3: Wildlife Habitat and Biodiversity for more information).
- A number of operational considerations are necessary when planning for tree retention (see Reserve (Leave) Trees on page 13-17 for discussion).

Figure 13-16: In this jack pine clearcut, residual trees were left in both clumps and as scattered individuals to maintain good wildlife habitat and reduce the visual impact of the harvest.

Harvesting Implementation

- Minimize road building and facilitate efficient skidding of timber during sale design.
- Preharvest planning and placement of temporary or seasonal haul roads and landing spurs can increase operability and production, identify BMP requirements, and reduce costs for better profitability.
- Utilize forwarding where operationally feasible to reduce road building and maintenance needs, and increase transport efficiency when timber sale units are distant from main haul roads.
- Provide for the most efficient transport of wood from sale, anticipating haul routes to markets and ingress/egress points onto public roads, minimizing conflicts with Forestry BMPs for Water Quality.
- All considerations should be clearly communicated to potential timber sale bidders during the bidding process to ensure all parties understand the limitations and expectations placed on the harvest and can evaluate the impacts on their operations and bid accordingly.

OPERATIONAL CONSIDERATIONS

- Conduct on-site meetings with the logger, landowner and resource manager prior to moving equipment onto a site. Such pre-sale meetings can help assure common understanding of landowner objectives, timber harvest specifications and site conditions.

Protecting Soil Productivity

- Identify soil or site conditions that may dictate specific timing, harvest methods or equipment to be used, or that may lead to weather-related or seasonal closure of the operation. These are important considerations for a logger and should be included when initially advertising a sale for harvest.

Protecting Water Quality

- Minimize stream, dry wash and wetland crossings. Use temporary crossings, such as portable bridges, timber mats, pole fords or ice bridges, if permanent access is not required to achieve forest management and landowner objectives. IMPORTANT: Such activity may require a permit from the Wisconsin DNR.
- Install stream and dry wash crossings at right angles to the water flow, where practicable.
- Incorporate water diversion devices where needed during timber harvesting activity. Divert surface flow before it enters landings or a waterbody. Incorporate water diversion devices during construction rather than as a remedial activity (see Chapter 12: Forest Road Construction and Maintenance).
- Identify lakes, streams, dry washes and wetlands prior to designating locations for new roads, skid trails and landings.
- Avoid crossing ephemeral ponds, harvesting in close proximity to and dropping slash or trees into ephemeral ponds (see Chapter 3: Wildlife Habitat and Biodiversity).
- To prevent rutting deeper than six inches on wetlands, shift harvest operations to a stable portion of the harvest area or alter operating techniques.

  Alternative techniques include:
  - Employing low ground pressure (LGP) equipment.
  - Using slash on skid trails as a driving surface.
  - Minimizing the amount of off-trail equipment operation to reduce the area disturbed by heavy equipment.
  - Waiting for colder weather to freeze the site or enhance freezing of the site by packing snow and ground vegetation with LGP equipment.
- Harvesting during frozen ground conditions is often ideal to protect a site; however, loggers and the forest products industry cannot limit operation to only the two well-frozen months. Many sites can be suitable for all-season logging by following the appropriate Forestry BMPs for Water Quality.

BMPs: Protecting Sensitive Areas

When harvesting near lakes, streams, and wetlands, follow the applicable BMPs (see Chapter 5: Riparian Areas and Wetlands), in addition to the following BMPs.

- Avoid operating equipment where excessive soil compaction, rutting or channelized runoff may cause erosion that affects water quality. The use of low ground pressure (LGP) equipment may allow operations to continue.
- Whenever possible, winch logs from steep slopes, if conventional skidding could cause erosion that affects water quality.
- Inspect soil-stabilization practices periodically, during and immediately after, harvest operations to ensure they are successful and remain functional. Follow BMPs in Chapter 12: Forest Road Construction and Maintenance.
- For winter harvesting, mark stream channels and existing culvert locations before snowfall.

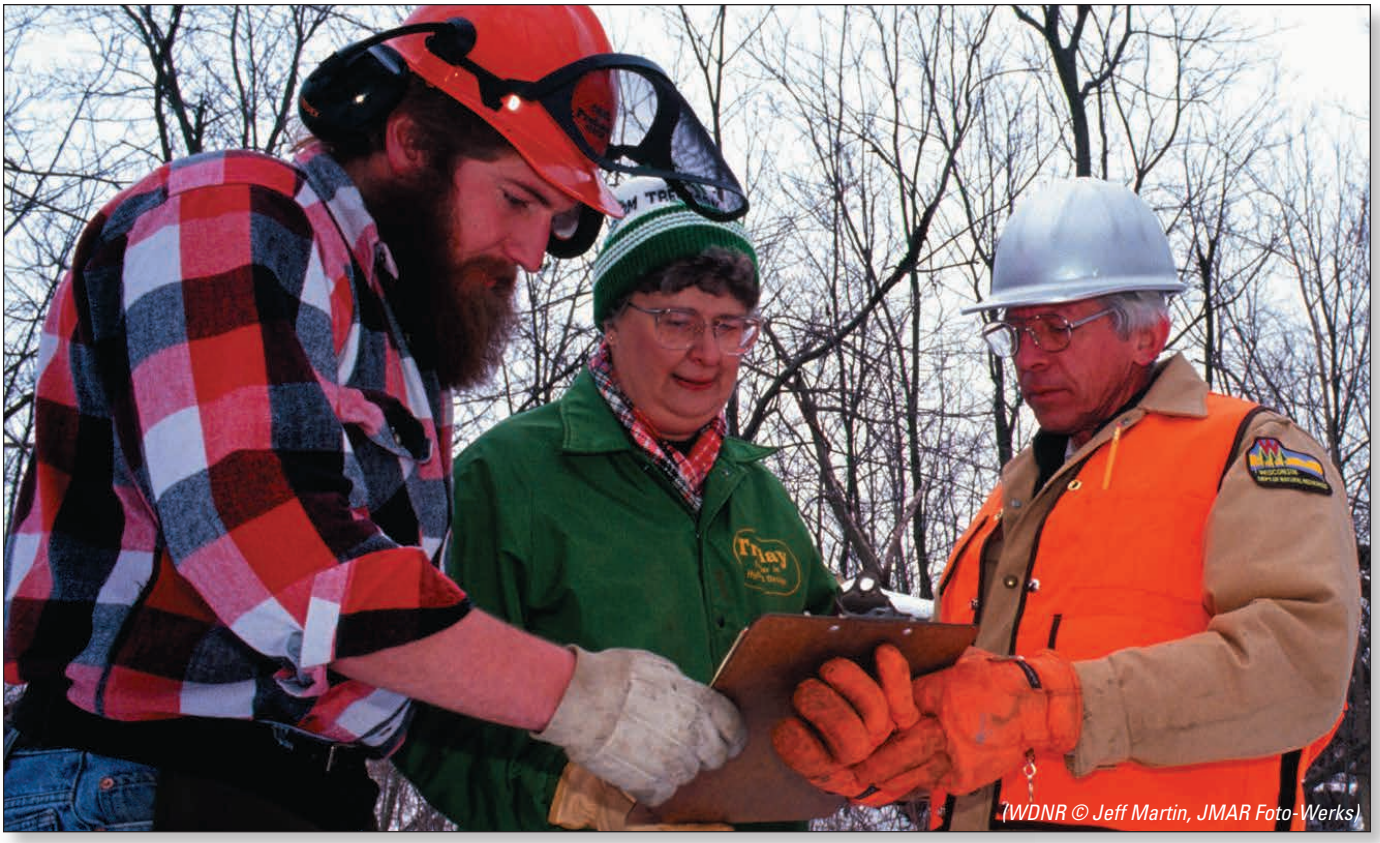


Figure 13-17: Conducting on-site meetings with a logger, landowner and resource manager prior to moving any equipment helps ensure a common understanding of contract specifications, timber harvesting regulations, landowner objectives, and site conditions.

Figure 13-18: Ephemeral ponds provide important wetland habitat for a number of important species, like the fairy shrimp, four-toed salamander and wood frog.

Dry Washes

Dry washes are incised, often V-shaped, hillside gullies experiencing active erosion. Dry washes are common along the steep slopes of southwestern Wisconsin's Driftless Area and Lake Superior's coast. Occasionally, conditions may also lead to the development of dry washes in other parts of the state.

Found in steep, hilly landscapes, large amounts of sediment can be swiftly eroded from dry washes and deposited elsewhere. In southwest Wisconsin, they are commonly found in wooded slopes below agricultural fields, pastures and ditch culverts. Dry washes are not found in flat areas.

Dry washes only receive water flow as surface runoff from snowmelt and rainstorms. They receive little to no flow from springs or seeps. If springs or seeps are present, it is more likely a stream with associated aquatic plants and animals rather than a dry wash.

Dry washes are actively experiencing soil erosion. If the stability of the dry wash is compromised by equipment, this can lead to more erosion, causing the dry wash to widen, deepen and progress further uphill (head-cutting).

To differentiate dry washes from streams, ravines, valleys, and other landforms, consider the following:

- Dry washes are not identified on topographical maps.
- Dry washes have deeply cut, steep sides.
- Dry washes have bare, eroding soil.
- Dry washes show signs of active erosion by concentrated water flow.

BMPs: Dry Washes

The following BMPs apply within 35 feet of each side of dry washes. The goal is to allow landowners to harvest timber while preventing further erosion in the dry wash during forest management activities.

- Use selection harvests or patch clearcuts within 35 feet of the dry wash to promote tree species appropriate to the site. No more than 50 percent of the area within 35 feet should be clearcut.
- Avoid locating roads and landings within 35 feet of the dry wash unless necessary for crossings. To the extent possible, avoid crossing the dry wash with equipment during harvesting operations. For crossings, follow the recommendations in Chapter 12: Forest Road Construction and Maintenance.
- Operate wheeled or tracked equipment within 15 feet of the dry wash only when the ground is frozen or dry. Minimize equipment activity around head of the dry wash in order to prevent further uphill progression (head-cutting) of the dry wash.
- Do not harvest fine woody material within 15 feet of the dry wash. NOTE: This BMP may be modified for specific site conditions, for specific operational issues or to meet specific management objectives if water quality will not be impacted. Additional guidelines can be found in *Wisconsin's Forestland Woody Biomass Harvesting Guidelines*.
- Minimize soil exposure and compaction to protect ground vegetation and the duff layer.
- Avoid cabling logs across the dry wash, where feasible, to prevent damage to the bank of the dry wash.

Stabilizing dry washes often requires addressing runoff problems beyond the tops of dry washes. Many times the source of these problems is agricultural lands or roads, which is beyond the scope of this field manual. Your County Land Conservation Department may be able to provide some direction on what actions you may take to repair a dry wash.

Protecting Cultural Resources

- If harvesting will take place in the area of a cultural resource, employ measures to reduce soil disturbance, including (but not limited to) hand felling, limited-area feller buncher, low ground pressure (LGP) equipment, cut-to-length systems, and temporary protection such as slash, corduroy, tire mats, or fill over geotextile. Again, all burial sites are protected against unauthorized disturbance in any case.

Skid Trails

- Skid trails are temporary, nonstructural travel ways for logging equipment, called skidders, to drag felled trees or logs to the landing for further processing, loading and transport to a mill.
- Plan progressive harvesting techniques that avoid trafficking over precut areas when possible.
- Design skid trail layout to minimize wounding of residual trees (see Wisconsin DNR *Silviculture Handbook*, 2431.5).
  dnr.wi.gov – keyword "silviculture"

BMPs: Skid Trails

Skid trail restrictions in riparian management zones are described more in detail in Chapter 5: Riparian Areas and Wetlands.

- Where possible, keep skid trail grades less than 15 percent. Where steep grades are unavoidable, break the grade, install drainage structures, and use soil stabilization practices (as described in Chapter 12: Forest Road Construction and Maintenance) where needed to minimize runoff and erosion. Grades greater than 15 percent should not exceed 300 feet in length.
- Use existing trails if they provide the best long-term access. Consider relocating existing trails if access can be improved and environmental impacts lessened.
- 5.1 To the extent practical, use existing skid trails to reduce disturbance.

Figure 13-19: A skid trail during active harvesting.

Landings

BMPs: Landings

- Locate landings on frozen ground or firm, well-drained soils with a slight slope, or on ground shaped to promote efficient drainage. Landings may need a crown shape to allow for drainage.
- Use existing landings if possible. Close existing landings in riparian management zones unless construction of new landings will cause greater harm to water quality than using existing landings.
- Locate residue piles (sawdust, field chipping residue, and other material) away from areas where runoff may wash residue into streams, lakes or wetlands.
- 5.1 To the extent practical, use existing skid trails to reduce disturbance.

REDUCING THE VISUAL IMPACTS OF LANDINGS

- When possible, avoid landings within view of travel routes or recreation areas. If it is not possible to avoid landings within these areas, screen landings from view as long as possible during logging.
- Keep the number of landings to a minimum, and plan them to access future sales.
- Seed, plant and regenerate landings promptly.
- Remove all products promptly when development of visible landings is necessary.
- Dispose of grubbed stumps and trees so they are not visible.
- Treat any slash at landings as soon as possible.
- Remove all trash upon completion of harvesting.

Minimizing Rutting

- Minimize rutting on primary skid trails, roads and landings, and avoid rutting in the general harvest area.
- If alternative operating techniques fail to eliminate rutting, stop harvesting operations.

BMP: Rutting

- Fill in ruts, apply seed and mulch, and install sediment control and drainage structures on skid trails and landings where needed to prevent erosion and sedimentation into surface waters (see Chapter 12: Forest Road Construction and Maintenance).

Managing Slash

- Favor practices that allow for dispersed slash on the site, rather than piling slash, where dispersed slash does not conflict with management objectives or reforestation. When piling slash, piles should be kept away from cultural resources.
- If moving slash on-site is desirable, use equipment that minimizes soil disturbance.
- Stump heights should not exceed the diameter of the stump.

REDUCING VISUAL IMPACTS OF SLASH

- Encourage maximum utilization of all felled trees in the harvest area.
- Minimize visual exposure to slash piles and windrows.
- Limit slash not screened from view to a reasonable height to avoid a negative visual effect.

BMP: Slash

- Do not dispose of or pile slash in areas where runoff may wash slash into lakes, streams or wetlands.

Snags (Standing Dead Trees)

- Leave as many snags as possible standing in harvest areas, consistent with the exceptions outlined below.

Reserve (Leave) Trees

Two general options are recommended for retaining reserve trees (live trees left unharvested when a stand is rotated). Plans for retaining leave trees may utilize one or, when appropriate, they may use the two options in combination (see Chapter 3: Wildlife Habitat and Biodiversity and Appendix A for more information).

OPTION 1: CLUMPS, STRIPS OR ISLANDS

- Retain leave trees in clumps, strips or islands in each harvest unit. Benefits of clumping leave trees include:
  - Potential to meet multiple management objectives simultaneously.
  - Visual quality.
  - Equipment maneuverability.
  - Longevity and durability of leave trees.
  - Potential for greater biodiversity within clumps.
  - Easier application in larger harvest units.
  - Reduction in apparent harvest size.
  - Better regeneration and growth of sun-loving species on the rest of the site.
  - Potential to provide nesting sites for some interior forest species when clumps exceed two acres.
  - Increased animal feeding efficiency and protection from predators.

- Clumps, islands or strips should:
  - Be distributed throughout a harvest unit.
  - Be adjacent to the Riparian Management Zone (RMZ) for even-aged management.
  - Vary in size, with a minimum of one-tenth acre per clump.
  - Center around or coincide with such features as:
    1) Wetland inclusions and seasonal ponds
    2) One or more large (greater than 18 inches DBH) active den trees or cavity trees
    3) Mast trees
    4) Preferred tree species (such as large white pine), particularly large, vigorous individuals
    5) Raptor nests or rookeries
    6) Sensitive communities or sites

OPTION 2: SCATTERED INDIVIDUALS

- As an alternative or supplement to clumps, employ scattered individual leave trees, especially if they are larger, wind-firm specimens of preferred species. Scattered leave trees may be easier to apply to small or narrow harvest units than clumps. Use the guidelines outlined in Chapter 3: Wildlife Habitat and Biodiversity, and Appendix A.

- During initial harvest entries of seed-tree or shelterwood cuts, select ultimate leave trees using the following guidelines:
  - Leave a variety of sizes and species of trees, along with the intended seed-trees and/or shelter trees, to be retained during the final harvest.
  - Plan for and protect integrity of reserve tree clumps in initial harvest entries.
  - Prevent damage to leave trees in initial and follow-up harvest entries.

- **Exceptions** to the previous leave tree and snag guidelines may be made for a number of reasons:
  - Operator safety (of loggers, aerial spray applicators, and others).
  - Public and contractor safety (hazard trees near right-of-way, recreation sites, roads, or airport vicinities).
  - Specific forest management applications (e.g., genetic considerations for seed reproduction systems).
  - Surrounding landscape concerns (e.g., adjacent sites to sharp-tailed grouse management units).
  - Forest insects and diseases (e.g., dwarf mistletoe on black spruce, jack pine budworm, or gypsy moth).
  - Shallow-rooted trees with little wind resistance.
  - Excessive shade inhibiting forest regeneration.

Generally, these potential problems can be avoided by intelligently designing the retention of reserve trees and considering their distribution and composition.

NOTE: During partial harvests (e.g., thinnings and uneven-aged selection), be sure that the remaining stand includes a minimum of three large mast trees and (potential) cavity trees per acre, as well as at least three snags per acre if available (see Chapter 3: Wildlife Habitat and Biodiversity, and Appendix A).

Providing Coarse Woody Debris

- Avoid having equipment disturb pre-existing large downed logs, stumps and uprooted stumps.
- If a snag must be dropped, leave it where it falls whenever possible.
- Create at least two to five bark-on downed logs greater than 12 inches in diameter per acre, if fewer than this number already exist. In choosing candidates for leave logs, consider the following:
  - Hollow butt sections or other defective lengths of at least six feet are preferred.
  - Sound logs and six- to 12-inch diameter logs may be used if they represent the best available candidates.
  - Hardwood logs have more hollows or cavities, and are favored by certain amphibians.
  - Conifer logs decay more slowly, thus remain present as structure on a site longer than hardwoods.
  - Using pines as downed logs, especially in summer, increases the risk of bark beetle damage to adjacent healthy pines.
- Scatter leave logs across the site, including a few near wetlands.
- **Exceptions** to guidelines for providing coarse woody debris may be made for a number of reasons including:
  - Alignment of skid trails
  - Specific silvicultural applications (e.g., insect pests)

Managing the Harvesting Process

Even the best harvesting design may fail for lack of vigorous, on-going, contract administration. Harvesting operations may extend over several months, and sometimes years. Problems need to be identified and dealt with early, before they become unmanageable. Efforts to minimize logging damage to the residual stand or to advance regeneration, the lopping and scattering of slash, the clean-up of road entrances, control of erosion, and many other activities need to be done concurrently with the cutting operation if they are to be most effective.

- The creation of "cutting zones" can be used to help administer large harvest areas. In this way, the cutting can be limited to only a specific portion of the harvest area until that "zone" is satisfactorily completed.
- A complete, accurate timber sale map (see Figure 13-30, page 13-24) is an extremely important tool for effective harvest administration. On complex cutting operations, it is absolutely essential. The map should be a part of the timber sale contract, and copies provided to everyone working on the job.

Figure 13-20: One harvesting option is to leave a minimum of three to nine scattered cavity/potential cavity trees, mast trees, or snags per acre to enhance wildlife habitat.

Understanding Harvesting Equipment and Harvesting Systems

COMMON TIMBER HARVESTING EQUIPMENT IN WISCONSIN

A basic understanding of the most common harvesting equipment and harvesting systems in Wisconsin can have a big impact on planning harvests in order to improve outcomes. For a landowner, knowledge of the capabilities and limitations of equipment can foster realistic expectations of what can and cannot be accomplished, and what to expect once harvesting begins.

Timber harvests can be broken down into steps or processes which are common to all timber harvests. These steps are felling, processing the felled trees, extraction (moving felled trees from stump to landing or road) and hauling to market. Timber harvesting equipment is designed to accomplish one or more of these steps in the most efficient and safe manner. No one machine can accomplish all the steps, but instead a combination of equipment is used. This combination of equipment is called a harvesting system. The best combination of harvesting equipment for a specific harvest depends on the silvicultural objectives (thinning versus regeneration), soils, topography, size and quantity of timber to be harvested, and costs.

It should be noted that the quality of a harvest under any system can vary widely and is strongly related to the skill level of the equipment operator. Highly skilled operators can overcome many limitations of the equipment.

MACHINES IN GENERAL

Tracked machines are more stable on slopes then rubber-tired machines. Tracked machines typically cause less soil compaction and rutting than rubber-tired machines as weight is distributed over a larger area. Rubber-tired machines are faster and more maneuverable than tracked machines.

STEP 1: COMMON FELLING EQUIPMENT

HAND FELLING

Hand felling refers to work done by hand with a chain saw.

Advantages:

- No limitations on soils or terrain.
- Few restrictions on size of timber to be harvested.
- Often used to process the trees in the woods or on the landing.
- Inexpensive equipment costs.
- Highly versatile.

Disadvantages:

- Exposes the operator to higher safety risks.
- Lower production levels than mechanized felling.
- Higher labor costs make it more difficult to be cost efficient in smaller timber.

Figure 13-21: Hand felling in Price County.

Figure 13-22: A feller buncher in Douglas County.

FELLER BUNCHER

A tracked or wheeled machine that severs the tree from the stump and holds it while additional trees are severed and collected, and then lays them down in bunches. Sometimes referred to as a "hot saw." Often used in conjunction with grapple skidders (described later).

Advantages:

- Lower labor costs versus hand felling.
- Safer than hand felling.
- Efficiency allows harvesting of smaller timber.
- Can be less damaging to regeneration as trees are directionally felled in bunches, but skidding must be carefully planned.
- Used in conjunction with tree length skidding can facilitate biomass harvesting.

Disadvantages:

- Not well-suited for steep slopes.
- Tree length skidding can result in potential for more damage to residual trees.
- Impacts on advanced regeneration can be greater.
- Requires processing in another step with additional equipment.

PROCESSORS

These are tracked or wheeled machines that sever a tree, and then process the tree into products by feeding it through the processor head to limb the stem, and then cut it into lengths suitable for market. Some machines even tally the amount of timber cut as it is fed through the machine. Sometimes referred to as a "cut-to-length" (CTL) machine. Most commonly used in conjunction with forwarders (described later).

Advantages:

- Lower labor costs.
- Trees are felled in a much safer environment than hand felling.
- Processors eliminate the need to process trees in another step with additional machinery.
- The direction and placement of felled trees can be controlled to minimize damage to those trees not being harvested.
- Can harvest smaller trees efficiently.
- Can place tops and limbs in front of the machine which it can drive over to help minimize rutting or compaction.
- Can reach into tight spots to thin out trees.

Disadvantages:

- High equipment costs.
- Limited ability to work on steep slopes.
- Some processor head types cause defect in saw logs.

Figure 13-23: A processor in Iron County.

Figure 13-24: A cable skidder in Iron County.

STEP 2: COMMON EXTRACTION EQUIPMENT

Skidders are machines that lift one end of a tree or log and drag the tree from the site. The other end of the log skids along the ground – hence the name. Skidders come in a range of types and sizes.

CABLE SKIDDERS

These machines use cables to winch trees to the skidder. The cable then suspends one end off the ground to reduce friction and drags the trees with the other end skidding on the ground to a landing. Sometimes referred to as a "pole skidder."

Advantages:

- Because it winches tree to the machine it can pull trees up relatively steep slopes that other machines cannot reach.
- Lower costs relative to other machines.

Disadvantages:

- Higher labor costs because driver must get off the machine and pull cable to the trees to attach it to them.
- Higher exposure to safety concerns.
- The distance that the operator must pull cable can limit efficiency.
- Tree length skidding will increase site disturbance including damage to residual trees and advanced regeneration.
- Require additional product processing on landing.

GRAPPLE SKIDDERS

These types of skidders are used in conjunction with feller bunchers. Instead of using cables like cable skidders, these machines have a grapple or clam to grab and lift a number of trees and then drag them to a landing.

Advantages:

- Moves timber to landing more efficiently with less labor since the operator does not need to leave the machine.
- Can handle large and small timber efficiently.
- Can move trees and tops to a landing to facilitate biomass harvesting.

Disadvantages

- Cannot operate on as steep of slopes as cable skidders.
- Tree or log length skidding can cause more site impacts including damage to residual trees and advanced regeneration and soil compaction.

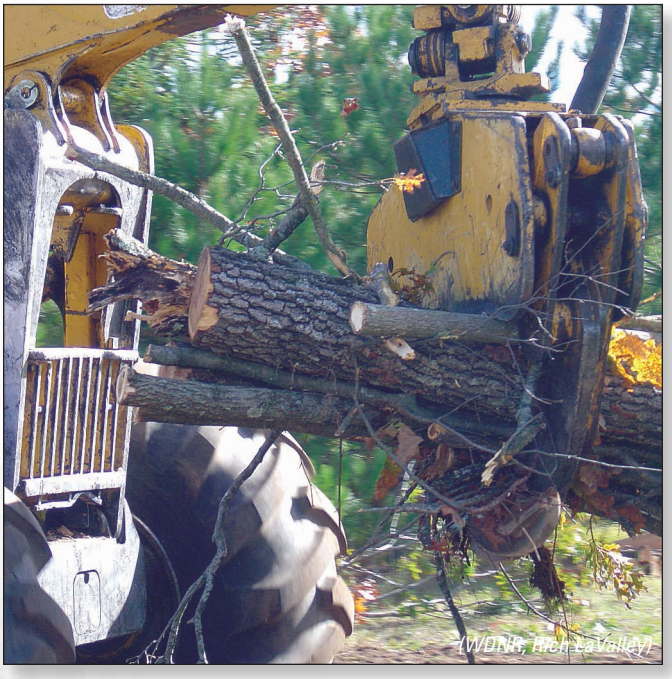


Figure 13-25: A grapple skidder in Waushara County.

(WDNR Archive)

Figure 13-26: A single bunk forwarder.

FORWARDERS

These machines pick up processed timber and carry it out to a landing where it is sorted for various markets. Because the wood is carried out instead of skid along the ground, the term forwarder is used.

Advantages:

- Because nothing is skidded, they can have very low impacts on the site or remaining trees.
- Slash can be left in the forest or can be loaded and forwarded out.

Disadvantages:

- Higher center of gravity limits uses on steep slopes.
- Not well-suited to long length forest products such as utility poles.

STEP 3: PROCESSING TREE TO PRODUCTS

If the trees are not processed into forest products in the woods they are brought to a landing (small clearing in the forest) where they are prepared for market. There are a few common pieces of equipment in Wisconsin that process trees on the landing.

CUT-OFF SAWS

One of the more common pieces of equipment in Wisconsin is a cut-off (slasher) saw. These machines are typically mounted on a truck frame with a loader boom to pick up and handle the trees that are dragged up to the machine. The loader places the log on a carriage where a large circular saw or chain saw bar cuts them to length. The tops are either dragged back into the forest or processed further into chips at the landing.

Disadvantages:

- Requires a fairly large landing to accommodate large amounts of equipment, trees and processed products.
- Disposal of cut off pieces of wood should be planned for.

Advantages:

- Lower labor costs.
- Able to cut logs as well as pulp.
- With a self loader, can sort various products for trucking.

(WDNR, Rich LaValley)

Figure 13-27: A cut-off saw in Waushara County.


(WDNR, Dale Rochon)

Figure 13-28: A self-feeding chipper in Iron County.


(WDNR, Jeff Barkley)

Figure 13-29: A self-feeding tub grinder in Douglas County.

CHIPPERS AND GRINDERS

Whole tree chipping has been used in Wisconsin for a long time, but with the increased interest in biomass harvesting, the use of chippers is becoming even more common today. Harvesting operations can either chip the entire tree or cut out the higher valued logs, bolts, and pulp and then chip what remains. Chips are hauled to mills for paper, wood pellets or fuel. There are a wide variety of chippers and grinders used today in Wisconsin. Both process the timber into small pieces. Chippers produce a more uniform-sized chip, while grinders can tolerate a higher degree of dirt and other contaminants.

COMMON HARVESTING SYSTEMS IN WISCONSIN

CONVENTIONAL SYSTEMS

A chain saw is used to hand fell and limb and top the trees, then a cable skidder skids them to a landing where a chain saw is used to buck them into lengths. **This system is most widely used in areas with higher value timber and steep topography.**

MECHANICAL SYSTEMS

The trees are felled by a feller buncher or processor and left tree length. Then a grapple skidder pulls groups of trees to a landing where they are processed into products by a cut-off saw or chipped. This system requires larger landings to accommodate tree length storage, has higher equipment costs, and is capable of handling small diameter timber or low-value timber efficiently. This system may have higher site disturbance and potential for soil compaction.

CUT TO LENGTH

Trees are felled, limbed and cut-to-length by a processor. Then a forwarder picks up the products and forwards them to a landing and sorts them by product in preparation for trucking. This system does not require an extensive system of landings and improved skid trails compared to other systems, has potentially lower site impacts and has higher equipment costs than conventional systems.

The Timber Sale Contract

A timber sale contract is the most important document involved in the timber harvesting process.

A well-prepared contract, along with a timber sale map, ensures that all parties have a mutual understanding of the operational considerations previously discussed. This section describes and clarifies the Sample Timber Sale Contract included in Appendix B. The Wisconsin DNR, the Wisconsin Woodland Owners Association, and University of Wisconsin-Extension jointly developed it as part of the Forestry Facts series. The sample contract suggests key elements for inclusion in any private timber sale contract whether a landowner uses the one in the appendix or one from another source. The same concepts are also generally present in timber sale contracts on public land.

Five Steps to a Successful Timber Sale

Landowners are encouraged to hire a professional forester to help with any of these steps. *A Directory of Foresters* (PUB-FR-021) is available from the Wisconsin DNR. This information can also be found at: ***dnr.wi.gov – keyword "forester."*** Useful information can also be found in the University of Wisconsin-Extension Forestry Fact #75: Hiring a Consulting Forester.

STEP 1: Prepare a written forest management plan that addresses your personal objectives and the desired future condition of the woodland. The plan should explain harvesting techniques, and any follow-up work that may be needed to achieve the preferred results.

STEP 2: Develop a harvest plan that describes the practices, locations and expectations for the harvest. This document should include a map of the harvest site.

STEP 3: Develop a comprehensive, written timber sale contract* that will be available as part of your timber sale advertisement.

STEP 4: Get competitive bids to help secure a fair offer and to find a skilled, careful logger that is experienced with your type of sale.

STEP 5: Check references and the performance history of both the consulting forester (if you plan to hire one) and the timber producer (logging contractor) you are considering for your timber harvest. The Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) has a Consumer Protection Hotline at **1-800-422-7128** that you can call to check for past complaints. The Great Lakes Timber Professionals Association (GLTPA) maintains records of training completed by logging contractors and also maintains lists of contractors who have attained Master Logger status. Master Logger's operations are periodically audited independently to a higher standard. If the forester you select is expected to scale or grade the cut products, make sure that he/she is qualified to perform the work.

* *A sample timber sale contract may also be downloaded in digital format from the following website:* ***dnr.wi.gov – keywords "harvesting your woods"***

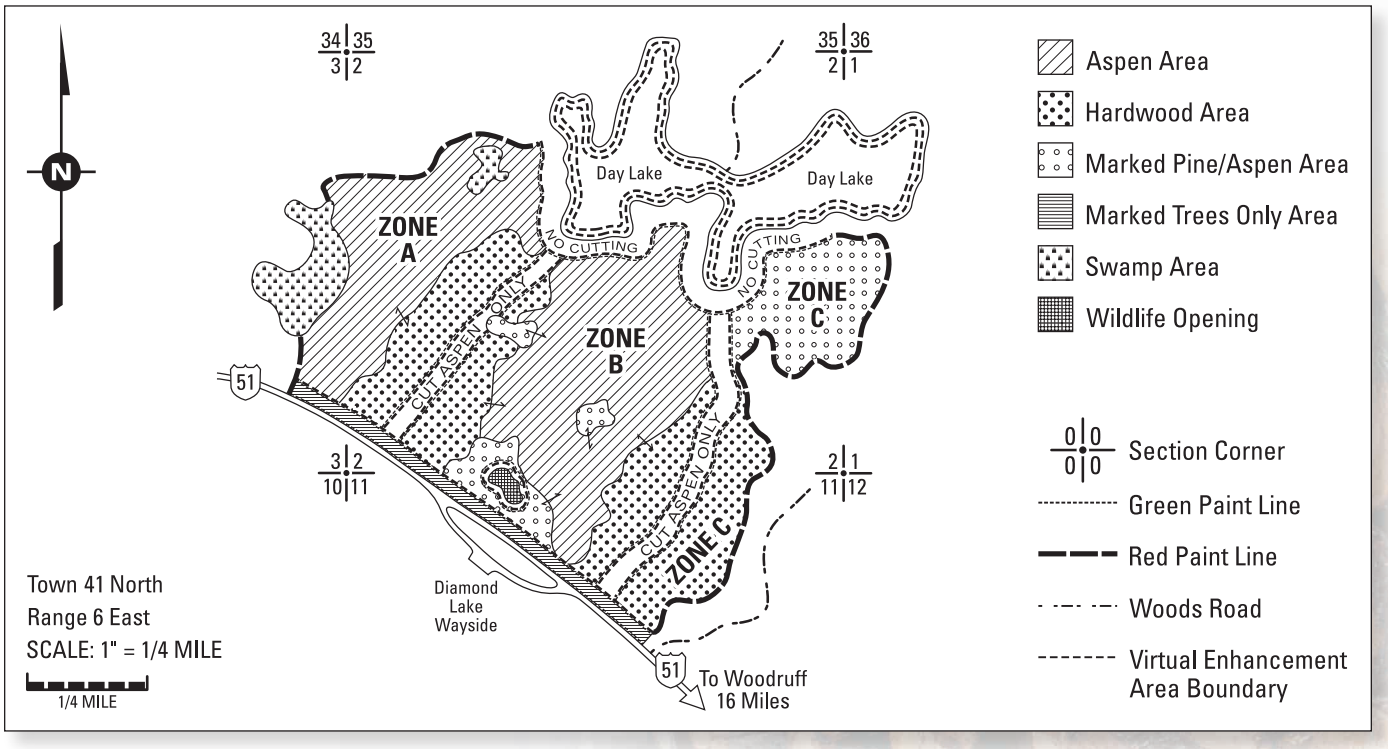


Figure 13-30: A timber sale map should be clear, concise and contain all the information a logger needs to determine what needs to be done and where. Boundary line locations, other ownerships, paint line colors, cutting specifications, cutting zones (if any), and any other pertinent information, should be completely spelled out.

Understanding the Sample Timber Sale Contract

The Sample Timber Sale Contract explained in this section contains a number of options. You will need to select the provisions and language that are appropriate for your harvest. The list of contract provisions is not meant to be exhaustive or necessarily applicable to every situation. You may choose to add or delete (by striking out) provisions. Landowners are encouraged to work with an attorney and professional forester in drafting a timber sale contract. Timber sale contracts usually include provisions that outline who, what, where, when, and how a timber sale will occur. Contracts will also spell out remedies in the event of a dispute. More stringent contracts may result in fewer bidders and, potentially, lower bids. Less restrictive contracts provide for less control. The section titles and provision numbers in the following explanations correspond to the section titles and paragraph numbers in the Sample Timber Sale Contract in Appendix B. Some sections are self-explanatory and contain less information.

Contract Breach: A Very Serious Decision

Deciding that the Purchaser has breached a timber sale contract should not be made lightly or over trivial matters. Contract breach is a very serious step that can have ramifications for you and the Purchaser well beyond this one event. Reputation is critical to a timber harvester's livelihood and to your ability to sell or resell your timber. You may also be sued – it is that important. Breach should truly be the final straw. Intermediate steps might include visiting with the Purchaser to hash out differences, having a third party intervene, or shutting the sale down temporarily.

What is Reasonable?

Throughout the Sample Timber Sale Contract, there are references to actions being "reasonable." In legal terms, reasonable means fair, proper, just, moderate, and suitable under the circumstances. The basic question to ask is: Would an outside observer familiar with harvesting practices feel the action was adequate and satisfactory?

If you have never harvested timber before or visited a logging site, it is important that you learn about and understand normal logging practices and their impact. Either visit logging sites or hire a consultant forester to help you determine if your expectations of post-harvest conditions are "reasonable."

PROVISIONS 1

Contracting parties. Beyond the actual Purchaser(s) and Seller(s) named in the contract, other individuals may be able to act in their place. For the Seller, this could be a partner in an LLP or one's heir. Of particular note is 1.c., which requires that the Seller provide written approval of subcontracting.

PROVISIONS 2-3

Entire contract. This section defines what documents comprise the entire contract (to include a harvest site map). It also outlines what constitutes a legal amendment to the contract.

PROVISIONS 4-7

Contract performance, period, extensions, and termination. Beginning and ending dates of the contract are established. The phrase "FOR TIME IS OF THE ESSENCE" demands reasonable diligence and completion within the period of the contract. Delays should only be authorized for reasons beyond the control of the Purchaser. This is essential to achieve your management objectives. Some provisions give you the flexibility to protect the land should unanticipated events or conditions occur. The Purchaser's authority to go on your land and conduct operations is through the contract.

PROVISIONS 8-11

Down payment, bond, remedies, and damages. Down payments are earnest money, and are not performance bonds. Performance bonds assure that costs incurred due to breach can be recovered from the bond, rather than going to court or otherwise recovering costs from the Purchaser. A performance bond may take the form of cash, a check, letter of credit, or escrow account. Be aware that many Purchasers may not agree to provide a performance bond unless it is to be held by a consulting forester or an objective third party such as an escrow agent. The Seller's remedies in the event of a breach are not just limited to routine contract damages. Other penalties or remedies may be pursued if the Seller so chooses.

PROVISIONS 12-14

Products to be removed. Specifications for how trees are marked or designated for harvesting are explained (e.g., "trees marked with orange paint" or "all trees within a red marked boundary"). Be certain that your property boundaries are well-marked and/or designated, and understood by the Purchaser. If the boundary has not been formally surveyed, you should meet with the adjoining landowners to agree on the location of the property boundary. The Seller retains sole control over the timber and other wood products (e.g., woody biomass) until payment is made. Timber cannot be removed from the property until paid for or payment has been arranged.

PROVISIONS 15-21

Sale type, scaling, hauling, and payments. There are many ways to sell timber. Each affects at what point ownership of cut products moves from the Seller to the Purchaser and who reaps the benefit of product sort and grade. This section defines under what conditions cut products may be removed from the property, how and by whom the cut products are to be measured, and when the Seller receives payment.

Scaling procedures include on-site and mill scales. The Seller should be aware that while some mills are willing to send mill slips to the Seller, others are not.

Prior to signing the contract, seek the advice of a tax specialist to determine whether income may be treated as a capital gain or regular income. Spreading the payment over two years may minimize your tax liability in any single year.

The Timber Products Table (#17) summarizes the type and volume of timber expected from the harvest and the price the Purchaser agrees to pay by unit. This information is important in all sales, even lump sum sales where the price per unit information can be used for damages or contract adjustments, if necessary.

In some cases, the term "mixed hardwoods" is used to describe products to be removed. Mixed hardwoods are small quantities of hardwood tree species of low relative value or not in sufficient quantity to be marketed in separate species categories. High-value species or products should be identified separately, even if the volume is small. In general, the use of mixed hardwoods should be restricted to pulp and/or woody biomass.

In some cases (e.g., woody biomass), wood fiber may be sold by weight or by cord. These situations may require conversions between volume and weight measures. Specifying the conversion factors in the contract is recommended.

PROVISIONS 22-34

Utilization and operations. Detail any timber and site protection measures here. Be specific about erosion control, weather, invasive disease and insect prevention, nonnative invasive plants, timing, equipment use (such as width or size limitations, use of a forwarder rather than a skidder, horses, etc.), operations during hunting seasons or other constraints you or your forester considers necessary.

Wisconsin has Best Management Practices (BMPs) to protect water quality and reduce the spread of invasive species. The State has also developed guidelines for the harvesting of woody biomass. If there are critical BMP needs or you want the Purchaser to comply with the biomass guidelines, you should list those, being as precise as possible.

(Continued on page 13-27.)

(Continued from page 13-26.)

Include consideration for archeological sites or endangered and threatened species (e.g., Natural Heritage Index listed species) where appropriate or required by law. Be aware that some requirements may affect the price that the Purchaser can afford to offer for the timber.

PROVISIONS 34-38

Notice of intent to cut and compliance with laws. Specify the party responsible for filing cutting notices and reports with the county clerk and the Wisconsin Department of Natural Resources (DNR). County cutting notices must be filed 14 days before cutting starts and renewed on January 1 of each year.

If the land is enrolled in the Managed Forest Law (MFL) or Forest Crop Law (FCL) a Wisconsin DNR Cutting Notice (DNR Form 2450-032) must be filed at least 30 days before cutting begins and a report of volumes cut must be filed within 30 days of completion of any cutting. Cutting shall commence within one year of the date of approval, or within one year of the date of filing if DNR approval is not required. Regardless of contract provisions, state statutes hold landowners liable for penalties related to non-compliance with MFL and FCL cutting notice and reporting requirements.

PROVISIONS 39-41

Title, boundary lines, and access. These clauses outline three important duties of you as the Seller.

1. You assure that you have the authority to sell the timber and will defend that right in court if necessary. A mortgage or land contract may require that the Seller seek permission of creditors before selling. Where there are multiple owners, all should consent. Tax program participants should ensure that the harvest is consistent with the approved forest management plan and that all required notices are submitted.
2. You will mark the boundary of the timber sale prior to harvest.
3. You will acquire written permission to cross a neighbor's land, if necessary.

PROVISION 42-48

Liability and insurance. These provisions protect the Seller from liability arising from the Purchaser's harvesting operation. The Purchaser is required to show proof of workers' compensation and public liability insurance. Be aware that a logger's liability insurance does not normally include damages caused by fire or timber trespass unless purchased as an option.

PROVISION 49

Training. Loggers can access training opportunities related to safety, forest management, and various BMPs and guidelines. If you expect them to have certain training, check and document that the Purchaser and the timber operators working on the site have completed the pertinent training programs.

PROVISIONS 50-52

Forest certification. If the land is certified (e.g., American Tree Farm Program, Forest Stewardship Council, etc.), additional contract language will be necessary. Sellers should provide Purchasers with certificate number(s), which you can find either on your certification documents or from the organization that certified your land. Timber from certified and noncertified land should be divided into separate timber sale contracts or otherwise clearly delineated to avoid mixing.

PROVISION 53

Contact information. This exchange of information between the Purchaser and Seller will ensure that both parties can contact each other easily. If you are using a Seller's agent (e.g., consulting forester), you'll want to provide his or her contact information, too.

POST-OPERATIONAL ACTIVITIES

- Evaluate the harvesting operation, and plan future adaptations at post-harvest conferences with the logger and landowner.
- Plan for removal of equipment and cut material from wetland areas at the end of the winter season prior to thawing.
- Avoid removing soil from the general harvest area to rehabilitate roads, landings and skid trails. Use already disturbed soil, if needed, rather than disturbing additional soil.
- Inspect and maintain any soil stabilization practices installed. Rehabilitate landings and skid trails when necessary to mitigate soil compaction and help to reduce erosion.
- Monitor the sale area and access routes for nonnative invasive plants, and take the necessary steps to control any species that may have been introduced through harvesting activities (see 6.5).
- Evaluate the adequacy of advance regeneration, and/or the need for reforestation.
- Conduct additional site preparation work, as needed, to ensure successful regeneration.

Figure 13-31: A forwarder offloads pulpwood at a woods landing. Forest management objectives may influence your equipment choice. Forwarders carry wood, thus causing little soil disturbance. Skidders scarify the soil by dragging trees or logs – a plus for natural regeneration where erosion is not a problem.

BMPs: Invasive Species

The following are Forestry BMPs for Invasive Species (IS-BMPs) that should be considered when planning and conducting timber harvests.

- 3.2 Prior to implementing management activities, scout for and locate invasive species infestations, consistent with the scale and intensity of operations.
- 3.4 Plan management activities to limit the potential for the introduction and spread of invasive species.
- 4.2 If pre- or post-activity control treatments are planned, ensure that they are applied within the appropriate time window.
- 4.3 Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.
- 4.5 Take steps to minimize the movement of invasive plants, insects, and diseases to non-infested areas, during forest stewardship activities.
- 5.1 To the extent practical, use existing roads, skid trails, and landings to reduce disturbance.
- 5.2 Avoid constructing new roads, skid trails, and landings in areas infested with invasive species where possible.
- 6.5 Plan for post-planting management of invasive species.

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

CONDUCTING A SUCCESSFUL TIMBER SALE: A PRIMER FOR LANDOWNERS

Conducting a Successful Timber Sale: A Primer of Landowners (PUB-FR-254). Rickenbach, M. G. Wisconsin DNR - Division of Forestry also as University of Wisconsin-Extension Publication GWQ036, 16 pages, 2003.
learningstore.uwex.edu/Assets/pdfs/GWQ036.pdf

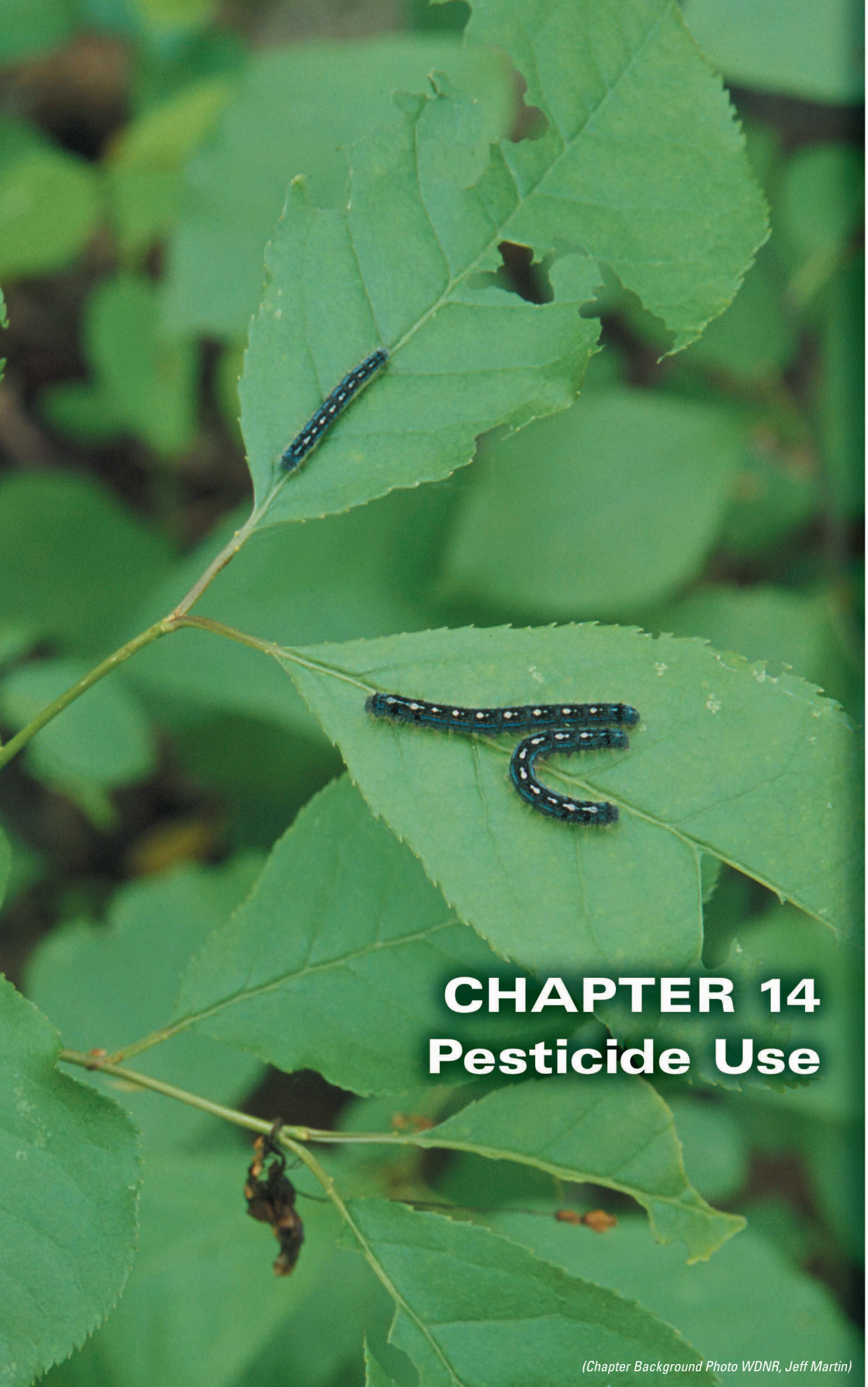
UNDERSTANDING THE SAMPLE TIMBER SALE CONTRACT

Understanding the Sample Timber Sale Contract. University of Wisconsin-Extension, Wisconsin Woodland Owners Association, and Wisconsin DNR. University of Wisconsin-Madison, Department of Forest and Wildlife Ecology Forestry Fact Number 94, also as PUB-FR-202 Wisconsin DNR - Division of Forestry, 11 pages, 2009.
dnr.wi.gov – keywords "harvesting your woods"

WISCONSIN'S FORESTLAND WOODY BIOMASS HARVESTING GUIDELINES

Wisconsin's Forestland Woody Biomass Harvesting Guidelines (PUB-FR-435-2014). Bronson, D. R., G. J. Edge, C. R. Hardin, S. K. Herrick, and T. G. Knoot. Wisconsin DNR - Division of Forestry and Wisconsin Council on Forestry, Madison, Wisconsin, 48 pp., 2014.
https://councilonforestry.wi.gov/Pages/WoodyBiomass/Overview.aspx

NOTES



14

CHAPTER 14
Pesticide Use

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 14
PESTICIDE USE

Figure 14-1: A spray plane equipped with special wing-mounted hoppers for dispensing Pheromone Flakes mixed with glue to control the spread of gypsy moths.

Pesticides are chemical compounds that can assist in meeting forest management, utility and right-of-way objectives by promoting the establishment, survival, growth, or maintenance of desired species or conditions.

Best Management Practices (BMPs) for water quality and other guidelines for use of pesticides are outlined in this chapter. Prominent pesticide-related rules referenced include Chapters ATCP 29, 30 and 33, Wisconsin Administrative Code; Federal Insecticide, Fungicide and Rodenticide Act (FIFRA); Federal Worker Protection Standard (WPS); and Chapters NR 107 and 140, Wisconsin Administrative Code. Users must also adhere to instructions and prohibitions printed on pesticide labels (see Appendix C for additional pesticide regulations). **The safety measures described here are important to follow regardless of whether they are designated as formal BMPs or laws – your health and protection of the environment depend on the responsible handling and application of pesticides!**

Integrated Resource Management Considerations

- Planning is the essential first step in reducing pest problems. Maintaining water quality and protecting other resources is an important consideration in all aspects of pesticide operation planning.
- The effective treatment time for pesticides varies depending on the product and objectives. Some are most effective during the active growing season, which corresponds with the summer tourist/recreational-use season. Some can be applied during the dormant season.
- Broadcast application methods for herbicides may have a greater visual quality impact than band or spot treatment methods.

BMP: Invasive Species

- 4.2 If pre- or post-activity pesticide treatments are planned, ensure that they are applied within the appropriate application timing. (The appropriate application timing can be found on the label of each pesticide container.)

PLANNING AND DESIGN

Consider All Your Options: Integrated Pest Management

Integrated Pest Management (IPM) can be defined as an approach to pest management in which all available necessary techniques, including cultural, chemical, genetic, and biological, are considered in a unified approach. IPM strategies have been developed to control forest pests without relying solely on chemical pesticides. Think about your objectives and develop a strategy to reach them. Determine what problems exist and what options you have to minimize them. Many insects, diseases and plants may not significantly impact the objectives of the management plan, so a careful evaluation of the potential impact of these organisms must always take place before deciding to apply a pesticide. Pesticide use should be considered as part of an overall program to control pest problems, but it should not be the sole solution. When planning to use a pesticide, the target organism can be an insect, disease-causing organism or undesired plant. For additional sources of information on IPM programs, see the resources at the end of this chapter.

Pesticide Characteristics Affecting Ground and Surface Water Contamination Potential

The four main pesticide characteristics that can greatly affect a pesticide's potential to contaminate surface water or groundwater are solubility, adsorption, half-life, and volatilization.

- **Solubility** is the ability of a pesticide to dissolve in water. The greater the solubility, the greater the chance that the pesticide will leach into groundwater or move in solution in surface water. Pesticides with very low water solubility's tend to remain at the soil surface and potentially move to surface water attached to sediment carried in runoff.
- **Adsorption** is the inherent ability of a pesticide to attach to soil particles. Some pesticides stick very tightly to soil, while others are easily dislodged. Adsorption increases as soil organic matter increases. An index or measure of soil adsorption is expressed by the **Koc Value**.
  - The greater a pesticide's ability to adsorb to soil particles (higher Koc Value), the less the potential for that pesticide to move (except by soil erosion in surface runoff).
  - Conversely, the lower a pesticide's ability to adsorb to soil particles (lower Koc Value), the greater the potential for that pesticide to leach into groundwater or move in solution in surface runoff.
- **Half-life** is the time it takes for a pesticide in soil to be degraded so that its concentration decreases by one-half. Each pesticide will have successive half-lives that will continually decrease concentrations by one-half.

  The persistence of the pesticide in soil is the time it takes for the pesticide to degrade to the point where it is no longer active. Pesticides that do not break down quickly can be a hazard if they move into groundwater or surface water in toxic forms.

  There are also soil and site characteristics that influence whether or not a pesticide will reach groundwater or surface water.
- Soils that are deep, high in organic matter, medium- to fine-textured (silty or clayey), and structurally sound are relatively good at "capturing" pesticides until they can be broken down by microbial activity. In general, the greater the depth to groundwater, the more the filtering action of the soil.
- Soils that are shallow (less than 20 inches), very coarse (sandy or gravelly) or drought-prone, are more likely to leach pesticides. Soils that are crusted or compacted are more likely to encourage pesticide runoff in surface water. A shallow depth to groundwater with highly permeable soils will also increase the chances of pesticide movement into groundwater. Surface water contamination can easily occur when pesticides are applied to sites adjacent to lakes, streams, wetlands, and natural drainage ways. If there is a quick conduit from the surface to the water table, such as a sinkhole, pesticides can be washed directly into the groundwater.

- **Volatilization** is the evaporation and movement of a pesticide beyond the target area caused by high temperatures. Pesticides that are made of ester formulations (examples: 2,4-D, Garlon 4 Ultra) are more likely to volatize above 85°F, whereas amine formulations (examples: 2,4-D, Garlon 3A) are less likely to volatize.

Selecting Pesticides

When the decision is made to use pesticides, choose products suitable for use on the target species and registered for the intended uses.

- Only use pesticides registered by the U.S. Environmental Protection Agency (EPA) and the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP). **Make sure the product is labeled for the intended purpose/application.** Restricted Use Pesticides (RUPs) can only be purchased and applied by someone who is certified and licensed by the Wisconsin DATCP.
- **Read and follow all label directions carefully prior to using any pesticide.** The pesticide label is the information printed on or attached to the pesticide container or wrapper. The label and supplemental labeling are legally binding documents; you must follow them explicitly.
- Maintain current labels and Safety Data Sheets (SDS). The SDS is a source of cautionary information and data that has more info about the product than the label. The SDS contains detailed info about the product's chemical and physical properties, its toxicological and ecological info, first aid info, and emergency response info.
- Evaluate other factors besides effectiveness and cost when selecting among pesticide options. Factors that influence potential impacts on water quality and other forest resources include site characteristics, pesticide characteristics (residual effects), application conditions, delivery systems, and application techniques.
- Select only pesticides labeled for aquatic use on sites where surface water is present at the time of application, or pesticides labeled for wetland use where water is near the surface. Make certain the product is labeled for the intended purpose/application.
- Select pesticides, application methods, equipment, and formulations that:
  - Avoid the potential for pesticide drift. **Drift** is the movement of pesticide in air currents or by diffusion onto property beyond the boundaries of the target area. Drift may occur as solid or liquid particles, or as vapors.
  - Avoid **overspray** or the application of pesticide beyond the boundaries of the target area.
  - Avoid pesticide residue movement to surface water and groundwater.

Selecting Application Methods

Choosing the proper application method will help ensure the target organism is affected, and help prevent drift, non-uniform coverage, and exposure to non-target organisms. There are several application methods including but not limited to broadcast, band spray, foliar, foliar and stem, basal bark frill, cut-stump, frill and hatchet injection, frill/hack and squirt, spot and soil application, or injection. Your choice should be based on careful consideration of the nature and habits of the target organism, the site, pesticide chosen, available equipment, cost, and efficiency. As mentioned previously, drift, overspray, and surface water and groundwater contamination must be avoided.

- Select the application method that is appropriate for the site and is needed to obtain your goal(s). For example, a targeted application that provides a low intensity, spot or band treatment may be preferable over a broadcast treatment.
- Use pesticide application equipment that minimizes soil disturbance.

Figure 14-2: A handful of pheromone flakes used for gypsy moth control instead of a chemical pesticide.

- The visual impact of vegetation treatment can be minimized by favoring band or spot treatment over broadcast, and by leaving untreated or selectively treated areas adjacent to travel routes and recreation areas.
- If an endangered, threatened or special concern species is known to be present, select pesticides, application method, and equipment with consideration to protect those species.

BMP: Spill Response

- Maintain a spill containment and clean-up kit appropriate for the site as well as all materials on the operation, and report all spills. See additional BMPs: Spills in Chapter 11: General Operational Guidelines, page 11-6.

Spill Response

A **spill** is the release of a compound into the environment including air, water, soil, etc., in any manner other than its intended use. Forestry pesticides that are spilled can enter surface water or groundwater. Spills near or in geologically-sensitive areas have a high probability of a portion of the spill reaching groundwater.

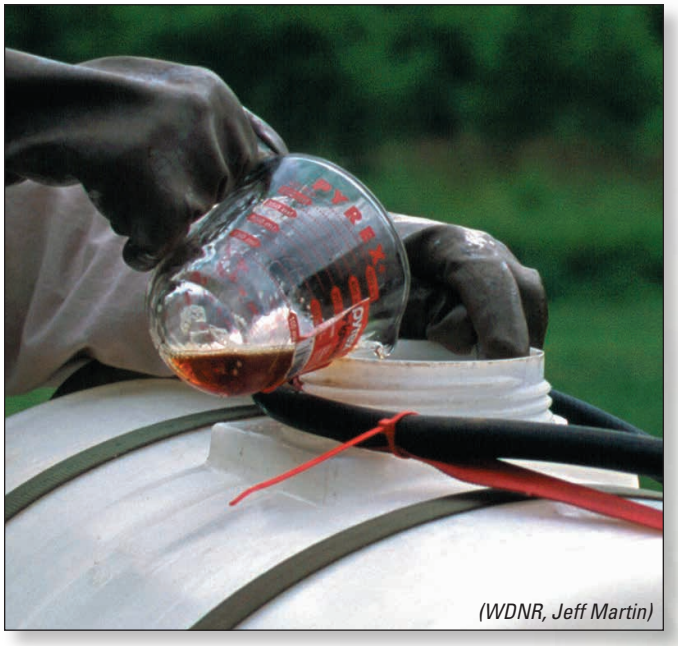
Treat spills properly. Recommended steps include the following:

- Protect yourself. Be sure you wear the necessary personal protective clothing and equipment so that you do not expose yourself to the material. Refer to the product label for specific recommendations.
- Control the spill (stop the leak).
- Contain the spill (keep it from spreading). Contain the spilled material in as small an area as possible; construct a dam to prevent the chemical from spreading. It is particularly important not to allow any chemical to get into any body of water, including storm sewers.
- Guard the site.
- Clean up the spill. Specific recommendations regarding clean-up procedures can be obtained from the chemical manufacturer. The chemical manufacturer lists an emergency number on the product label, which anyone can call for information regarding how to respond to an emergency situation that involves a specific product. Each product also has a Safety Data Sheet (SDS) that outlines what to do in case of a spill.
- Notify the authorities. **Contact the Wisconsin DNR whenever a spill occurs. Phones are answered 24 hours a day. Call 1-800-943-0003**. NR 706 provides specific guidelines for reporting spills to the Wisconsin DNR.

OPERATIONAL CONSIDERATIONS

- **Conduct on-site meetings with the contractor, landowner and resource manager prior to moving equipment onto a site.** Such meetings can help assure a common understanding of landowner objectives, contract specifications, and site conditions.
- **Know the law.** The Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) administers Chapter ATCP 29 and 30, Wisconsin Administrative Code, Pesticide Use, Control and Restrictions, which is the primary regulation concerning pesticide use in Wisconsin. ATCP 29 and 30 provide details regarding all aspects of pesticide use, and **must be followed**.
- **Read the label.** The pesticide label is the information printed on or attached to the pesticide container or wrapper. The label and supplemental labeling are legally binding documents; you must follow them explicitly.

Proper pesticide management practices make efficient use of chemicals while preventing or minimizing impacts on surface water, groundwater and other forest resources. Residues of pesticides used in forestry can affect these resources at any time – from transporting pesticides to container and waste disposal.



(WDNR, Jeff Martin)

Figure 14-3: Exercise caution when mixing and loading pesticides into the spraying tank. Carefully measure the required amount in accordance with the pesticide label.

Transportation of Pesticides

The Federal Department of Transportation has designated many chemical compounds, including some pesticide active ingredients, as hazardous materials. Special training is required to transport hazardous materials. For questions on this topic, contact the Wisconsin State Patrol.

- The safest way to transport pesticides is secured in the back of a truck; never carry pesticides in the passenger compartment of any vehicle. Do not allow passengers or pets to ride in the back of the truck with the pesticide. Do not carry food, feed, seed, propagation material, or fertilizer with pesticides in the back of a vehicle.
- Inspect all containers prior to loading, and ensure that all caps, plugs and bungs (stoppers) are tightened.
- Wear the personal protective equipment and chemical-resistant gloves even when handling unopened pesticide containers.
- Select transportation routes to minimize the impact of a potential spill on water quality.
- Never leave pesticides unattended.
- Keep the emergency number for reporting spills handy; call **1-800-943-0003**.

Storage of Pesticides

If you store pesticides, you must protect and secure the area to keep out unauthorized people and animals. Also, post signs that clearly indicate you store pesticides in the building. Read and follow the storage statements on the label.

- Locate pesticide storage facilities at sites that minimize the possibility of impacts on water quality in case accidents or fires occur. Locate the facility down wind and downhill from sensitive areas such as houses, play areas and livestock facilities.
- Select unloading and operational storage locations where spills resulting from accidents or vandalism will not have impacts on water quality.
- The storage facility should be well lit so you can read the label and detect any leaks, and should be well ventilated so fumes do not accumulate. The floor of the building should be sealed cement and sloped to a small basin or sump for collection and recovery of any spills. The basin or sump should be integral to the cement floor, i.e., no seams. The basin or sump should be large enough to contain the contents of the largest container in storage. Insulate the facility to keep the temperature between 40°F and 100°F. Keep the area well-ventilated by installing an electrically-shielded, exhaust-type, ventilating fan. Put up "no smoking" signs, and let the fire department know the storage area's location and contents. Keep a shovel and absorbent material (e.g., cat litter) in the storage area for use in containing spills. A clean water source should be available for washing skin and/or flushing eyes. Emergency phone numbers should be posted by each entrance.
- Avoid storing pesticides for extended periods of time. The shelf-life of a pesticide is hard to predict. To prevent deterioration, mark each container with its date of purchase and use older products first; buy only what you need.
- Store only pesticides and pesticide equipment in storage facilities. Never store pesticides with food, feed, seed, plant propagation material, fertilizers, veterinary supplies, or personal protective equipment.
- ATCP 33, the Bulk Pesticide Storage Rule, must be followed if liquid containers larger than 55 gallons, or solid pesticides in undivided quantities greater than 100 pounds, are stored.

Emergency Planning and Community Right-to-Know

- The federal Emergency Planning and Community Right-to-Know Act and the Wisconsin Superfund Amendments and Reauthorization Act (SARA) provide guidance for communities to prepare responses to accidental releases of chemicals listed as extremely hazardous substances. OSHA and SARA maintain lists of substances considered extremely hazardous. Some pesticides appear on these lists.
- The EPA also prepared a list of extremely hazardous substances and their threshold planning quantities (TPQs). If you use or store any listed substance in a quantity at or greater than its TPQ at any one time, you must contact the State Emergency Response Board and your local emergency planning committee. The local committee should assist you in preparing a facility site plan. Employers who are subject to OSHA's right-to-know law are also subject to community right-to-know reporting requirements.
- For a complete list of extremely hazardous substances or for more information regarding the Emergency Planning and Community Right-to-Know Act, contact the Wisconsin Emergency Management Agency at **608-242-3232**.

Mixing and Loading Operations

The hazard involved in mixing and loading pesticides requires you work with at least one other person. Wear personal protective equipment listed on the product label. If there are no specific instructions, wear at least a chemical-resistant apron and gloves, protective eyewear, long-sleeved shirt and pants.

BMP: Mixing and Loading Operations

- Mix and load pesticides outside of riparian management zones and, where practical, in upland areas.

- Review the label before opening the container to ensure familiarity with current use directions.
- Exercise care and caution during mixing and loading of pesticides.
- Do not fill/clean pesticide equipment where pesticide might enter a well or surface water, or where rising water could flood the filling/cleaning site.
- **It is illegal to fill pesticide equipment directly** from waters of the state other than from public water supplies or private wells fully protected against back-siphonage either by an air gap or other equivalent protection device. Protect your water supply from contamination by using an air gap or an antisiphoning device.
- Comply with spill containment surface requirements if you mix, load or transfer more than 1,500 pounds of active ingredient at one site in a calendar year, or if you do so within 100 feet of a well or surface water.
- Do not mix or load pesticides within eight feet of a well or surface water under any circumstances.
- Fill a tank from surface water if the tank is used for water only; **no pesticide container should come within eight feet of any surface water**.
- Replace the pour caps, and close bags or other containers immediately after use.
- Transport and store hoses used to fill pesticide application equipment in a manner that prevents direct contact with pesticides, gasoline or oils, or surfaces on which these substances have been spilled.
- Do not leave a spray or mix tank unattended while it is being filled.
- Triple-rinse all empty plastic and metal pesticide containers, and add the rinse water to the spray solution. You can use the rinsate in a future mix provided the pesticide in the rinsate is labeled for the site, and the final mix does not exceed label rates.

(WDNR, Jeff Martin)

Figure 14-4: Triple-rinse all containers and measuring cups, and add rinse water to the spray solution.

Pre-application Activities

Ensure that pesticide applicators are properly licensed in the appropriate category by the Wisconsin Department of Agriculture, Trade and Consumer Protection when a license is required – see the resources at the end of this chapter for more information.

- Refer to and follow label directions before applying a pesticide.
- Mark the boundaries of the area for treatment.
- Protect vegetation that is part of a cultural resource (such as historic homestead sites) if it will be impacted by herbicide applications.

Timing and Weather Considerations

BMP: Timing and Weather Conditions

- Apply chemicals only under favorable weather conditions.

Figure 14-5: Apply chemicals with the right equipment during calm weather to avoid unwanted drift. Band or spot applications, seen above in a walnut plantation, are preferred to broadcast spraying.

- Avoid applying pesticides when the likelihood of significant drift exists. Use a drift control agent when appropriate.
- Consider applying pesticides near dawn or dusk, when wind speeds are generally lowest.
- Follow the directions on the label that tells you not to spray when the wind speed is above a certain threshold.
- Limit broadcast applications (both aerial and ground) to appropriate temperature and relative humidity conditions. High temperatures enhance loss of volatile pesticides and the rate of evaporation of droplets. Relative humidity also influences the rate of evaporation, with the rate increasing with decreases in humidity. Rain can also prevent successful application.

Applying Pesticides

BMPs: Applying Pesticides

- Check all equipment for leaking hoses, connections and nozzles to prevent chemical leaks from equipment.
- Calibrate spray equipment to apply chemicals uniformly and in the correct quantities.
- Follow all EPA label instructions on containers.
- When conducting aerial applications:
  - Hire a licensed aerial applicator.
  - Identify and avoid riparian management zones and surface water to prevent chemicals not labeled for aquatic use from drifting over open water or from accidentally being applied directly on the water.

- Read and follow all label directions carefully prior to using any pesticide. The pesticide label is the information printed on or attached to the pesticide container or wrapper. The label and supplemental labeling are legally binding documents; you must follow them explicitly.
- Employ the lowest reasonable equipment pressure when applying pesticides.
- Select a nozzle type that produces the largest drops at a given rate and pressure appropriate to the chemical being applied.
- Avoid applying pesticides on ephemeral ponds unless that application is part of the management objective. If unable to avoid pesticide use in these areas, select only pesticides labeled for aquatic use when water is present at the time of application. Select pesticides labeled for wetland use when the water table is near the surface.

- Avoid broadcast application methods within riparian management zones (RMZs). Appropriate treatments within RMZs include:
  - Use of pesticides labeled for aquatic use
  - Manual or mechanical treatments
  - No treatment
  - Spot, banded, stump, basal bark, frill/hack and squirt, or injection treatments
  - Use of less soil-mobile pesticides
  - Increasing filter strip width when using toxic to highly-toxic insecticides

- **Applicator Certification/licensing Requirements:** Pesticide Applicator Training (PAT), provided by the University of Wisconsin-Extension, provides the training and certification to people who want to mix, load, supply, or direct the use of restricted-use pesticides. Only a certified applicator may work with restricted-use pesticides. PAT is also recommended for any person working with pesticides. Participation in this program, certification and licensing may be required for person's involved with pesticides, depending on the activities planned. Contact the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) (see the Resource Directory) to determine whether or not you need to be certified or licensed.

- **Other Training Requirements:** Employees covered by the Worker Protection Standard (WPS) include agricultural workers and pesticide handlers who work in farms, forests, nurseries or greenhouses (other than members of an agricultural owner's immediate family). Workers covered by WPS must be trained on general pesticide safety principles every five years. This training may be obtained through PAT or training programs in compliance with the EPA.

Protecting Water Resources

Pesticides spilled or applied to the surface of the land can be carried or leached down to groundwater by water moving through the soil. Pesticides can also reach surface water in runoff or in contaminated groundwater that is discharging to surface water. **ATCP 29 and 30** outline Wisconsin's DATCP regulatory program for the prevention and control of groundwater and surface water contamination. **Chapter NR 140** also contains rules that the Wisconsin DNR has written to govern groundwater protection.

- Avoid applying pesticides directly to water except where the pesticide is specifically labeled for application to water. When the pesticide does not have a full aquatic label, avoid riparian management zones, filter strips or shade strips and other reserve areas adjacent to all streams, lakes, wetlands, and ditches that contain water at the time of application. Always refer to the label to determine legal use and application.

- Prohibit aircraft transporting pesticides from crossing open water where practical. Aircraft also should not fly down the course of any recognizable stream. Where stream crossings cannot be avoided, they should be made at right angles to the stream course. Chemical application should be shut off during turns and over water.

- Select potential heliport or helipad locations with consideration for two conditions that could affect water quality: 1) flight patterns in relation to waterbodies; and 2) locations adjacent to waterbodies.

BMPs: Protecting Water Resources

- Use chemicals in riparian management zones with guidance from a trained natural resource professional.
- Use spot-injection or stump treatment methods when applying chemicals not labeled for aquatic use in riparian management zones.
- Avoid applying herbicides in areas where the chemicals can kill stabilizing vegetation on slopes, gullies and other fragile areas subject to erosion that drain into surface water.

POST-OPERATIONAL ACTIVITIES

Equipment Clean-up and Container and Waste Disposal

BMP: Equipment Clean-up

- Rinse spray equipment and discharge rinse water only in areas that are part of the application site.

BMP: Container and Waste Disposal

- Dispose of chemical containers according to label instructions.

Figure 14-6: Use only properly maintained spraying equipment that has been checked for leaks. Make sure the nozzle type produces the largest drops at a given rate and pressure appropriate to the chemical being applied.

The federal government regulates the disposal of pesticide waste under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the Resource Conservation and Recovery Act (RCRA). In Wisconsin, the Wisconsin DNR further regulates such disposal under Administrative Codes NR 500 series and NR 600 series.

- Clean equipment on a concrete pad with a collection basin and tanks to hold rinsewater. Use the rinsewater for preparing future mixes for a labeled site. Never clean in areas where pesticide residues will enter streams, lakes, wetlands, or groundwater.
- Rinse mixing apparatus at least three times. Apply rinsate in spray form to the area to be treated, being sure not to exceed label recommendations.
- Rinse all empty plastic and metal pesticide containers three times, and add the rinsewater to the spray solution. To properly triple-rinse containers:
  - Empty the pesticide into the spray tank and allow the pesticide container to drain.
  - Fill the container 10 to 20 percent full with water (or solvent, in some cases), rinse, and pour the rinse water into the spray tank.
  - Repeat the previous step two more times, and apply rinsate to the spray site.
  - Apply all leftover solutions and rinsates to the treatment area, being sure not to exceed label recommendations.
- Puncture and flatten containers not intended for return to the manufacturer.
- Refer to the product label for additional information on proper disposal.
- **It is illegal to bury or burn any pesticide containers in Wisconsin.**
- Dispose of triple-rinsed containers in one of four ways:
  - Return them to the dealer for reuse or refilling.
  - Recycle them through the Wisconsin Fertilizer and Chemical Association Plastic Pesticide Container Recycling Program.
  - Bring them to a county Pesticide Clean Sweep program.
  - Dispose of them at an approved landfill.

FOREST CERTIFICATION

When working on forestland that is enrolled in a forest certification system it is important to understand which standards apply and how to implement them. All forest certification systems require compliance with state and federal regulations that govern the use of pesticides. Additionally, some forest certification systems may not allow the use of certain pesticides, regardless of the label recommendations. Note that pesticide certification, which is governed by the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP), acknowledges that a certified pesticide applicator has received the relevant training to apply pesticides. This pesticide applicator certification is entirely different from a forest certification system that provides standards that the land manager must comply with to maintain forest certification. A certified pesticide applicator is licensed by the Wisconsin DATCP to use any pesticide determined to be appropriate for the site and that is labeled for the pest targeted for control. However, this does not mean that the pesticide being applied is acceptable under the standards of the forest certification system.

Figure 14-7: Band spraying reduces the amount of herbicides used for site preparation and maintains ground cover in between the rows.

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

ENVIRONMENTAL PROTECTION AGENCY

www.epa.gov/pesticide-registration

INFORMATION ON HIGHLY HAZARDOUS PESTICIDES

ic.fsc.org/en/our-impact/program-areas/forest-program/pesticides

INFORMATION ON PESTICIDE LABELS

www.cdms.net/Label-Database

INFORMATION ON WORKER PROTECTION STANDARD (WPS)

npic.orst.edu/reg/wps.html

TO REPORT PESTICIDE SPILLS

Contact the Wisconsin DNR at 1-800-943-0003.
dnr.wi.gov – keyword "spills"

WISCONSIN DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION (DATCP) PESTICIDE DATA BASE SEARCH SITE

www.kellysolutions.com/wi/

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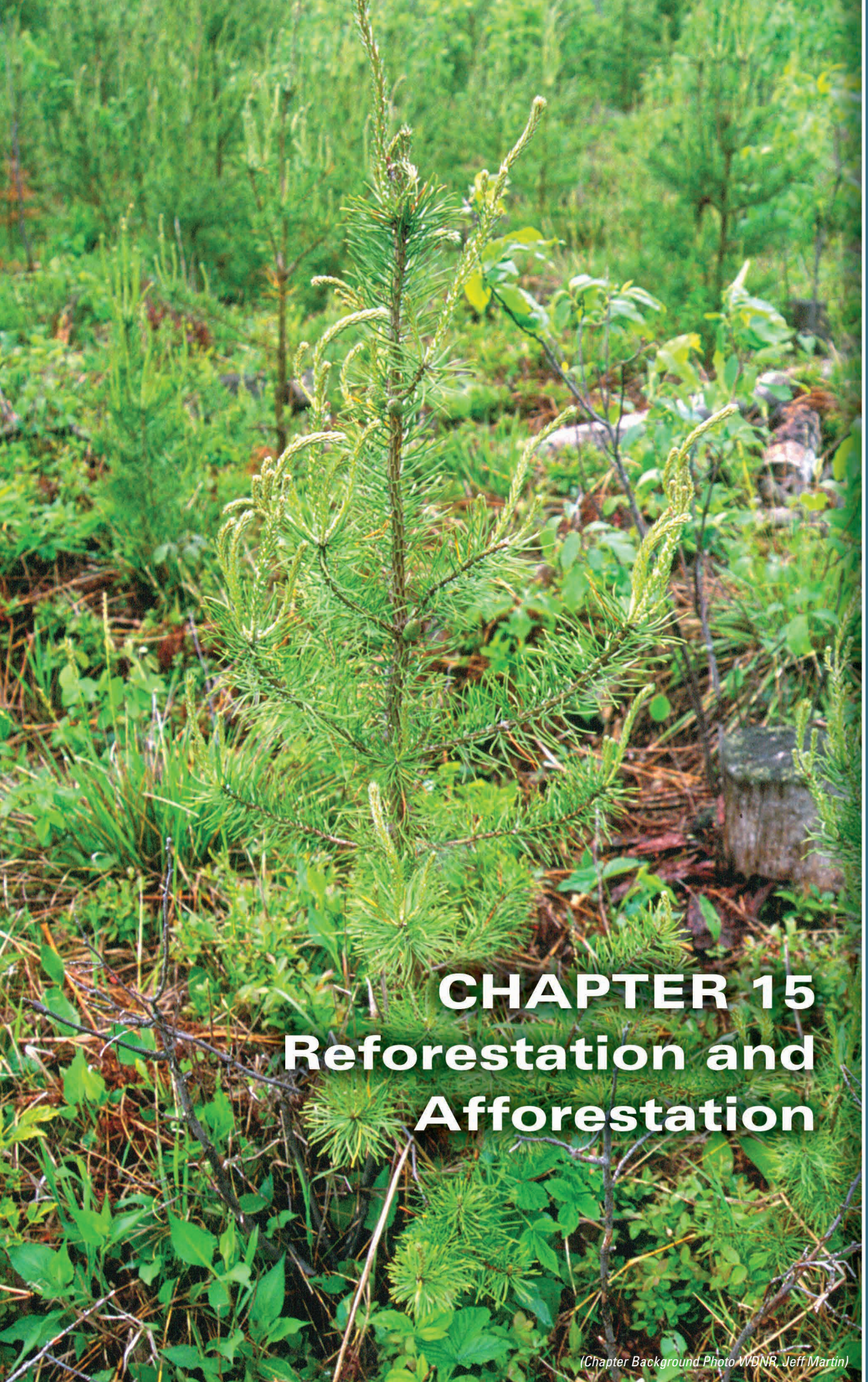


CHAPTER 15
Reforestation and Afforestation

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 15
REFORESTATION AND AFFORESTATION

Reforestation is the practice of regenerating and growing healthy trees on previously forested sites. Reforestation can include both natural and artificial methods.

- **Natural regeneration methods** include root suckering, stump sprouting, or natural seeding as a result of the application of one of the silvicultural systems as described in Chapter 2: Generally Accepted Silvicultural Principles.
- **Artificial regeneration methods** include aerial and ground seeding, or planting seedlings and cuttings by hand or with a planting machine.

This chapter provides an overview of the planning, design, site preparation, and planting methods needed to successfully establish forest stands in Wisconsin.

Integrated Resource Management Considerations

- A written reforestation plan will increase the likelihood of success by clarifying all of the site preparation and planting details, and the measures needed to minimize any impacts on other important resources.

AFFORESTATION

The practice of planting and seeding trees to create a young forest on non-forested land such as a fallow agricultural field.

TYPE CONVERSION

Changing the dominant species composition of a forest from one forest cover type to another.

RESTORATION

The process of reintroducing and maintaining native flora on a given site.

- Landowners should analyze their available budget, time constraints, and access to reforestation resources (e.g., nursery stock, equipment and labor) when considering a reforestation project. **A realistic budget must account for the cost of establishment and follow-up care,** such as controlling competing vegetation. Many plantings fail or have less than desirable results due to inadequate planning or to limited capital assets needed to support establishment of a fully stocked forest. Cost-sharing programs are available to assist landowners in completing reforestation efforts. More information on cost-sharing can be found at: ***dnr.wi.gov – keyword "WFLGP"*** or by contacting your local DNR forester.
- Species selection, site preparation and planting methods, and plantation design can affect 1) visual quality, 2) the degree of soil disturbance, and 3) wildlife habitat values.
- When planning and performing mechanical or chemical site preparation in advance of establishing a new stand, maintaining good soil conditions is critical. Practices that result in excessive soil exposure, compaction, rutting, or removal of surface soils may reduce tree survival and growth, or create the need for additional treatments. Site preparation methods, timing and intensity should be evaluated for potential soil erosion and impacts on soil productivity.
- Reforestation considerations should be evaluated as part of any harvesting plan when managing stands at or near rotation age.
- Protection of cultural resources may require modification of reforestation efforts.
- Endangered, threatened and special concern species can be impacted by reforestation projects.
- Consider the impact planting trees can have to non-forested natural communities (e.g., fragment open landscapes, provide predator habitat).

Figure 15-1: Artificial regeneration methods include machine planting which is quite appropriate when old farm fields are planted, in this case, to red pine.

Figure 15-2: Natural regeneration methods, like the shelterwood harvest that resulted in these young red oak seedlings, are described in Chapter 2: Generally Accepted Silvicultural Principles.

PLANNING AND DESIGN

Setting Goals

The first step in planning a reforestation or afforestation project is to evaluate how it relates to both short- and long-term landowner goals. Such goals might include producing income from timber, improving habitat for specific wildlife species, restoring a natural plant community, reducing soil erosion, improving water quality, or enhancing the aesthetics of the land. **Remember that many goals are compatible with each other, allowing a single forest planting to serve multiple purposes.**

Site Evaluation

Planning reforestation or afforestation activities begins with evaluating the planting site. Knowledge of likely limiting site factors such as soils, existing vegetation, topography, wildlife browse damage, presence of invasive species, fire risk, and productivity potential will aid in selecting suitable species, preparing the site, and prescribing post-planting management practices.

CLIMATE

Tree species are adapted to a specific range of climatic conditions. Since Wisconsin has a wide range of climates, our state hosts a wide variety of native tree species (some with wide habitat ranges and others with narrow soil or climate preferences). Therefore, it is important to select species that are adapted to the climatic conditions of the planting site. For example, several species reach the northern limit of their range in Wisconsin. Species like black walnut are limited to the southern portion of the state by climatic factors such as minimum winter temperature. Other climatic factors to consider when initiating a plantation are timing and amounts of precipitation, the potential for ice storms and snow loads, and risks associated with early or late frosts (see 6.4).

SOILS

Soil properties affect the moisture and nutrients available for tree growth. Therefore, a careful analysis of the soil characteristics and uniformity is a critical step in selecting trees species that are well-adapted to the planting site. The USDA Natural Resource Conservation Service's (NRCS) soil survey information is available online and can be used to better understand the site's soil characteristics and to match tree species with appropriate soils. The NRCS Web Soil Survey can be found at: ***websoilsurvey.nrcs.usda.gov/app***.

If possible, examine the soil to a depth of two to five feet with a test hole or auger, paying particular attention to:

- Soil texture – is it too coarse or sandy?
- Organic matter – how much is present?
- Depth of topsoil – what is the available rooting depth?
- Parent material – is high or low soil pH a potential problem?
- Available moisture – is there adequate organic matter in the soil?
- Internal drainage – does water drain freely or puddle following rain?
- Nutrients – does current vegetation appear lush or chlorotic?
- Bulk density – is the soil compacted or have a hard pan due to past land use?
- Erosion patterns – has original topsoil been heavily eroded?

A careful soil examination is the best way to evaluate the potential of any site to support tree growth. Site quality is almost impossible to change significantly once trees are planted, so a careful assessment of soil and site characteristics is essential. Some nutrient deficiencies can be adjusted with fertilizers and other soil amendments but such treatments are expensive and logistically challenging. Soil uniformity can also be checked so that species recommendations can be customized to fit the site. Alternative methods of soil evaluation include the use of published soil surveys, and completion of soil lab analysis. Soil survey reports and/or soil maps offer a general assessment of landscape soil features, but may not be sufficiently detailed to help with small plantings. Also, older soil surveys may not reflect current conditions if intensive agriculture or other development has reshaped the local soil resource. A soil lab analysis provides information on selected soil properties, and can identify possible nutrient deficiencies. For information on how to submit soil samples for testing to the University of Wisconsin Soil and Forage Lab visit: ***uwlab.soils.wisc.edu***.

COMPETING VEGETATION

Existing and potential vegetation will compete with young seedlings for moisture, nutrients and light. **Not all vegetation is alike in its ability to compete with young trees,** and must be evaluated in order to determine the timing and extent of appropriate control measures. Vegetation existing on the planting site is an obvious consideration, but other plants that regenerate readily from dormant seeds or from well-established root systems also pose potential problems. The types and amounts of competing (or potentially competing) vegetation (native and nonnative) must be considered when selecting appropriate planting stock, site preparation treatments and maintenance activities. Nonnative invasive plants are typically more aggressive than other undesirable plants and may require more effort to control (see 3.2, 6.1 and 6.5).

TOPOGRAPHY

Elevation, slope, aspect (north, south, east or west), and surface drainage affect the local environmental conditions of a planting site. For example, northern aspects generally have lower evaporation rates, and therefore, greater available soil moisture to support plant growth. Topographic affects may influence more than just growth potential. Occurrences of white pine blister rust can be worse in certain landscape positions (e.g., certain drainage channels, or some ridges) where humidity and the aerial movement of spores increase.

PRODUCTIVITY

Site productivity is the capacity of a site to yield a given forest product in a specified period of time, and has traditionally been measured as gross volume per acre per year. Evaluation of productivity levels will help in the selection of species that will exhibit optimal growth on the planting site. Productivity can be evaluated in several ways:

- **Site Index:** Examining the growth rates of existing or adjacent forest trees.
- **Habitat Type Classification:** Using other plant community information.
- **Site Productivity History:** Examining the records of past yields or performance.
- **Soil Surveys:** Using soil information to project stand growth rates.

Some of these measures are indirect, and provide estimates of potential productivity rather than precise measurements. Keep in mind that productivity generalizations from one species to the next vary greatly – what may be viewed as adequate productivity for one species may prove to be inadequate for others.

Figure 15-3: Promoting a mixture of species encourages and maintains diversity – which also provides wildlife habitat diversity – and the positive visual impact of a natural-appearing landscape.

LANDSCAPE POSITION

The benefits of a forest planting can be enhanced if it is compatible with and complimentary to the surrounding forest cover types and ecological communities. Examine the broader landscape within a one to five mile radius or larger to assess existing cover types, habitat needs, and management trends. For example, tree planting may be used to establish mast-producing species, such as red oak, in areas where the oak resource is declining due to natural succession or species conversion. Alternatively, past development practices may have fragmented a landscape that can now be coalesced via a successful planting. Regenerating a stand in a fragmented landscape will require different considerations than a site that is within a primarily forested landscape.

INSECTS, DISEASES AND ANIMALS

Insects, diseases and animals can have locally devastating impacts on young plantings, and hamper reforestation success. Proper site evaluation must include an assessment of these risks. The key to recognizing potential pest or predation problems is to examine the following:

- Site history – were earlier forest stands disease or predation prone?
- Current conditions - are insect or disease populations present in residual trees, in the soil or on decaying woody material that pose a threat to regeneration?
- Vulnerability of tree species to browse – is there a high deer population? Does the species being planted have a history of browse problems?
- Population trends – are new pests/pathogens present that influence the survival of regeneration?
- Evidence of alternate hosts on the planting site – are site conditions conducive to problems?
- Vulnerability of tree species to infection based on site characteristics – does the preferred reforestation species have a history of pest/predator problems?

Timing site preparation and regeneration activities to avoid invasive insect and disease issues is critical to the survival of regeneration.

SUCCESSION

Forest plantings can have long-term effects on the landscape. Planted species may begin to regenerate naturally, affecting the future species composition on the current and nearby sites. Landowners may wish to purposely introduce a seed source into a new planting, in the expectation that it will create natural regeneration opportunities at stand rotation. A mixed red and white pine plantation that has developed an understory of white pine seedlings is a good example of the long-term effects of seed source introduction. Or a planting can help provide shade-intolerant or mid-tolerant species (e.g., jack pine, white birch or northern red oak) that are being lost to natural succession in the landscape around the site.

ENDANGERED RESOURCES

Endangered, threatened and special concern species can be impacted by site preparation activities, by altering the existing vegetation, or by introducing new species. Perform a Natural Heritage Inventory (NHI) screening prior to reforestation activities in order to identify and address potential impacts. You may need to alter your choice of species or regeneration technique (see Chapter 3: Wildlife Habitat and Biodiversity for more information on NHI).

Planting Design

A planting design will provide specific details for the creation and management of a planting including acreage, species, number of trees, spacing, row alignment, nursery stock type, arrangement, site preparation and planting method, layout of roads and firebreaks, and any post-planting cultural treatments. A written reforestation plan and map should be developed to help clarify all these details, and facilitate any modifications prior to planting. A plantation map can help show precise planting locations, species arrangement, and access roads. Maintaining records of treatments is valuable to future landowners and managers as they evaluate future stand treatments.

A planting design is directly tied to a landowner's goals, and the resources and capabilities of the planting site.

EXAMPLES OF GOALS AND THEIR ASSOCIATED DESIGN CONSIDERATIONS

Timber Management

- Match species with potential future market demands and opportunities.
- Provide equipment access for release, thinning, pruning, and harvesting.
- Include harvest roads and firebreaks.
- Manage to encourage and maintain tree species diversity. Add species that will create future natural regeneration opportunities.
- Leave space around power lines, underground cables and gas lines.
- Avoid steep slopes and wet areas.
- Provide closer spacing of hardwoods to improve sawtimber quality by limiting branch size and persistence.
- Reserve an open area to use periodically for storage of cut forest products and equipment when harvesting occurs.

Aesthetics

- Use a variety of species, including wildlife shrubs.
- Use non-row plantings, curved rows and irregular edges for a more natural effect.
- Plant species with desirable fall color.
- Leave openings or islands of various sized and aged trees.
- Retain landmarks and distinct features.
- Create or retain scenic views.
- Locate trails or roads to take advantage of scenic quality.

Wildlife Management

- Enhance biological diversity and complement habitat in the surrounding landscape, especially habitats that benefit Species of Greatest Conservation Need.
- Offer habitats that are in locally short supply.
- Choose species which provide preferred food for desired wildlife, unless browsing will negatively impact establishment of trees.
- Establish or expand wildlife travel corridors so they connect habitats.
- Create irregular boundaries for more habitat options.
- Enhance interior forest habitat by planting artificial openings, such as isolated fields.
- Plant around existing "wolf" trees.
- Leave frost pockets and odd corners unplanted to improve habitat variety.
- Leave wildlife openings.

Erosion Control

- Establish forested or grass buffers (or riparian management zones) near lakes, streams and wetlands to help slow runoff and prevent siltation.
- Plant trees along contours to help control runoff.
- Leave drainage pathways covered in grass.
- Concentrate trees in "problem" areas.
- Plant long-lived tree species in riparian management zones.
- Plant highly erodible upland fields to decrease runoff.

Species Selection

The tree species selected for reforestation and afforestation must be compatible with the landowner's management goals, and biologically-suited to the planting site. After determining the potential advantages and limitations of the planting site, select a species or combination of species that emphasize the advantages and overcome the limiting factors. Consider the following (see also 6.4):

- Site requirements, especially soil factors and habitat type.
- Climatic suitability, both short- and longer term (i.e., 75 to 100 years or more into the future).
- Potential growth rate on site.
- Compatibility of growth rates in mixed species plantings.
- Sunlight requirements.
- Potential competition problems.
- Potential for herbivore browse damage as well as insect and disease problems.
- Wood and fiber properties and potential markets.
- Encourage and maintain tree species diversity. Add species that will create future natural regeneration opportunities.
- Timber, wildlife, erosion control, and aesthetic values.

Detailed information on individual tree species' characteristics is available in the Wisconsin DNR *Silviculture and Forest Aesthetics Handbook, 2431.5*. The handbook can be found at: ***dnr.wi.gov – keyword "silviculture."***

Figure 15-4: Successful planting requires vigorous seedlings of sufficient size with a healthy root system. Notice the invasion of celandine in these woods. The plantings will survive competition with celandine; however, natural regeneration may be hindered. The invasive plant should be considered in management plans.

Spacing

Initial spacing will affect both the productivity and the management of a plantation. The choice of spacing will depend on the species selected, product desired, need for and intensity of intermediate stand treatments, expected initial survival, and cost.

Height growth can be reduced at extremely high or low densities. Fortunately, the most commonly used tree planting densities fall within a range that does not reduce dominant tree height (see Table 15-1). In Wisconsin, commonly recommended planting densities range from 500 to nearly 1,000 seedlings per acre.

Generally, for quality hardwood tree production, choose a closer spacing to encourage straight boles, and small, lower branches that self-prune easily. Hardwood plantings for wildlife purposes can use wider spacing to encourage crown development and earlier seed production. Note that plantation spacing requirements may be specified by some cost-sharing and tax law programs.

	4′	5′	6′	7′	8′	9′	10′
4′	2,722	0	0	0	0	0	0
5′	2,178	1,742	0	0	0	0	0
6′	1,815	1,452	1,210	0	0	0	0
7′	1,556	1,244	1,037	889	0	0	0
8′	1,361	1,089	908	778	681	0	0
9′	1,210	968	807	691	605	538	0
10′	1,089	871	726	622	545	484	436
12′	907	726	605	518	454	403	363
15′	726	581	484	415	363	323	290

Table 15-1: Number of trees per acre by spacing (in feet).The blue numbers represent the more commonly recommended spacings for reforestation purposes.

ADVANTAGES AND DISADVANTAGES OF WIDE AND CLOSE SPACING

Wide Spacing Advantages

- Planting costs are less.
- Increased tree diameter growth rates.
- Trees may produce greater quantities of seed/mast at an earlier age.
- Increased understory growth will provide wildlife food and habitat, and increased plant species diversity.

Wide Spacing Disadvantages

- Increased vegetation competition and maintenance.
- Reduced stem quality due to larger branch diameter, and longer branch retention.
- Fewer crop tree choices.
- Increased fire hazard.

Close Spacing Advantages

- Faster crown closure which shades the understory resulting in less vegetation competition and maintenance.
- Partial mortality less likely to result in understocked conditions.
- Potential to reduce size and persistence of branches on lower bole.
- Reduces ladder fuels and fire hazard for some species.
- Large wood volumes accumulate in early years.
- Greater number of trees to select from during thinning operations and more crop tree choices.

Close Spacing Disadvantages

- Increased site preparation, planting and seedling costs.
- Early timber stand improvement may be needed to reduce crown competition.
- Access during initial thinning operations may be difficult.
- May lead to weaker boles and potential for stem bowing or damage due to heavy snows or ice if initial thinnings are delayed.

Planting Arrangement

Planting arrangement refers to the pattern or distribution of tree and shrub species across a planting site. The arrangement of species may be varied to match topographic features, changing soils or site conditions. For example, a mixed hardwood plantation may concentrate black walnut seedlings on the deeper topsoils of the lower slope, and place red and white oak seedlings near the ridge tops and convex slopes. The arrangement should also consider the growth characteristics and compatibility of species planted next to each other. For example, due to the fast juvenile growth of shagbark hickory, an alternating pattern with red oak or black walnut may result in suppression of the hickory. One solution is to group the species within the planting to minimize problems associated with very different juvenile growth rates.

Conifer and hardwood mixtures have been recommended for afforestation in Wisconsin. The benefits of these conifer-hardwood mixtures include:

- Conifers assist in early crown closure and capturing the site.
- Cost of plantation establishment is less than for a pure hardwood plantation.
- Conifers improve the quality of hardwoods by shading out lower branches, and forcing hardwoods to grow straight.
- Conifers provide wind protection and offer an easy alternative for a first thinning.
- Conifers reach merchantable size faster and may help provide earlier income than a pure hardwood planting.
- Increased species diversity and future natural regeneration opportunities.

Figure 15-5: In addition to other benefits, mixtures of hardwoods – planted here in tree shelters – and conifers may be more resistant to insect and disease pests than monocultures.

One disadvantage to this mixture is that, once established, the options for chemical release of the plantation are more limited than pure conifer plantings. **Initial site preparation treatments are critical for successful conifer-hardwood plantations.** In addition to making future thinning more difficult, alternate row plantings may encourage increase browsing of the hardwoods, as the conifers offer concealment for deer.

Mixed conifer plantings have become more common, typically mixing red and white pine together either in single species rows or randomly mixed during planting. Other mixed conifer species planting include spruce and tamarack or white cedar.

Interplanting is the practice of planting new seedlings between or among existing forest growth. Sometimes forests fail to regenerate as expected after a harvest, and interplanting provides a way to supplement natural regeneration. The planting arrangement in this situation will depend on an evaluation of the number, size and spatial distribution of desirable advanced reproduction. Do not forget to factor in the contribution of stump or root sprouts to fill all or part of the reproduction deficiency. Interplanting is almost always accomplished by hand planting. Interplanted trees will be in competition with other vegetation so their success can be measured against the growth of dominant competing vegetation. Generally, larger sized seedlings (e.g., 2-0 or 3-0 hardwoods and 3-0 or transplant conifers, see "Planting Stock Age Classes – What Do Those Numbers Mean?" sidebar on page 15-13 for clarification) are needed to compete with the advanced reproduction and sprouts. These types of plantings generally require some type of release early in the establishment phase.

Underplanting is similar to interplanting but is done prior to the final harvest of a mature forest stand in an attempt to establish a species desired in the next forest stand. Often aesthetic concerns adjacent to important visual travel corridors prompt this effort. Underplanted species must be able to tolerate shade for several years until established and the overstory is removed. Attempt to limit damage to planted trees when the overstory is removed. An example is underplanting white pine in an oak stand adjacent to a major road right-of-way with the intent to develop a white pine understory that will provide some visual relief when the oak harvest is scheduled.

Direct Seeding Versus Seedlings

One of the initial planning decisions when planning artificial stand regeneration is whether to plant seeds or seedlings. Each method has advantages and disadvantages in terms of ecology, site preparation needs, operational logistics, and expense.

The advantages of direct seeding include:

- Less expense for conifer plantings or small areas.
- Applicable on difficult terrain or shallow soils.
- Good root development with no transplant shock.
- Potential for a more uniform stocking than in a naturally regenerated stand.
- Natural stand appearance; no rows or uniformly spaced trees.
- Improved hardwood stem quality in high density plantings.

Direct seeding is often times not successful due to improper planning or inadequate germination conditions. Many factors influence seed germination, and careful planning is critical in highly variable field environments.

Other disadvantages include:

- Necessity for intensive site preparation and follow-up competing vegetation control.
- Difficulty controlling stand density.
- Greater costs for hardwoods depending on the quantity of seed used.
- Small planting areas may be subject to heavy seed predation.
- Hardwood seed production is unpredictable and highly variable in most years and does not store well.

Proper seed collection, handling and storage are critical to the establishment of direct seeded plantations. Seed collected during an abundant seed year is usually higher quality, especially if mature seeds are collected just before, or simultaneously with, seed fall. Always consider seed source by collecting from quality trees that are within 200 miles of the planting site, or from sources that have proven performance through genetic testing. Properly store, stratify and treat seed to maximize germination rates. For additional seed handling information on particular species, refer to the *USDA Forest Service Woody Plant Seed Manual* found at: ***www.fs.usda.gov/nsl/nsl_wpsm.html***.

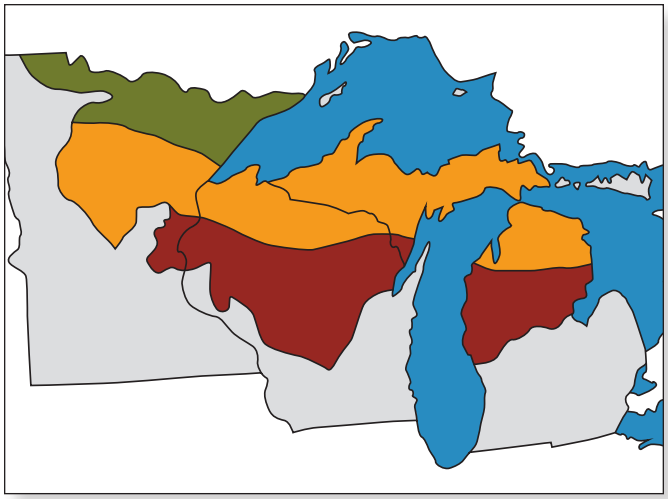


Figure 15-6: Jack Pine Seed Source Trial (20-year Results). Seed zones established for the appropriate movement of jack pine seed sources in Wisconsin. Tree performance is generally best when seed sources are kept within a particular zone. (Adapted from Jeffers and Jenson, 1980)

Figure 15-7: Interplanting spruce seedlings by hand in a harvested hardwood stand to augment natural regeneration, and provide species diversity. The presence of celandine, an invasive plant, in this stand may hinder natural regeneration and should be considered during planning.

Seed Source Selection

Seed source is an often overlooked but critical component in a successful reforestation program. **Selecting appropriate seed sources will improve the overall productivity of the plantation, since the trees will be adapted to the environment of the planting site.** Appropriate seed source selection will also reduce catastrophic plantation losses due to poorly adapted genetic material. Poorly adapted seed sources can survive and grow for many years, until an environmental event, such as an early frost or extremely cold winter, results in catastrophic losses.

Local seed sources (e.g., Wisconsin) are the most appropriate unless proven otherwise through genetic testing. For example, genetic testing has revealed that southern Ontario white spruce sources are well-adapted to Wisconsin's environmental conditions, and also offer improved growth rates over local sources. Tree improvement efforts by the Division of Forestry and other agencies continue to examine seed source performance across Wisconsin in order to identify appropriate sources and seed zones (see Figure 15-6). Advanced tree improvement practices include 1) the establishment of seed production areas to facilitate the collection of seed from quality native stands, 2) the establishment of progeny tests where individual families are tested and selected for high performance, and 3) seed orchards for the production of high quality seed with superior genetic potential.

Planting Stock Type Selection

Selection of the best nursery stock type for a given situation depends upon the identification of planting site factors that influence seedling establishment and early growth. Consider the relative advantages and disadvantages of containerized versus bare-root stock versus cuttings in order to select the planting stock that will meet the landowner's goals, and overcome any limiting factors of the planting site.

Containerized stock is usually less than one-year-old and is grown, shipped and planted in a soil "plug" of peat, perlite (or vermiculite) and sand. Usage in the Lake States has been restricted primarily to conifer seedlings, but recent advances in pot sizes have allowed some production of containerized hardwoods. The advantages of containerized stock include the fact that seedlings can be grown in six to 15 weeks, they have high survival rates, superior initial height growth, more uniform size, and good plantability, especially on rocky sites where it may be difficult to open a large hole for bare-root seedlings. In addition, these seedlings are less likely to experience transplant shock since the tree is planted in the rooting medium, and the process makes more efficient use of seed. Finally, containerized stock extends planting seasons, and seedlings can perform well on adverse sites. Containerized seedlings also are more resistant to heat and drying stress, so transportation and storage are less problematic. Containerized stock, however, is more expensive than bare-root stock, more bulky to transport and handle, less able to compete with weeds, susceptible to deer browse, prone to frost heaving when planted on bare mineral soil, and often smaller in size.

Bare-root stock is seeded and grown in nursery beds for one to three years, and may be moved to a transplant bed to improve root development. Conifer seedlings should have a four to six millimeter caliper, and a 2:1 shoot to root ratio (i.e, a shoot twice the length of the root). Hardwood seedlings should have good lateral root development with a minimum of five primary lateral roots (greater than one millimeter in diameter) for optimal seedling survival and growth. Advantages of bare-root stock include lower costs, ease of transportation and storage, competitive advantage over weeds, less susceptibility to deer browse, and faster root regeneration. Bare-root stock, however, takes longer to grow, can dry out quickly due to exposed roots, is prone to root damage and deformity during planting operations, and may require special planting considerations due to the larger seedling size.

Cuttings are practical for only a few tree species in Wisconsin, typically hybrid poplar, cottonwood and willow. The cuttings are typically six to 10 inch pieces of the previous year's stem growth and do not have any root development present. The cuttings or "sticks" have one to five dormant lateral buds and are planted buds-up directly into the soil. Root tissue develops on the buried cut surface and terminal growth originates from one of the buds on the cutting.

PLANTING STOCK AGE CLASSES – WHAT DO THOSE NUMBERS MEAN?

Bare-root stock is often sold using an age class designation, such as 1-0, 2-0, 3-0 or 2-1. The first numeral refers to the number of years grown in a seedbed. For example, a 2-0 designation means the tree was grown for two years in a seedbed. The second numeral refers to the number of years grown in a transplant bed. For example, a 2-1 designation means the seedling was grown for two years in a seedbed and was lifted and replanted in a transplant bed for one year (transplanting improves root development).

OPERATIONAL CONSIDERATIONS

Site Preparation

Site preparation is the creation of favorable growing conditions to encourage the establishment, survival and growth of the preferred tree seedlings. The biggest obstacle facing seedling establishment is competition from other vegetation. Effective site preparation will temporarily reduce competing vegetation, and create a sufficient number of suitable germination and growing sites without causing excessive soil disturbance. Site preparation can be accomplished through mechanical means, the use of chemicals, prescribed fire or a combination of these approaches. Select a technique or combination of techniques based on specific species regeneration requirements and site characteristics including soil, topography, vegetation, access, and distance to surface waters. Consider targeted methods (low-intensity, spot or band) and equipment that minimizes site disturbance.

MECHANICAL

Mechanical site preparation accomplishes two major goals: providing a planting site for seedlings or a microsite for seed germination; and providing initial control of the vegetation competing with the preferred tree species for sunlight, moisture, nutrients, and growing space. Mechanical site preparation typically disturbs the soil and can be accomplished by scalping, disk trenching, disking, root raking, roller chopping, furrowing/plowing, rotovating, or any other method that removes some or all of the existing vegetation from the planting site. Herbicides are often used in conjunction with or as a follow-up to mechanical site preparation. In some situations such as clay or organic soils, mechanical methods can be used to prepare soils for planting or seeding and to prevent soil cracking and frost heaving. The exposure of bare soil increases the risk of erosion and the establishment of invasive plants. Consider the nonnative invasive plants in the vicinity to get a sense of what may take hold after the disturbance (see 4.3). Each site needs to be evaluated and measures taken to minimize these risks.

There are three basic situations where mechanical site preparation is normally used. The first is to **reforest an existing forest site that has been harvested**, leaving stumps, tops and varying amounts of woody debris. These sites are normally reforested through natural seeding, hand planting, or in some cases, direct seeding. In most cases, heavy machinery is needed to create planting or seeding sites and to allow planters to move between individual planting sites. Tracked or wheeled tractors are commonly used to pull site preparation equipment. Erosion can be an issue if work is done on slopes.

The second situation for mechanical site preparation is during **afforestation of former agriculture lands**, such as cropland or pasture. An herbicide treatment is commonly recommended and may be used in combination with the mechanical site preparation methods (see pages 15-15 and 15-16). Generally, herbicide application is necessary for several years to keep grass and weeds in check until the seedlings are fully established and above the competing vegetation.

The third situation for mechanical site preparation is for **spot or interplanting of existing stands**. Trees are planted in scattered locations.

Figure 15-8: Soil scarification with a spiked anchor chain is a type of mechanical site preparation that prepares a seed bed for acorns in oak forests.

COMMON MECHANICAL SITE PREPARATION METHODS

Previously Forested Sites

- **Patch scarification** with a Bracke or Leno scarifier provides parallel rows of patches eight feet apart and six to eight feet within rows. The scarifier paddles gouge a shallow depression in the ground surface which removes vegetation and creates an exposed soil bed 12 to 18 inches in diameter where the seedling can be hand planted or seed deposited. Planting density is mechanically set by timing of paddle rotation. Sites may be treated in advance with herbicide or after planting to control competing vegetation. Scalps may be skipped or incomplete on sites with rocky soils and/or heavy woody debris. Patch scarification results in minimal soil disturbance. This method is used for site preparation for hand planting or seeding.
- **Disk trenching** produces parallel trenches eight to nine feet apart using a large diameter disk/wheel with large metal teeth. A rotating disk rakes debris away from the trench and creates a shallow planting trench in which seedlings or cuttings are hand planted at desired spacing within the row. Sites may be treated in advance with herbicide or after planting to control competing vegetation. Trenches may be incomplete or skipped on sites with rocky soils and/or heavy woody debris. Disk trenching is typically done the year prior to spring planting on non-frozen soils. This is the preferred site preparation treatment on large, tough sites following a harvest. This method is used primarily for site preparation for hand planting.
- **Straight blade scarification** of the soil to remove duff layer and reduce competing understory plants. Exposes mineral soil to provide desirable seed bed and germination conditions. Often done prior to harvest on unfrozen soils in mature jack pine stands with serotinous cones. Target one-third to two-thirds surface treatment. Leaves small mounds across the site but compaction of sands helps provide soil moisture contact for germinating conifer seeds.
- **Root/rock raking** involves using a crawler/tractor with a toothed blade to remove woody debris and rocks and reduce ground vegetation. Debris is raked into piles or windrows on the planting site either to be burned or left to decompose on site. There are potentially high impacts to soil and existing vegetation, but timing with frozen soils can reduce these impacts. Stumps may or may not be removed. Piles and windrows occupy site space and reduce acreage available for planting. This method is used for site preparation for hand or machine planting or seeding.
- **Furrowing or trenching** using a Hester plow or fire plow to produce a two to three foot wide planting/seeding space where surface vegetation has been peeled to the side. Furrows or trenches are spaced six to eight feet apart and parallel. Furrows are hand planted at spacing intervals within the furrow to meet desired stocking levels. There are potentially moderate to high impacts to the soil. For natural regeneration methods, scarification patches may be more random in size and spacing. This method is used for site preparation for hand planting or seeding.
- **Anchor chain scarifiers** are generally used to disturb the surface soil and vegetation in preparation for natural or direct seeding. This method is often used in conjunction with a natural regeneration system, such as a shelterwood or seed tree for white pine or oak. A crawler/tractor is used to drag heavy, spiked anchor chains across the site. Sites may be treated in advance with herbicide to aid in seed bed preparation. Work is typically done shortly before or during seed fall. This method is used primarily for site preparation for seeding.

COMMON MECHANICAL SITE PREPARATION METHODS

Previously Forested Sites (continued)

- **Salmon blade scarification** of the soil surface to remove duff layer and reduce competing understory plants. Exposes mineral soil to provide desirable seed bed and germination conditions. Often done prior to harvest on non-frozen soils in mature white birch or northern red oak stands.
- **Disking** stand area prior to harvest to create seed bed, to incorporate seed, and/or to reduce competition. Often timed with seed/acorn fall. This method is used for site preparation for hand or machine planting or seeding.
- **Tree or pole length skidding** during harvest to expose mineral soil and reduce shrub layer competition. This method is used primarily for site preparation for seeding.
- **Trench seeder or torpedo tube** is dragged across the site to expose mineral soil and release seeds as the seeder/torpedo spins in trench.
- **Roller chopping** to crush/sever existing vegetation and create exposed mineral soil in advance of direct seeding.
- **Fecon (brush land) mowing** to remove understory and other competition and create a seed bed for direct or natural seeding.

Former Agricultural Lands

- **Tree planting machines** pulled by tracked or wheeled tractors prepare the site as trees are being planted. A combination of coulter and scalper attachments on the planting machine cut sod away from a narrow trench in which the seedling or cutting can be planted and which can remain free of vegetation for several months. Rows are spaced six to 10 feet apart to allow for equipment between the rows (i.e., mowers, sprayers) until seedlings are established. This method is typically used on sites converted from agricultural fields. Sites with heavy woody debris may require a larger crawler/tractor with v-blade to clear planting patch for towed planting machine.
- **Disking, plowing and rotovating** are commonly used site preparation methods when converting agricultural fields to hardwood stands.

Spot or Interplanting of Existing Stands

- **Hand scalping** is used in areas where machine access is not possible or practical. A small bare soil patch is created using a shovel or mattock. Normally the radius of a hand scalp should be at least as big as the height of the surrounding vegetation. In some cases, this type of scalp is done chemically. This method is used for site preparation for hand planting or seeding.
- **Bracke scarifiers** can be used where machine access is possible (see details above). This method is used for site preparation for hand planting or seeding.
- **Straight blade scarification** can be used where machine access is possible (see details above). This method is used for site preparation for hand planting or seeding.

Figure 15-9: A Two-row Leno scarifier set up to create scarified patches in a clearcut. This approach causes minimal site disturbance, yet provides exposed soil for ideal planting conditions.

Figure 15-10: A disk trencher provides row scarification to prepare a harvested area for tree planting or direct seeding. Patch or row scarification methods like this one reduce competition for the new tree seedlings while minimizing soil disturbance on the site. Here, the mechanical and chemical site preparation are combined in one operation nine months prior to spring hand planting.

BMPs: Protecting Resources

- Operate mechanical site preparation and tree planting equipment on the contour where necessary to minimize erosion into lakes, streams, and wetlands.
- Avoid operating mechanical site preparation and tree planting equipment on slopes greater than 30 percent, where the slopes drain directly into lakes, streams, and wetlands.
- Minimize raking in areas, or under conditions, in which soil could erode and enter lakes, streams, and wetlands. Two preferred practices are: (a) shear and rake when soil is frozen and (b) rake lightly to remove only slash.
- Suspend operations during wet periods if equipment begins to cause excessive soil disturbance that will increase erosion into lakes, streams, and wetlands.
- Deposit site preparation residues in stable locations outside riparian management zones and filter strips.
- Use patch scarification, low-intensity prescribed burns, or manual site preparation in areas that are adjacent to lakes, streams, and wetlands, or areas that have steep slopes, erosion prone soils, or saturated soils that drain to surface water. Consider hand planting in these areas.
- 4.4 Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.
- 4.5 Take steps to minimize the movement of invasive plants, insects, and diseases to non-infested areas, during forest stewardship activities.

NOTE: Prescribed burning and herbicides are also used for site preparation; BMPs for these tools are listed in Chapter 14: Pesticide Use and Chapter 17: Fire Management.

DESIGN CONSIDERATIONS FOR MECHANICAL SITE PREPARATION

- Design mechanical treatments of regenerating stands to protect reserve areas and structural habitat components retained in previous stand treatments.
- Design practices to avoid funneling water or directing runoff or sediment into water and wetlands.
- Minimize soil disturbance by favoring practices that do not remove surface soils or only remove enough soil as needed to effectively accomplish tree establishment.
- Time site preparation activities and use proper equipment to minimize rutting and compaction of soils.
- Identify occurrences of nonnative invasive plants, and if necessary, treat infestations prior to mechanical site preparation to help prevent spread. Monitor and control new infestations after site preparation activities are completed (see 3.2, 3.5, and 4.2).
- Favor practices that allow for dispersed slash or slash in small piles on the site, rather than piling or windrowing, in situations where residual slash does not conflict with management objectives or reforestation.
- Time site preparation work to coincide with a good seed year in order to maximize the chances of success when regenerating a stand by natural seeding.

CHEMICAL

Chemical site preparation can be an effective method to temporarily control competing vegetation, and increase the amount of sunlight and water available for plant growth. Chemical methods may involve simple equipment, can be less expensive, and provide longer control than mechanical site preparation. **However, chemical effectiveness depends on the appropriate herbicide selection, the timing of application, application rate, and weather conditions.** Herbicide applications may need to be repeated for several years to ensure stand establishment. All herbicides must be applied in accordance with label recommendations and their registered use. Detailed forestry herbicide information is available at: ***dnr.wi.gov – keyword "herbicide"*** or see Chapter 14: Pesticide Use, for additional information on the safe use of herbicides.

BURNING

Prescribed burning, or controlled ground fires, can be an effective and inexpensive means of removing or reducing vegetation, and preparing a suitable seedbed in advance of planting or seeding. Burning can also improve soil nutrient levels and ectomycorrhizal development. Prescribed burning, however, can reduce the effectiveness of pre-emergent herbicides, may stimulate growth of some annuals that compete with seedlings, and can increase solar heating at the groundline, leading to seedling mortality. The use of fire as a vegetation management technique is very appealing to many small landowners because it appears "natural" – but it can be dangerous and may be costly if fire escapes from the planting site onto adjacent stands and ownerships. **Effective and safe use of prescribed fire requires proper design of the firebreaks, appropriate suppression and personal protective equipment, careful evaluation of weather conditions on the day of the burn, and training.** For more information on prescribed burning visit: ***dnr.wi.gov – keywords "prescribed burn"*** or see Chapter 17: Fire Management and Appendix G: Resource Directory for sources of technical assistance and information on any permits required. Permits and site review by Wisconsin DNR fire control personnel are required in high hazard areas of Wisconsin.

Cover crops are appropriate for afforestation sites where they are grown to prevent establishment of nonnative invasive plants and other competing vegetation. Cover crops can also control soil erosion, improve soil condition, and increase water-holding capacity. When selecting a cover crop, choose a species that will accomplish the site preparation objectives, but not adversely impact tree growth. Legumes are sometimes selected as cover crops because they can enhance soil nitrogen. Small grain crops, such as winter wheat and rye, can inhibit nonnative invasive plants and other competing vegetation, and add organic matter to the soil while providing limited competition for tree seedlings. Winter wheat can be spring seeded to produce a less vigorous but effective cover crop.

Figure 15-11: Herbicide strips free seedlings from competition for water and nutrients, harmful allelopathic chemicals produced by grasses, and potential girdling by rodents that use grass as cover.

Former agriculture fields present a unique set of site preparation challenges. Fields that were in row crops the previous year, such as corn or soybeans, generally require a pre-emergent herbicide to control germination of dormant seed from competing vegetation. Herbicides can be very effective in this situation. Cover crops may also be used to control competing vegetation. Alfalfa, clover or some perennial grasses provide fierce competition for tree seedlings and seeds. Alfalfa and sod are easiest to control during the year prior to planting, with an early fall application of herbicide when the plants are still actively growing. Alternatively, rotation into a row crop or other desirable cover crop at least one year prior to afforestation, followed by planting of seedlings, has been especially effective for hardwood plantings on heavy soils.

Planting

PACKAGING

Plastic-lined boxes or bags are preferred for shipping bare-root seedlings because they help prevent physical damage and keep seedlings moist. Paper bags or burlap bales provide less protection from physical damage. Bales will suffice for very short storage or transport periods, but bales leave the shoots exposed and subject to drying. All packaging methods can slow air circulation when stacked. Containerized seedlings are shipped in the plastic or styrofoam container in which they grew at the nursery, therefore, the roots are protected. However, care should be taken to protect the exposed shoots during transportation. Also, regularly monitor the moisture level in the containers.

SEEDLING CARE AND HANDLING

Reforestation surveys indicate that the most common problems facing seedling survival are moisture stress, poor handling, and physical damage before planting. From the time seedlings are lifted from the nursery bed to the time they are planted, it is critically important to keep the seedlings moist (relative humidity 90 to 95 percent) and cool (34°F to 36°F). Seedlings must remain in a state of dormancy during this period. As temperatures rise, plants begin to respire, and can quickly deplete their energy reserves. Seedlings that exhibit mold growth indicate storage at above optimum temperatures. This improper storage may ultimately impact seedling vigor and survival. Buds can break dormancy and begin to grow, placing the new growth at risk of breakage or damage prior to planting. If seedlings are allowed to dry out, the root hairs become permanently damaged, and are unable to absorb adequate water and nutrients. Physical damage from handling can impair root hairs, shoot tips and buds which will slow initial growth of the seedlings.

ROOT PRUNING AND CULLING

Root pruning may be necessary for seedlings with long fibrous root systems in order to facilitate proper planting. **Remember that the key to seedling establishment and survival is a vigorous root system, so approach root pruning conservatively.** Severe root pruning can quickly lead to seedling mortality after planting because seedlings will not have sufficient root area to absorb water. Recommendations for pruning 2-0 conifer nursery stock are to clip the root system eight to 10 inches below the root collar. Larger conifer nursery stock, such as 3-0 or transplants, require a larger root system in order to maintain a proper shoot to root ratio. Most hardwood nursery stock can be pruned to eight to 10 inches below the root collar, and the lateral roots can be pruned at four inches from the main taproot. Remember that larger hardwood stock must be pruned more conservatively, and may require specially designed planting equipment to prepare adequate planting holes. Root pruning must be done in a cool environment where the seedlings will not be exposed to the drying effects of wind and sun, therefore, the planting site is often the worst place to conduct root pruning. Sharp and sanitary root pruning equipment must be used. Roots damaged by ripping, stripping or crushing reduces moisture availability to the seedling at a critical period.

It may be necessary to cull weak, small or root damaged seedlings at this time. Bulk orders include extra seedlings to allow for (or offset losses from) culling. The nursery often provides specifications on what should be culled from a bulk order. Eliminate the wilted, discolored, damaged, decayed (roots or stem will be soft and spongy) or galled seedlings. Galled seedlings (or seedlings with unusual round or oblong swellings) may be infected with a fungus that will ultimately kill the seedling (see Figure 15-12). Keep seedlings moist during the entire pruning and culling process. Place the seedlings back into their packaging, remoisten and reseal the packages tightly to keep in moisture.

Figure 15-12 : Jack pine seedling with a small gall. This seedling should not be planted.

MACHINE PLANTING

Machine planting is well-suited for large orders, planting on even terrain, heavy soils, and planting hardwoods with large root systems. Planting machines generally require a 30 to 50 horsepower tractor. A minimum of three people are recommended – one to drive the tractor, another to ride the planting machine, and a third to provide seedlings to the planter and check for proper planting technique. The same stock handling principles listed previously apply to machine planting. Do not load too many trees in the machine's storage bins at one time or hold too many seedlings in hand to feed the planting machine. Instead, supply stock in small amounts to keep seedlings moist and cool. The average machine planting crew can plant 5,000 trees per day.

HAND PLANTING

Hand planting is necessary when the terrain is rough, steep, the seedlings are too small or large for machine planting, or when interplanting within an existing stand or plantation. The most common tools used for hand planting include a shovel, planting bar ("dibble"), or hoedad. The average inexperienced tree planter can hand plant about 500 seedlings per day, depending on site conditions and stock type. A professional tree planter can often hand plant 1,000 or more seedlings per day. For an instruction sheet regarding proper hand planting techniques, refer to: ***dnr.wi.gov – keywords "tree planting."***

When planting by hand, remember to keep the seedlings shaded, cool and moist at all times. Do not leave packages of seedlings exposed to sunlight and warm temperatures at the job site. Utilize a reflective tarp, and consider delivering the stock in stages during the workday. Carry seedlings in a planting bag or bucket along with wet burlap to keep the root systems moist. **Handle the roots as little as possible, and do not carry the seedlings exposed to the air or immersed in water.** The roots should hang freely in the planting hole and not be twisted or crooked. The new soil line should be slightly above the seedling's root collar. The soil should be packed firmly around the seedling to maintain good soil to root contact and eliminate air pockets.

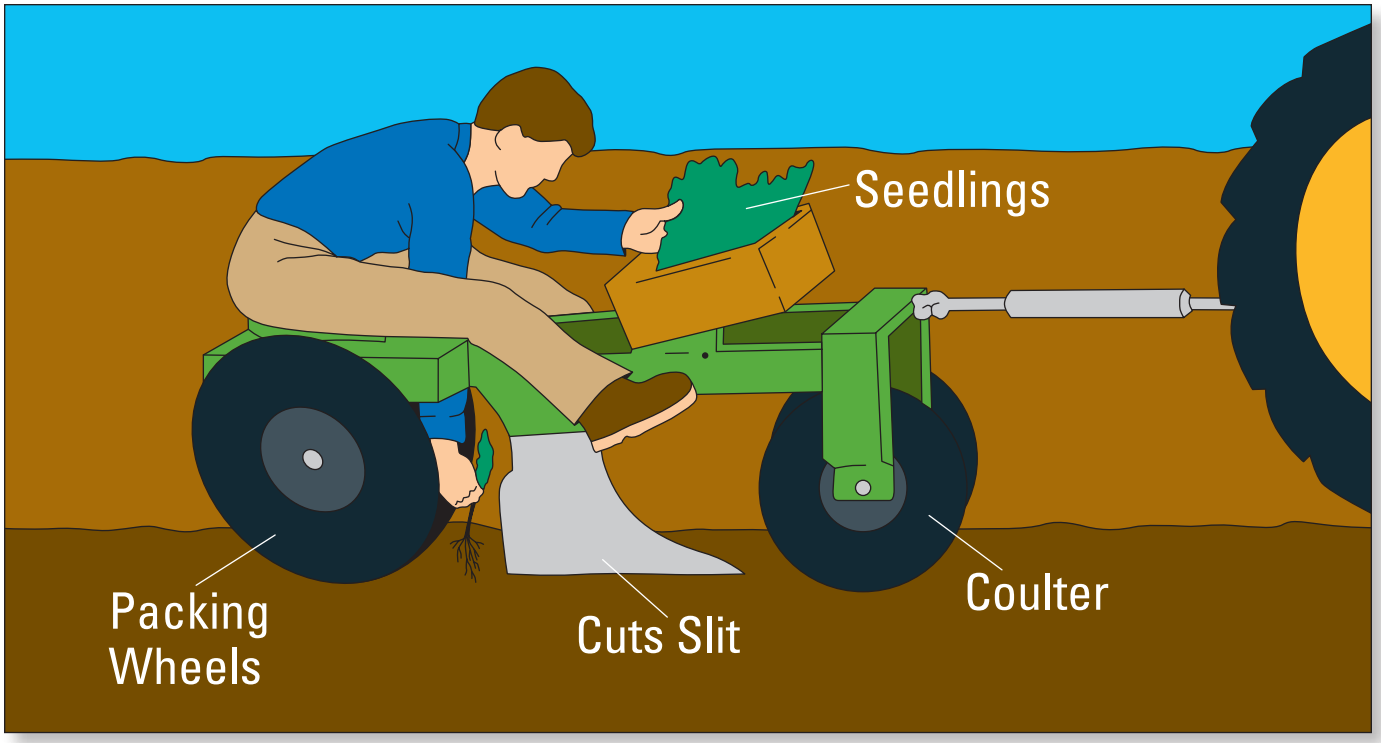


Figure 15-13: A planting machine. It works by opening a slit about 10 inches deep into the soil. A person on the machine inserts a seedling into the slit, and holds it at the appropriate planting depth until the rear packing wheels close the slit. Hardwoods often require a wider and deeper planting slit than conifers to accommodate the large, fibrous root systems.

Figure 15-14: Machine planting hardwood seedlings along the edge of a farm field found in southern Wisconsin.

Figure 15-15: This tree planter is using a hoedad to hand plant jack pine seedlings on this harvested and site-prepped area in the Black River State Forest.

TRANSPORTING

Seedlings are most at risk from overheating, moisture stress, and physical damage during transportation and immediately before planting at the field sites. Plants must be kept cool and free from wind and sunlight exposure. For large orders, a refrigerated truck is recommended. If a pickup truck is used, place a foam sheet on the truck bed, and spacer boards between the foam and boxes for ventilation. Cover the packages with a solar reflective tarp (reflective side down) to prevent heat build-up. Consider transporting seedlings early in the day to take advantage of cooler temperatures or use insulation, ice packs, snow, or large coolers to help keep the seedlings cool.

Do not place seedlings in a hot car trunk or leave them in a sunny location. If you suspect the seedlings have not been kept consistently cool since leaving the nursery, sprinkle cool water on the roots and reseal the packages.

SEEDLING STORAGE

Most people do not have access to truly adequate long-term cold storage. Always minimize storage time and plant seedlings as soon as possible after delivery. Storage only allows more time for problems to develop. If seedlings must be stored for short periods of time (one to two days), seek out local cold storage facilities such as produce businesses or orchards. Keeping a constant temperature below 40°F is the key to proper storage. Unheated basements and root cellars may work for very short periods, if the temperature is constant and below 40°F. Do not use storage sheds or similar buildings because the temperatures can fluctuate greatly during the day. Do not immerse seedlings in water for long periods of time as this can damage fine root hairs. Heeling in or planting in a shallow trench can also lead to root damage and additional transplant shock.

DIRECT SEEDING

Seed can be sown with a variety of equipment, such as seeding sticks, dribblers, broadcast seeders, or seed drills. The most effective means of direct seeding will depend on the species and seed size, and the planting site characteristics. Seed treatments may be needed to discourage predation by animals. Detailed information on seeding equipment and techniques is available in the Wisconsin DNR *Silviculture Handbook, 2431.5*.

REFORESTATION AIDS

There are a wide variety of products available to aid in the survival of a plantation.

Tree shelters protect trees from animal browse and improve initial height growth by creating a greenhouse effect. They make seedlings easier to locate, and protect the trees from herbicide damage. Tree shelters do not eliminate the need for vegetation control and require annual maintenance. Netting should be placed on the top of shelters to prevent the accidental death of birds in search of nesting sites. Shelters block a significant quantity of incoming light, so they should be used in full sun conditions. Tree shelters are used primarily with high value hardwoods, and the cost may not be economically justified for many landowners. Other problems associated with the use of shelters include stem dieback and rodent nesting. After a few years, tree shelters may actually inhibit sapling growth, so they should be removed once terminal shoots have emerged from the shelter top, and the sapling becomes rigid enough to stand on its own.

Mulches and vegetation mats are used to suppress competing vegetation growth, retain soil moisture and reduce erosion. Mulches can include bark, sawdust, straw, wood chips or other materials. Mulches must be applied to a depth adequate to suppress weed growth (i.e., two to three inches), but should not be heaped or mounded immediately next to the seedling. Mulches are labor intensive to apply and can attract rodents seeking nesting areas. Vegetation mats are typically made from plastics or natural fibers. They suppress weed growth while still allowing water infiltration. The primary disadvantage of mats is the high cost.

Root dips and gels are hydrating gels used to coat seedling roots prior to handling and planting operations. Their primary purpose is to prevent drying of the seedling's roots during the planting process.

POST-OPERATIONAL ACTIVITIES

Monitoring Program

Some monitoring process should be used to evaluate plantation survival and assess maintenance needs. A regular program of monitoring helps ensure the success of a reforestation project. Minimally, plantations should be evaluated during the first growing season, four to five months after planting (although earlier evaluations may make problem diagnosis easier), and again during the second, third and fifth growing seasons to verify survival and establishment. During the evaluation process make note of symptoms, including discoloration or the loss of foliage, injury from animals, and presence of damaging insects, diseases, and nonnative invasive plants and other competing vegetation problems.

Survival counts are a quick way to determine if replanting is necessary in order to meet management goals. Estimating survival on random 1/100 acre plots throughout the plantation can assess seedling survival. To survey seedling survival attach an 11.8 foot length of cord to a stake to represent the radius of a 1/100 acre plot. Place the stake in the center of each plot and count the number of live and dead planted trees within 11.8 feet of the plot center. Each tree counted represents 100 trees per acre, multiply the number of live and dead planted trees by 100 to determine the number of trees planted per acre. The number of live trees per acre divided by the total number of trees per acre equals the survival percentage. Average the values from all the plots to determine the survival for the whole plantation. The number of plots required to obtain a reliable survival estimate depends on the size of the plantation and the variability of survival. A rule of thumb is to do one plot per acre for the first 10 acres, and one additional plot for each additional five acres of plantation. An alternative method (faster, but potentially less accurate) is to select a row and count the number of live and dead trees to estimate survival and stocking. Switch rows periodically to sample across the entire plantation.

Vegetation Control

The success of a planting will often be determined by the control of competing vegetation before and after the trees are planted. **Good site preparation will get seedlings off to a fast start, but competing vegetation may need to be controlled for at least three growing seasons, or until the trees are well-established.**

Figure 15-16: Rapid tree growth results from proper care and planning (e.g., grass control when seedlings were young and adding white pines to help trees grow tall and straight) as evidenced by this 30-year-old black walnut plantation in Dane County.

Herbicides are often the most effective method for follow-up control of competing vegetation. The proper choice of herbicide, timing and method of application are critical to ensure that planted trees are not damaged. More information on herbicides for forest management is available at: ***dnr.wi.gov – keyword "herbicide"*** or see Chapter 14: Pesticide Use, for more information on the use of herbicides.

Mechanical control of competing vegetation may be suitable for some post-planting situations. Shallow disking or rototilling between rows is effective if care is used to avoid damaging the trees and their root systems. Mowing can reduce competing vegetation maturation and seed production, and minimize rodent habitat, but it may also stimulate grass root growth and intensify competition for soil nutrients and water. Mowing can prevent the physical smothering of trees (i.e., lodging as grasses and broadleaf plants die and fall over in the winter). Hand or mechanical cutting of woody vegetation using brush saws and brush mowers, may effectively release young seedlings, but repeated treatments may be needed due to stump sprouting.

Animal Control

Most forest plantings will experience some type of animal damage (e.g., browsing, rubbing, rodent bark feeding), however, the severity of that damage will vary across planting sites and between tree species. Many different techniques can be employed to discourage severe wildlife damage.

POPULATION CONTROL

Hunting can be an effective way to reduce local deer and rabbit populations. **Rodenticides have been used to control mice, pocket gophers and meadow voles, however, these baits are hazardous and can affect non-target organisms.** Rodenticides may be restricted and require a license (see the Resource Directory for sources of assistance).

HABITAT MANIPULATION

Wildlife damage can be minimized by manipulating the habitat in and around the plantation. Mowing and other grass control measures will reduce rodent damage by removing their habitat, and increasing access by predators such as hawks. Constructing raptor perches (posts that are placed throughout the plantation to allow raptors to sit above the plantation) can also improve rodent predation. The removal of brush and hedgerows virtually eliminates rabbit damage, since they do not venture far from shelter. Manipulating the planting design can protect high hazard areas and discourage animals from entering the plantation. For example, plant several rows of less palatable trees, such as spruce, next to existing woodlands or along obvious travel corridors.

PROTECTION DEVICES

There are a wide variety of products available to protect seedlings. Electric fences, tree shelters, bud cap protectors, and bud nets create a physical barrier between the seedling and animal. **These devices must remain intact to be effective and maintenance is often required.** Repellents rely on fear, conditioned avoidance, or taste to discourage animal browse. Repellents can work for short periods, but their effectiveness is reduced with time.

Insect and Disease Control

All plantations will experience some degree of insect and disease damage. If local pockets of damage develop, or problems persist, carefully identify the pest organism and assess the degree of damage prior to developing control recommendations. Once trees are damaged and weakened, they become susceptible to further attacks by pests. Proper identification becomes complicated when more than one organism or injury is present (see the Resource Directory for sources of assistance in insect and disease identification). Additional information on pests that affect young plantations is available in the Wisconsin DNR *Silviculture Handbook, 2431.5*.

Information on insects and diseases can be found in Chapter 8: Threats to Forest Health.

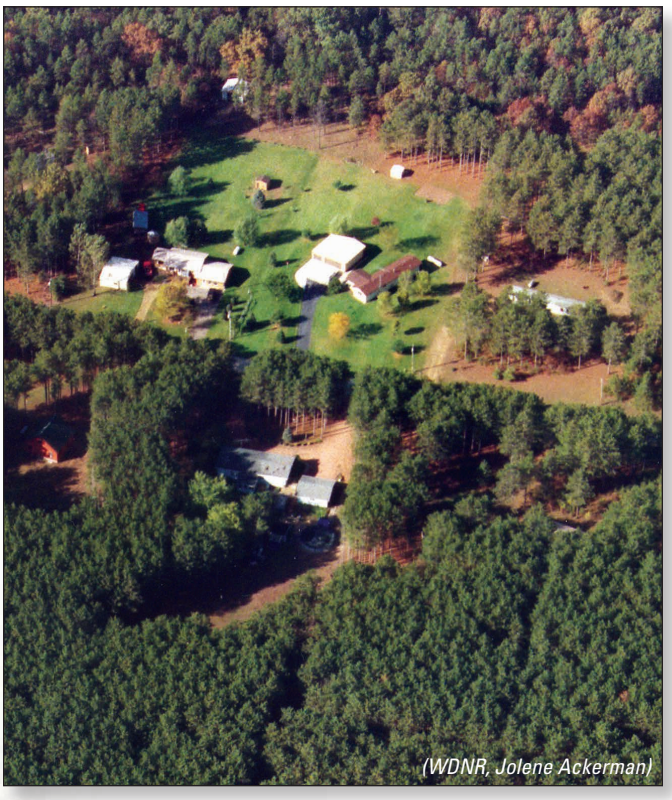


Figure 15-17: Pine plantations hold an allure for rural builders, but such settings pose problems. Soil compaction and root injuries commonly lead to tree mortality near homes. Thinning to keep trees healthy is often impractical in housing developments. Poor air circulation, mold and extreme fire hazard are troubles experienced by homeowners.

Weather and Environmental Damage

DROUGHT

Adequate soil moisture is crucial when the trees are young and lack fully developed root systems. Trees damaged by drought appear wilted and have yellow or brown foliage. The symptoms should appear similar throughout the plantation. Recovery is possible if seedlings get water before extensive damage is done. Drought will weaken seedlings and predispose them to insect and disease attacks.

FROST/FREEZE INJURY

Frost damage generally occurs in depressions or low areas where cold air settles. The foliage and/or young shoots will curl, turn black and die. Freeze injury can cause hardwood stems to dieback the following growing season. Trees from inappropriate southern seed sources, and species on the edge of their natural range, are particularly susceptible. Frost damage rarely kills trees, but it does slow growth and predispose the seedling to insects and diseases.

HERBICIDES

Improper application or timing of a herbicide can damage or kill seedlings. Foliage and shoots will usually appear yellow and have distorted growth (see Chapter 14: Pesticide Use).

POLLUTANTS

Damage from pollutants can resemble many different problems, and is difficult to identify. Sulfur dioxide, ozone, and road salt are common tree damaging pollutants. White pine is particularly susceptible and should not be planted in areas frequently exposed to air pollution or road salt.

FIRE

The best way to prevent a fire is to reduce the amount of fuel in and around your plantation. Establish and maintain disked firebreaks and mowed access roads in order to prevent the spread of a fire, and provide easy access by fire control equipment.

DESICCATION

Dry winter winds may cause desiccation of conifer seedlings, and turn needles reddish brown. This damage is mostly an aesthetic concern.

BMPs: Invasive Species

The following are Forestry BMPs for Invasive Species (IS-BMPs) that should be considered during planning and implementing reforestation and afforestation activities.

- 3.2 Prior to implementing management activities, scout for and locate invasive species infestations, consistent with the scale and intensity of operations.
- 3.5 Plan for post-activity management of highly damaging invasive species.
- 4.2 If pre- or post-activity control treatments are planned, ensure that they are applied within the appropriate time window.
- 4.3 Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.
- 4.4 Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.
- 4.5 Take steps to minimize the movement of invasive plants, insects, and diseases to non-infested areas, during forest stewardship activities.
- 6.1 Limit the introduction and spread of invasives during reforestation or revegetation site preparation activities.
- 6.4 Select plant materials that are site appropriate to favor establishment and vigor.
- 6.5 Plan for post-planting management of invasive species.

RESOURCES FOR ADDITIONAL INFORMATION

HERBICIDES FOR FOREST MANAGEMENT
dnr.wi.gov – keyword "herbicide"

SILVICS OF NORTH AMERICA
Silvics of North America, U.S. Department of Agriculture Forest Service.
www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm

SILVICULTURE HANDBOOK
Silviculture Handbook, Publication Number 2431.5, Wisconsin DNR, Madison, Wisconsin, 2002.
dnr.wi.gov – keyword "silviculture"

UNIVERSITY OF WISCONSIN INSECT DIAGNOSTIC LAB
www.entomology.wisc.edu/diaglab/entodiag.html

UNIVERSITY OF WISCONSIN PLANT DISEASE DIAGNOSTIC CLINIC
pddc.wisc.edu

UNIVERSITY OF WISCONSIN SOIL AND PLANT ANALYSIS LABS
uwlab.soils.wisc.edu

UNIVERSITY OF WISCONSIN-MADISON FORESTRY EXTENSION
forestandwildlifeecology.wisc.edu/extension-about_us

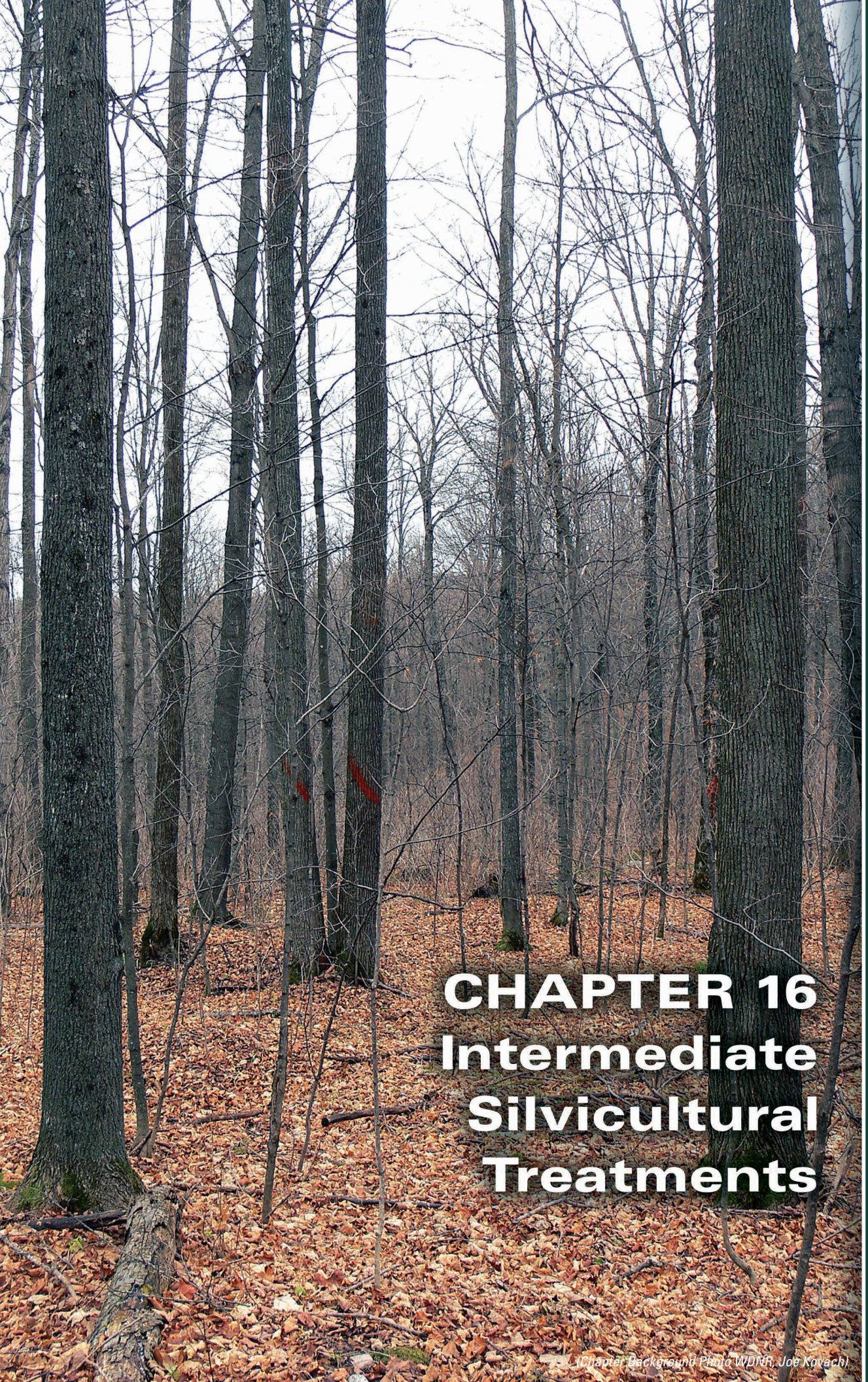
WEB SOIL SURVEY
U.S. Department of Agriculture, Natural Resource Conservation Service.
websoilsurvey.nrcs.usda.gov/app/

WISCONSIN DNR REFORESTATION PROGRAM
dnr.wi.gov – keywords "tree planting"

WISCONSIN NURSERY DIRECTORY
Wisconsin Nursery Directory, Forestry Fact Publication Number 14, University of Wisconsin Extension.
forest.wisc.edu/sites/default/files/pdfs/publications/14.PDF

WOODY PLANT SEED MANUAL
Woody Plant Seed Manual, U.S. Department of Agriculture Forest Service.
www.fs.usda.gov/nsl/nsl_wpsm.html

NOTES



16

CHAPTER 16
Intermediate Silvicultural Treatments

(Chapter Background Photo WDNR, Joe Kovach)

CHAPTER 16
INTERMEDIATE SILVICULTURAL TREATMENTS

Figure 16-1 and 16-2: The importance of tending an even-aged stand is illustrated by comparing these two plots in the famous Star Lake thinning experiment started by Fred Wilson with red pine planted in 1913. Figure 16-1 (left) shows the poor growth and mortality in the plot that was never thinned. The adjoining plot, Figure 16-2 (right), shows the impact that periodic thinnings (every five to 10 years starting in 1943) can have on red pine growth and quality.

Intermediate treatments begin after regeneration is established and are carried out as prescribed throughout the life of a forest stand. These treatments make up the "tending" portion of an overall silvicultural system. **Primary goals include improvement of stand composition, structure, growth, quality, health, and the production of specific benefits desired by the landowner.** Some intermediate treatments, often called **timber stand improvement (TSI)**, are non-commercial, requiring outright investment by the landowner. Other intermediate treatments can yield income.

Integrated Resource Management Considerations

- Intermediate treatments can affect timber productivity, stand structure, wildlife habitat, species and habitat diversity, aesthetics, water quality, and soil condition. Careful consideration must be given to all the ramifications of a planned treatment.
- Intermediate treatments generally improve tree vigor and health, but high intensity treatments in stands lacking vigor and strength can cause stress and short-term predisposition to health problems. Logging damage can cause wounds that predispose trees to future health problems.
- Invasive plants can be encouraged or discouraged by intermediate treatments and operations. They can preclude the success of treatments. Invasive plants should be controlled and/or eliminated during intermediate treatments to the greatest extent possible (see 4.2 through 4.6).
- Intermediate treatments can increase visual penetration and access. Season or hours of operations may need to be restricted to mitigate visual impacts.
- Heavy equipment can damage cultural resources.

PLANNING AND DESIGN

Figure 16-3: Having a trained forester collect inventory data for each stand on the property is necessary before prescriptions can be developed to achieve the management objectives.

- Conduct on-site meetings with the landowner, forest resource manager, and logger prior to implementing operations. Clarify objectives, specifications, regulations, and site limitations.
- Identify crop tree management objectives, characteristics, number per acre, and spacing.
- Consider the retention of wildlife trees, snags and coarse woody debris.
- In some cases, logging residues (slash) and stumps can facilitate infestations, and may require treatment. Timing of cutting (and other operations) should consider disease and insect cycles.
- Evaluate soil conditions and control heavy equipment operations to limit compaction, rutting and erosion.
- If necessary, evaluate the need for additional slash control measures, or seasonal operating restrictions to mitigate visual impacts.
- Identify any cultural resources that may occupy the site and develop measures to protect them.
- Identify occurrences of invasive species, and, if necessary, treat infestations prior to conducting stand improvement activities to help prevent spread (see 3.2 and 4.2).

Figure 16-4: Frequent communication between the forester, landowner and other resource professionals helps ensure that management objectives are fully achieved.

OPERATIONAL CONSIDERATIONS

Intermediate treatments can be grouped into release, thinning/improvement, salvage/sanitation, and pruning operations.

Consider invasive species when conducting intermediate treatments (see 4.3 through 4.6).

Release

Release is a treatment designed to free young trees (saplings and seedlings) from undesirable, usually overtopping, competing vegetation. **The purpose is to regulate species composition and to improve growth and quality.** Release treatments are designed to provide potential crop trees with sufficient light and growing space, by freeing their crowns and controlling competition.

The need for release treatments are based on a number of considerations:

- An assessment of the relative growth rates (height growth in particular) of the competing and desired species.
- The degree of impact the competing species has on the health and vigor of the desired species.
- The relative cost/effectiveness of a partial versus complete release versus no action.

Complete release involves the release of an entire layer of vegetation. Examples would be the control of aspen suckers and brush in a new pine plantation, or the control of competing red maple stump sprouts after the establishment of red oak seedlings following a shelterwood harvest. In these situations, essentially all of a particular species in the stand are considered crop trees. The objective is not necessarily to kill the competing species, but to set back and/or retard their growth so as to allow the desired species to gain dominance. A complete release normally occurs soon after a new stand is established, when competing vegetation begins to interfere with the free growth of the desired species and/or individuals.

Partial release involves the release of only selected crop trees. A partial release is usually done before the main stand is 15 years of age, and involves the following criteria:

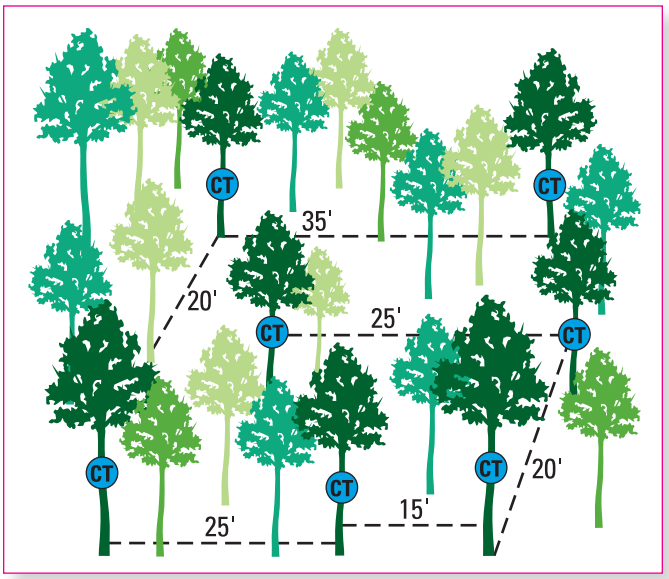


Figure 16-5: Spacing is an important consideration when selecting crop trees (CT). If you space crop trees 25' apart, you will end up with about 70 crop trees per acre. Some crop trees can be spaced 15' apart, while others can be spaced 35' apart.

- Crop trees are selected based on landowner objectives, species, tree vigor, and tree quality. The maximum number of well-spaced crop trees per acre generally ranges from 50 to 200, depending on landowner objectives and stand condition (see the crop tree selection guidelines in Appendix A).
- Only the direct competitors are cut. Any plant that is not going to suppress, endanger or hamper the growth of desired individuals is left to grow. All trees with crowns that touch or interfere with each crop tree are removed.
- When sprout clumps are involved, all but the best one or two stems are cut. Retain healthy sprouts that originate from the root collar, have u-shaped stem attachments, are of relatively large size, and have well-shaped and well-developed crowns.

There are three types of release treatments: weeding, cleaning and liberation. They are differentiated based on the type, age and size of vegetation eliminated. Within a stand, they can be applied individually or in concert, once or multiple times.

WAYS TO CONTROL COMPETING SPECIES

Physically Tear the Plant Out of the Soil	• A very effective but expensive method.
Cutting	• Most effective against species that do not sprout, e.g., most conifers. • Species that sprout may require repeated treatments to effectively control. Cutting in late spring and summer is most effective. • Relatively expensive, unless a product can be harvested.
Girdling (see Figure 16-6)	• Most effective against species that do not sprout. • Most effective when done in late spring and summer. • Generally applied only to trees greater than 4" DBH.
Fire	• Usually kills trees by girdling. • Generally not used to release young trees.
Herbicides	• Very effective and often the most cost-effective. • Methods of application include aerial spraying, ground-level foliar spraying, basal spraying, stump spraying, and bark incisions. • Herbicides are toxic chemicals, see Chapter 14: Pesticide Use.

Some general operational considerations relative to release treatments that remove large, overtopping trees are:

- Cutting may allow the realization of income, but protection of the young stand from felling and harvesting operations is critical.
- Care should be taken following the elimination of high shade so that intense crown competition from sprouts or the release of fast growing weed species does not develop.
- Reserve trees retained from the previous stand can provide benefits related to wildlife, aesthetics, water and soil quality, protection of special or sensitive sites, landmarks, and, in certain cases, timber production. Where objectives include the retention of reserve trees, residual crown closures of less than 15 to 20 percent generally will not significantly impair the development of the young stand (see Appendix A).
- In most cases, nearly full sunlight is preferred to promote optimum growth of young, established stands.

Figure 16-6: Girdling can be an effective way to remove selected larger trees from a stand with minimal damage to surrounding reproduction.

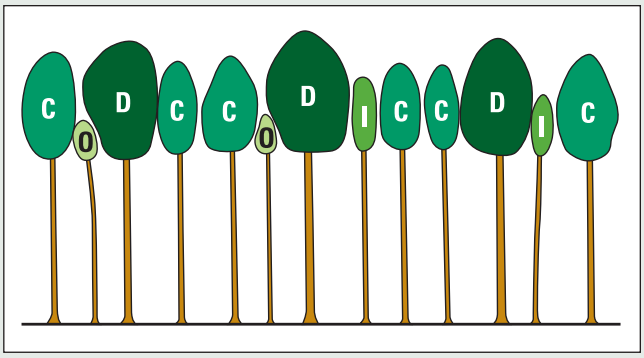


Figure 16-7: This illustration shows the relative positions of trees in the different crown classes in an even-aged stand that has not been thinned. *(Adapted from © David M. Smith, 1962, The Practice of Silviculture (7th Edition), John Wiley & Sons, Inc.)*

DOMINANT (D)

Dominant trees have crowns extending above the general level of the crown cover, and receive full light from above and partly from the side. Dominant trees are larger than the average trees in the stand, and have well-developed crowns that may be somewhat crowded from the sides.

CODOMINANT (C)

Codominant trees have crowns forming the general level of the crown cover, and receive full light from above but comparatively little from the sides. These trees usually have medium-sized crowns that are often crowded on the sides.

INTERMEDIATE (I)

Intermediate trees are shorter than dominant and codominant, but have crowns extending into the crown cover formed by codominant and dominant trees. Intermediate trees receive a little direct light from above, but none from the sides. They usually have small crowns that are considerably crowded on the sides.

OVERTOPPED (O)

Overtopped, also called suppressed, are trees with crowns entirely below the general level of the crown cover. Overtopped trees receive no direct light either from above or from the sides.

Thinning

Thinning is a cultural treatment, conducted in stands past the sapling stage, made to reduce the stand density of trees primarily to improve growth, enhance forest health, or recover potential mortality. Typically, **it entails the removal of trees to temporarily reduce stocking to concentrate growth on the more desirable trees**. Normal thinning does not significantly alter the gross production of wood volume. Thinning impacts stand growth, structure and development, and increases economic yields. Individual thinnings can be commercial or non-commercial (TSI), depending on landowner objectives and local markets for materials cut in the thinning operation.

How and when thinnings are applied depends on landowner objectives and the desired benefits. A schedule of thinning for a stand should identify the thinning methods to be used, the intensity of application, and when thinnings will occur. Ideally, a thinning schedule should be systematic, flexible and consistently followed throughout the rotation. In selecting trees for thinning, primary focus should be on the trees that will remain (the principle crop), as opposed to those to be cut.

There are four basic methods of thinning. Stand conditions and thinning needs vary over time, often resulting in the application of more than one method over a stand's rotation. The four methods of thinning are mechanical thinning, low thinning, crown thinning, and free thinning.

MECHANICAL THINNING

Mechanical thinning is the removal of trees in rows, strips, or by using fixed spacing intervals.

- Frequently, these are the first thinnings in young stands that are densely crowded and/or relatively uniform with little differentiation into crown classes. This method becomes less suitable as variation in the size and quality of the trees increases.
- **Row thinnings** (see Figure 16-8) cut all trees in rows or strips at fixed intervals throughout the stand. They are often utilized for the first thinning(s) in plantations where the rows are readily apparent. The removal of every third row is the most common practice. They are also used to provide access for harvesting equipment in dense, unthinned stands.
- **Spacing thinnings** involve selection of trees at fixed intervals for retention and cutting the rest. This strategy is most applicable as the first thinning in very overcrowded young stands developed from dense natural reproduction.

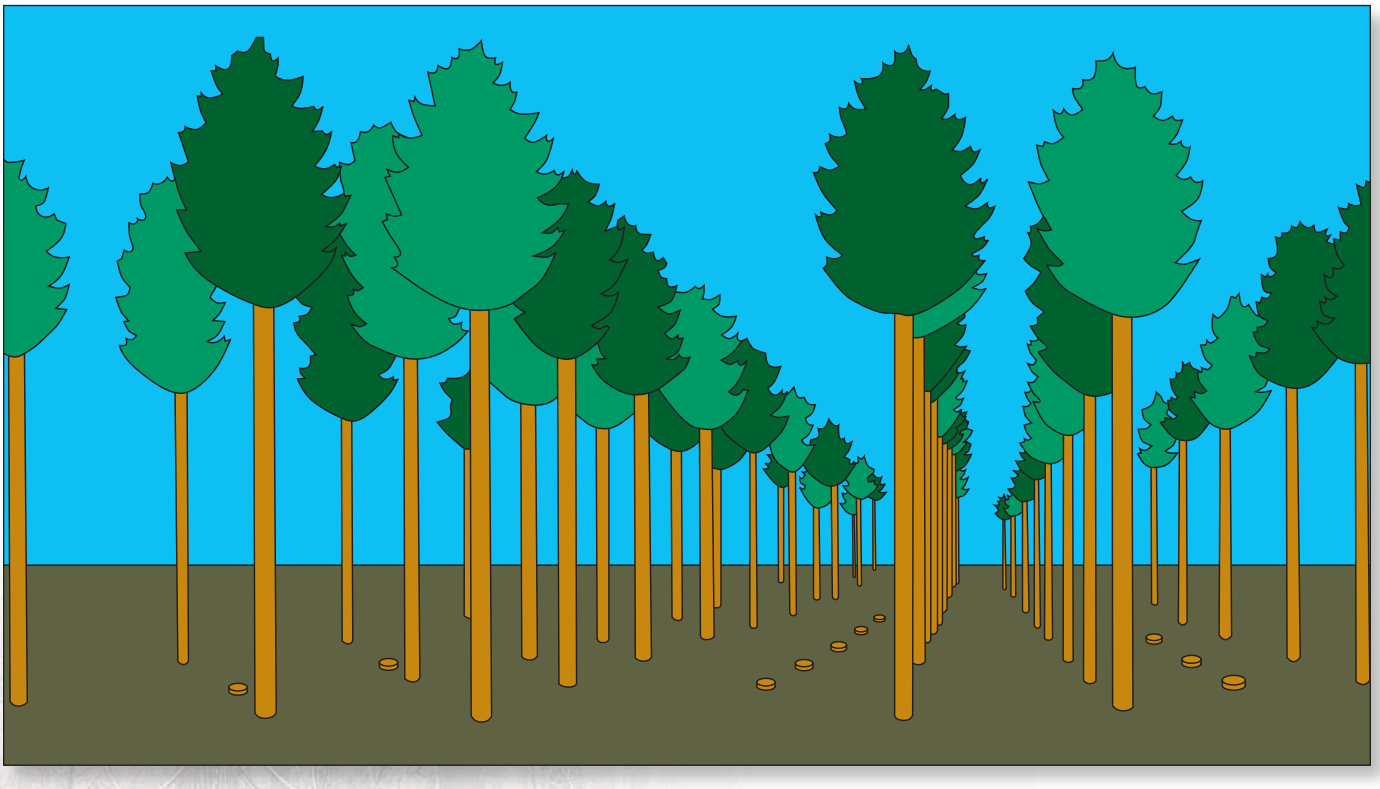


Figure 16-8: A mechanical row thinning in a pine plantation in which every third row of trees has been removed. The opening in the canopy should close in a few years. *(Adapted from Fact Sheet G3398, Wisconsin Woodlands: Intermediate Cuttings in Forest Management, University of Wisconsin-Extension)*

LOW THINNING

Low thinning, or thinning from below, (see Figure 16-9) involves removal of trees from the lower crown classes to favor those in the upper crown classes. This strategy of removing the smallest trees and retaining the largest trees accelerates and simulates somewhat the natural elimination of the lower crown classes through competition.

- This type of thinning generally removes smaller diameter trees, and marketability can sometimes be difficult.
- Light- to medium-intensity low thinnings (removing suppressed and intermediate trees) are not recommended except in specific cases. They facilitate utilization of trees that would otherwise die due to suppression (competition), but the release of the remaining trees from competition is minimal.
- Heavy low thinnings are generally recommended. They involve the removal of some codominants in order to create canopy openings and release the crowns of crop trees to stimulate their growth. Stocking guides are used to help determine residual density levels.

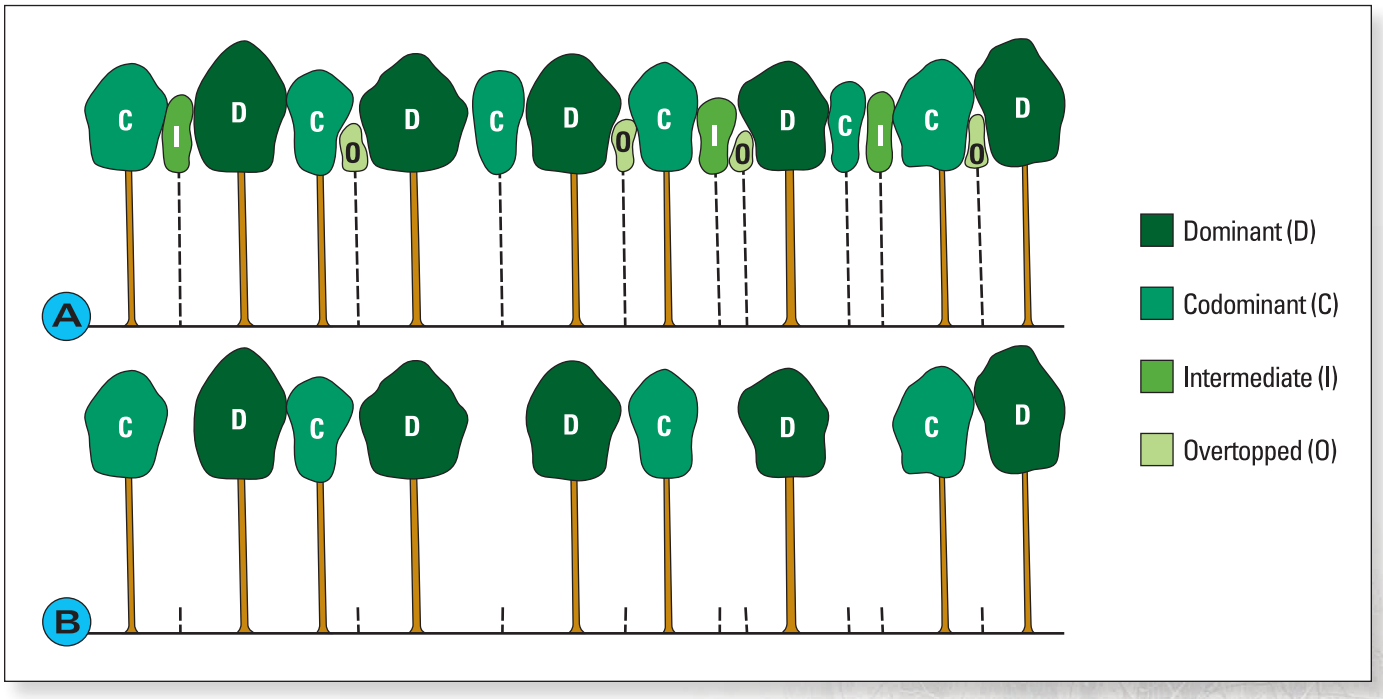


Figure 16-9: How a stand might look before (A), and after (B), a low thinning. The letters on the tree crowns denote crown classification. *(Adapted from © David M. Smith, 1962, The Practice of Silviculture (7th Edition), John Wiley & Sons, Inc.)*

CROWN THINNING

Crown thinning, or thinning from above, (see Figures 16-10 and 16-11) involves removal of trees from the dominant and codominant crown classes in order to favor the best trees of those same crown classes. Large intermediates that interfere with crop trees also can be removed. The method stimulates the growth of selected, preferred trees (quality) without sacrificing the production of quantity.

- Crown thinnings are normally used to develop quality sawtimber. They are usually commercial operations and the trees removed are relatively large.
- Crop trees are selected based on landowner objectives, species, vigor, quality, strength, and health (see Appendix A: Timber Management - Crop Tree Selection, page A-1).
- Crown thinnings are a recommended method to develop and manage quality hardwood stands for the production of high value sawtimber and veneer logs.
- 40 to 150 well-spaced dominant and codominant crop trees per acre are released. In fast growing young stands with small crowned competitors, crop trees are released on four sides. In slower growing older stands with larger crowned competitors, crop trees are released on one to three sides.
- To optimize growth, the remaining stand should also be thinned. Release the best dominant and codominant trees by removing high risk, lower vigor, and poor quality competitors. Stocking guides are used to determine residual stand density.
- To be effective, crown thinning requires considerable skill in tree selection and density management. The timing and intensity of a particular thinning is important in managing stem form and natural pruning.

FREE THINNING

Free thinning is the removal of trees to control stand spacing (density) and favor desired crop trees using a combination of thinning criteria without strict regard to crown position. In application, this method is a free combination of selected concepts and techniques garnered from both low and crown thinning methods.

Follow crop tree selection and order of removal guidelines (Appendix A). Utilize stocking guides to help determine target residual density. Free thinning is recommended to develop and manage quality hardwood stands for the production of high value sawtimber and veneer logs. Free thinning requires considerable skill in tree selection and density management to be effective.

Figure 16-10: This crop tree, released on two to three sides by cutting competing trees, is now free to grow.

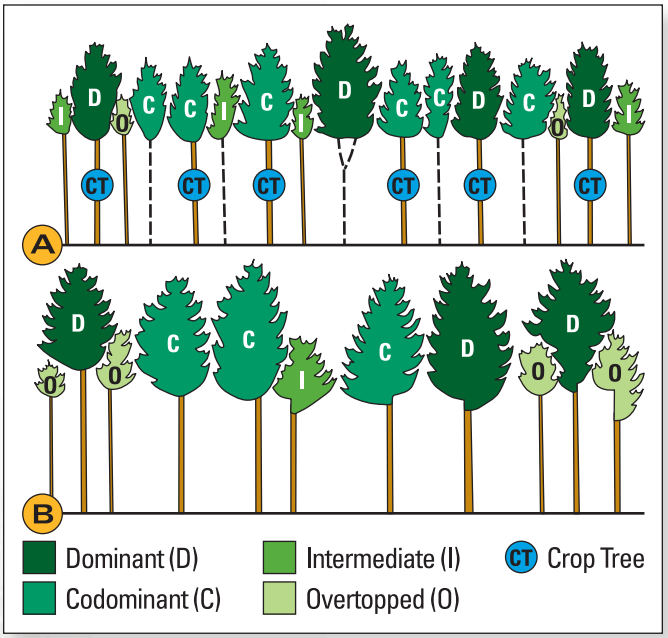


Figure 16-11: The upper sketch (A) shows a coniferous stand immediately before a crown thinning. The crop trees are indicated by the blue circles marked "CT." The lower sketch (B) shows the same stand about 20 years after the crown thinning, which has reclosed to the point where a low thinning would be desirable. (Adapted from © David M. Smith, 1962, The Practice of Silviculture (7th Edition), John Wiley & Sons, Inc.)

SOME OPERATIONAL CONSIDERATIONS RELATIVE TO THE TIMING AND INTENSITY OF THINNING OPERATIONS

- The timing and intensity of each thinning depends on landowner objectives, stand composition and structure, stand condition and health, and other past and planned management activities. A tentative schedule should be developed, indicating the projected timing and intensity of each thinning. Time oak harvests to minimize the risk of introducing the fungus that causes oak wilt. For more information, visit ***dnr.wi.gov – keywords "oak wilt."***
- The intensity of thinning refers to the proportion of the stand removed in a particular thinning.
- As intensity increases, frequency usually decreases.
- Target stocking levels are determined based on optimizing stand growth and yield for a specific forest cover type. Stocking guides (see Figure 16-12) define the lower and upper limits of stand density on a given site. The lower limit (see Figure 16-12, B-line) is normally used to guide thinning applications. Regular reduction of stand density to the lowest level at which full occupancy is maintained should result in the most rapid diameter growth that can be maintained without reduction in total volume yields.
- Initial thinnings normally begin when crowns begin to touch each other. Precommercial thinning (TSI) requires an investment, but can increase net returns over the rotation. It is typical, however, to postpone the initial thinning until an immediate profit can be produced.
- Normally, a thinning is indicated when 1) the live crown ratios of crop trees begin to decline, 2) the diameter growth of crop trees begins to decline, 3) stand density increases to near or above specified upper limits delineated in stocking charts, and/or 4) sufficient timber volume accumulates to support a harvest.
- The effects of thinning are temporary. After each thinning, the remaining trees grow taller, diameters increase, crowns expand, and canopy gaps close.
- Thinning every eight to 15 years is a recommended general guideline for commercial thinnings.

It is important to control logging damage when thinning. Logging wounds can predispose the remaining trees to disease and decay. Thinnings are meant to increase resistance to damage (e.g., insects, disease, wind, etc.). However, they can also temporarily predispose stands to damage, especially where trees are not particularly vigorous or strong.

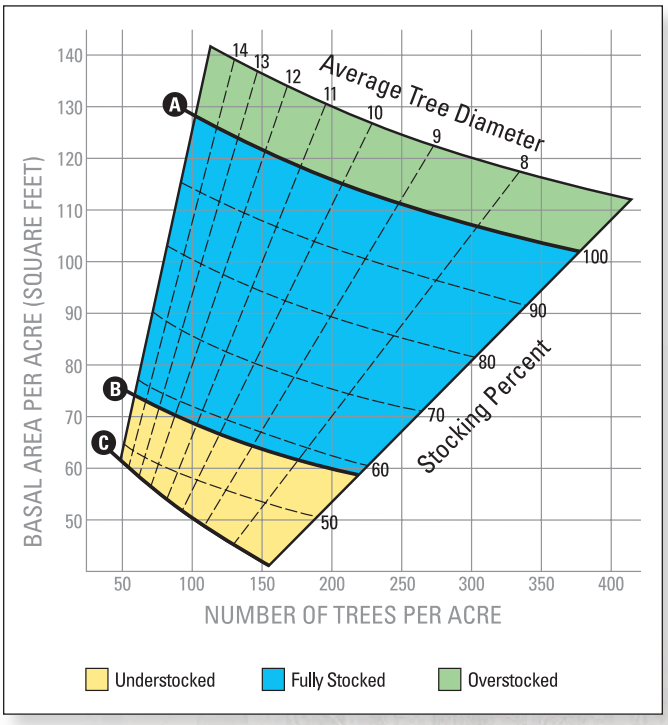


Figure 16-12: Stocking guide/chart for upland central hardwoods displaying the relation of basal area, number of trees, and average tree diameter (the tree of average basal area) to stocking percent. The area between A-line and B-line indicates the range of stocking where trees can fully utilize the site. C-line shows the limit of stocking necessary to reach the B-line level in 10 years on average sites. Similar guides are available for each species. (Adapted from I. L. Sanders, 1977, Manager's Handbook for Oaks in the North Central States, USDA Forest Service General Technical Report, NC-37, North Central Forest Experiment Station, St. Paul, MN)

Thinning Clumps of Trees

Clumps refer to root, root collar, or stem sprouts, as well as trees of seed origin growing in close proximity to one another so their lower boles contact each other or have the potential to contact each other. They commonly occur in hardwoods. **Clump thinning** is the removal of some, but not all, tree members of a clump. This practice can predispose residual trees to butt rot, stain, or wilt disease, which enter directly from adjoining cut sprouts or wounds made while clump thinning. To minimize decay in the lower bole and to avoid some wilt diseases, it is generally recommended to avoid clump thinning pole-sized or larger clumps by either leaving or removing all stems in a clump.

Though it is best to thin clumps before trees reach pole-size or larger, some stands will have an overabundance of clumps in larger diameter classes. If the stand has the potential to produce quality hardwood logs, consider the complete removal or full retention (versus thinning) of clumps. If choosing to thin clumps, cut only those stems that originate at the root collar or below, connect in a U-shape union, *and* which allow for cutting without wounding residuals. Also, consider species specific susceptibility to decay and the potential for disease introductions (e.g., oak wilt and sapstreak; see Figures 16-13 through 16-16).

Figure 16-14: Avoid thinning sprouts that are attached above the root collar like the cut sprouts shown here (white arrows). The residual basswoods will develop butt-decay because of this practice.

Figure 16-13: A residual tree with butt-rot due to clump thinning. The cut stem was connected to the residual stem in a v-shape. The residual stem was wounded when the other stem was cut (white arrow points to chain saw wound). This facilitated the decay. Decay may have also transferred directly from the cut stem into the residual stem.

Figure 16-15: A sugar maple clump with stems originating at the root collar and meeting in a narrow-angled V-shape. Thinning is not recommended because the chances of wounding the residual in this clump is high. It is recommended to take or leave both stems.

Figure 16-16: One of these stems could be thinned without great risk for decay in the residual because they have a U-shaped connection at the root collars. Thinning clumps with U-shaped unions has been shown to result in less decay than thinning clumps with V-shaped unions.

Improvement Cutting

Improvement cutting is the removal of less desirable trees of any species in a stand of poles or larger trees, primarily to improve composition and quality. Trees are removed to encourage the growth of more desirable trees within or below the main canopy. Trees considered for removal include undesirable species, trees of poor vigor, trees of poor quality, and injured or unhealthy trees. Potential crop trees should be a preferred species and relatively well-formed, vigorous and healthy.

Improvement cuttings are applied to stands that have been unmanaged, neglected or poorly managed. The intent is to remove undesirable material, and set the stage for productive management to accomplish landowner objectives. In most cases, stand improvement can be completed in one to three operations. In cases where the current stand is of such poor quality that rehabilitation is untenable, the preferred choice is to initiate regeneration to develop a vigorous, new stand.

Salvage and Sanitation Cutting

Salvage cutting is done to remove dead, damaged or dying trees resulting from injurious agents other than competition. The goal is to recover economic value that would otherwise be lost. Salvage operations are done for profit, with the intent of utilizing damaged trees and minimizing financial losses. Salvage should be conducted as soon as possible following a damaging event. Dead trees deteriorate rapidly during the first growing season after death, but not all species degrade at the same rate and not all injuries have the same impact. Severe stand damage will require the implementation of regeneration methods. Before implementing salvage operations, consider potential impacts on other resource benefits (e.g., water quality, wildlife and biodiversity) and possible mitigation measures.

Presalvage cutting involves removal of valuable trees at high risk of injury or mortality from damaging agents. This method attempts to anticipate damage by removing vulnerable trees that are in imminent danger of being damaged or killed.

Sanitation cutting removes trees that are a threat to stand health by stopping or reducing the actual or anticipated spread of insects such as pine bark beetles or diseases such as oak wilt. It is precautionary protection implemented to reduce the spread of damaging organisms, or in anticipation of attacks to prevent or delay the establishment of damaging organisms. Sanitation cuttings eliminate trees that are present or prospective sources of infection for insects or fungi that might attack other trees. The removal of trees must actually interrupt the life cycle of the organisms sufficiently to reduce their spread to other trees. In some cases, simply removing infested or infected material is one part of several steps needed to mitigate an insect or disease issue. Consult information related to a specific pest in order to understand all of your options.

Figure 16-17: An improvement cut in this upland hardwood stand removed overtopping, undesirable trees, thus "releasing" small poletimber from competition that reduces growth rate.

Pruning

Pruning is a silvicultural technique, typically applied to improve timber quality and value. It is the removal, close to the branch collar or flush with the stem, of side branches and multiple leaders from a standing tree. Branches are removed because they form knots, which are a common defect of lumber, and reduce timber value. The retention of large, dead branches low on the trunk is particularly counterproductive. Multiple leaders are removed to improve stem form. Sometimes, pruning is applied to control disease, or improve aesthetics or accessibility.

Pruning is expensive. Only the best quality crop trees on good sites should be selected for pruning. It is most commonly applied to conifer plantations of species which are poor natural pruners, but which can significantly increase value by producing clear lumber (e.g., white and red pines). Pruning can enable more aggressive thinning strategies, if the promotion of natural pruning is no longer a concern. Combining pruning and aggressive thinning can facilitate the production of increased value in a shorter period of time, by stimulating rapid healing of wounds and promoting the production of clear wood.

Some operational considerations relative to pruning are:

- Careless, poorly implemented pruning can cause tree injury. Avoid excessive green pruning of live branches.
- The best time to remove a branch is just before death or within several years thereafter.
- Pruning should occur in young stands before the lower branches become relatively large. Removing large (greater than one to two inch diameter), live branches can damage quality.
- Pruning is best done in the dormant season – fall to late-winter is best. Time pruning of oak to minimize the risk of introducing the fungus that causes oak wilt. For more information, visit: ***dnr.wi.gov – keywords "oak wilt."***
- The first pruning should be in young, vigorous poletimber, following early initial thinning.
- Candidates for pruning should be the most vigorous, healthy, dominant (tallest), and largest diameter crop trees for the dominant age class – the very best individuals.
- Before implementing, identify the minimum tree specifications and the maximum number per acre. Typically 50 to 200 crop trees are pruned per acre, generally in two to three operations.
- A typical final objective as a result of pruning is a clear trunk to 17 feet; prune at least to nine feet. Each pruning is done to the topmost whorl of dead branches or into the lower portion of live crown. The ratio of live crown to tree height after pruning should exceed 50 percent.
- Cuts should be made just outside of the branch collar (swollen tissue when branch meets stem) and not flush with the stem. Do not tear or loosen bark in the branch collar area. Combining hand and pole saws provides an effective and economical choice. Other tools and machines are available, and may be preferable depending on species, limb characteristics, and pruning height.

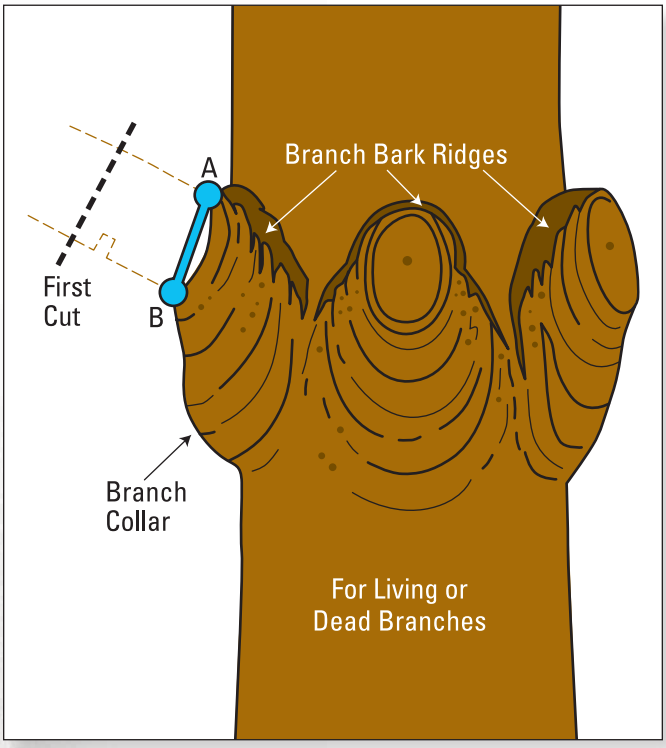


Figure 16-18: When pruning, leave the branch collar. Cut from point "A" to point "B."

POST-OPERATIONAL ACTIVITIES

- Rehabilitate landings, skid trails, and access roads to mitigate soil erosion, rutting, compaction, and the spread of invasive plants (see 6.2).
- Monitor and control any new infestations of nonnative invasive plants. Clean equipment before moving from any infested site to an area that is free of invasive plants (see 4.2, 4.4 and 4.5).
- Careful records should be kept of intermediate treatments in order to assess the growth response, economic viability, and the need to refine future thinning schedules.

BMPs: Invasive Species

- 3.2 Prior to implementing management activities, scout for and locate invasive species infestations, consistent with the scale and intensity of operations.
- 4.2 If pre- or post-activity control treatments are planned, ensure that they are applied within the appropriate time window.
- 4.3 Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.
- 4.4 Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.
- 4.5 Take steps to minimize the movement of invasive plants, insects, and diseases to non-infested areas, during forest stewardship activities.
- 4.6 Take reasonable steps to avoid traveling through or working in small, isolated, populations of invasives during forest stewardship activities.
- 6.2 Revegetate or reforest as quickly as feasible after site disturbance.

Figure 16-19: A dense thicket of nonnative invasive honeysuckle on one side of a property fence. Honeysuckle on the near side was cut, and the stumps were treated with herbicide.

Figure 16-20: Seeding can be as easy as spreading grass seed by hand as this landowner is doing on his freshly-graded woods road. Use non-invasive species and certified weed-free seed.

Figure 16-21: Retaining slash on skid trails is an effective way of reducing soil compaction and rutting from use of heavy logging machines.

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

CROP TREE MANAGEMENT IN EASTERN HARDWOODS

Crop Tree Management in Eastern Hardwoods. Publication Number NA-TP-19-93, Perkey, A. W., Wilkins, B. L. and Smith, H. C, U.S. Department of Agriculture, Forest Service, Morgantown: New Entry Sustainable Farming Project, 1993.

THE DICTIONARY OF FORESTRY

The Dictionary of Forestry. Helms, J. A. (Editor), Society of American Foresters, 1998.

INTERMEDIATE CUTTINGS IN FOREST MANAGEMENT

Intermediate Cuttings in Forest Management. Wisconsin Woodlands Publication Number G3398, Hebschmann, M. and Martin, J., University of Wisconsin-Extension, 1987.

NATURAL DISTURBANCE AND STAND DEVELOPMENT PRINCIPLES FOR ECOLOGICAL FORESTRY

Natural Disturbance and Stand Development Principles for Ecological Forestry. Publication Number GTR NRS-19, Franklin, J. F., R. J. Mitchell, and B. J. Palik, U.S. Department of Agriculture, Forest Service, Northern Research Station, 2007.

THE PRACTICE OF SILVICULTURE

The Practice of Silviculture, Seventh Edition. Smith, D. M., New York: Wiley, 1962.

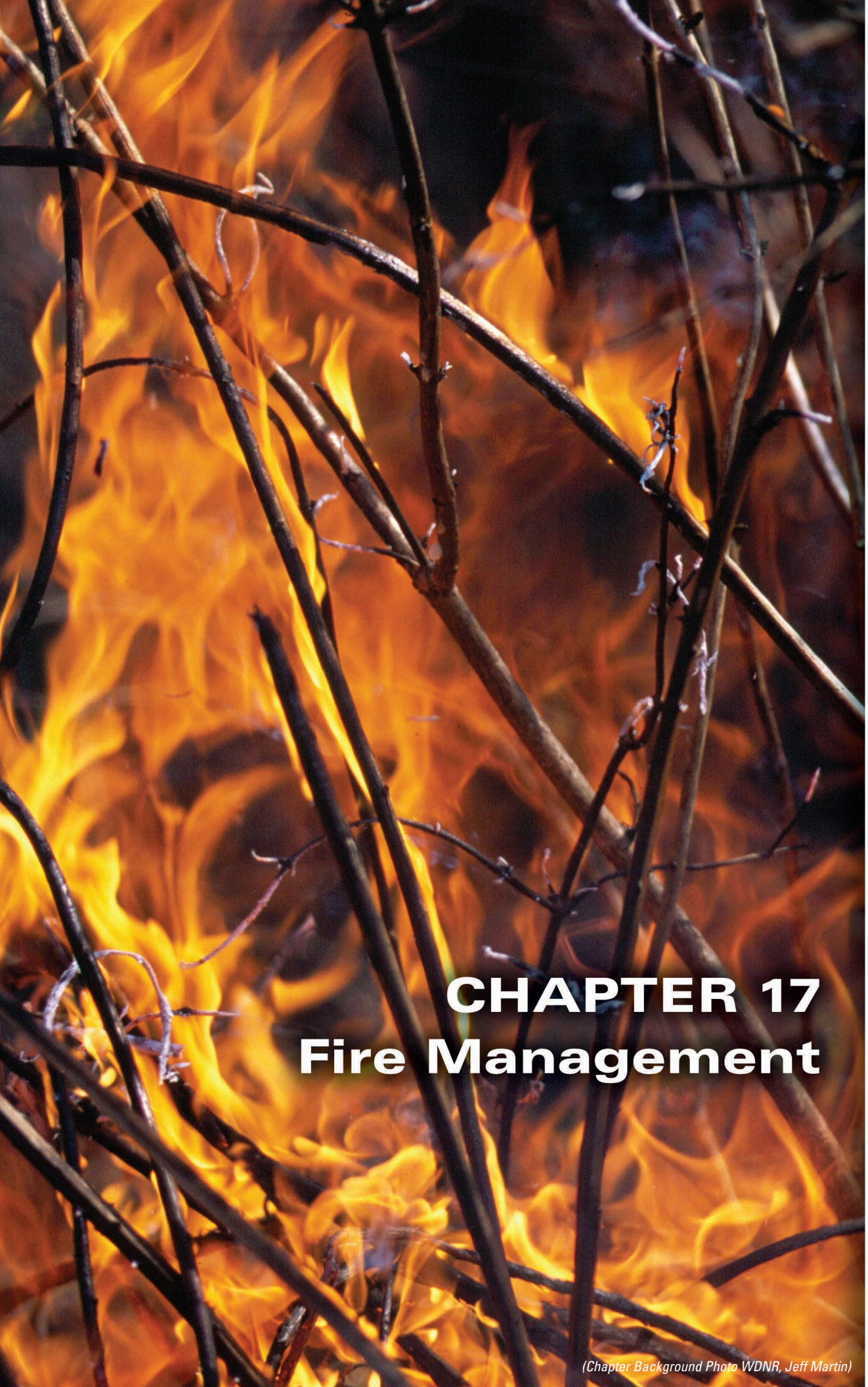
SILVICULTURE: CONCEPTS AND APPLICATIONS

Silviculture: Concepts and Applications. Nyland, R. D., New York: McGraw-Hill, 1996.

SILVICULTURE HANDBOOK

Wisconsin DNR Silviculture Handbook. Publication Number 2341.5.
dnr.wi.gov – keyword "silviculture"

NOTES



17

CHAPTER 17
Fire Management

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 17
FIRE MANAGEMENT

Part I: Wildfire Management

Part II: Prescribed Fire Management

Part I: Wildfire Management

Figure 17-1: A Wisconsin DNR tractor and fire plow construct a control line to protect a home from a wildfire in Marquette County. Careless people cause over three-fourths of such wildfires, debris burning being the number one cause. Many of these fires can be prevented and losses minimized with diligent precautions and fuel management.

Wildfire management involves the control, containment and suppression of a wild or uncontrolled fire. A **wildfire** is defined in Wisconsin state statues as an uncontrolled, wild or running fire burning in forest, marsh, field, cutover, or other lands.

Every year, more than 2,500 wildfires occur in Wisconsin, causing thousands of dollars of damage to property, and destroying natural resources. Wildfire managers prioritize the protection of lives, property and resources – in that order. The challenge of every manager is to minimize the damage done by wildfire, while at the same time ensuring the safety of everyone involved.

Protection of Resources from Wildfire

The protection of forest resources is vital to maintain the economics and aesthetics of Wisconsin forests. Landowners can implement a number of simple strategies to protect our valuable forest resources.

- **Maintain access trails and roads.** The spread of wildfire can be slowed by these barriers, thus limiting potential fire damage. Well-maintained roads also allow fire suppression crews to more easily access the wildfire area, speeding up suppression and mop-up.
- **Construct firebreaks or barriers to fire**, to protect high value forest resources, such as conifer plantations. The construction of firebreaks involves the elimination of flammable natural fuels, such as grass and leaves. Removal of the fuels down to bare mineral soil, will slow/stop the spread of wildfire into protected areas.
- **Remove the lower limbs of conifers and small trees near larger conifers** to help minimize the potential of catastrophic crown fires. The elimination of these "ladder fuels" will not allow a fire burning in surface fuels to climb into the crowns or tops of the existing trees. **Crown fires**, or fire in the tops of conifers, destroy the economic value and kill the trees. Crown fires also have the greatest potential for damage to lives, property and natural resources, and are extremely difficult and dangerous to control once they are started.

Protection of Property from Wildfire

Protecting property such as buildings, homes and garages is a high priority. Property owners in wildland areas can take some simple precautions to assist in protecting their property from the ravages of wildfire. The objective is to create an environment where buildings can survive a wildfire without the intervention of firefighters.

PLANNING PRECAUTIONS

- Plant fire resistant landscaping vegetation around homes. Deciduous plants hold more moisture and are less flammable than conifer plants. Carefully space plants and prune them regularly. Remove dead leaves and other litter from around the plantings.
- Construct buildings using fire resistant materials when at all possible. Such materials include cement, stucco, plaster, steel, masonry, and fireproof sidings. Roofing materials should also be fire resistant. Available materials include Class A shingles, metal sheeting or ceramic tile. Embers and sparks igniting nonfire resistant roofs have played a major role in the destruction of buildings on large forest fires.
- Plan a defensible space extending 30 feet around the building as free of combustible fuel as possible.

EXISTING STRUCTURES

- Maintain building driveways to a standard of 12 feet wide and 15 feet of vertical clearance. This allows fire trucks access, and forms a firebreak to slow or stop wildfire. The driveway should also include a turnaround near the buildings to allow fire suppression equipment to easily escape to safety.
- Clear the roof and gutters of needles, leaves and other debris.
- Screen outside openings to the basement, attic and roof vents.
- Mow the lawn and keep all vegetation healthy and well-watered.
- Clean up leaf and needle litter, especially against buildings and under porches and decks.
- Store woodpiles and other flammable materials at least 30 feet away from structures.
- Maintain a defensible space extending 30 feet around the buildings. The objective is to create an environment where the buildings can survive a wildfire without direct intervention from fire suppression crews. This 30-foot zone of protection should be as free of combustible fuel as possible to limit any ignitions from the wildfire. Trees should be pruned up six to 10 feet, and all tree limbs within 15 feet of the building removed. Any dead vegetation such as leaves, needles, twigs, and branches should be removed. The grass should be mowed and adequately watered.

Part II: Prescribed Fire Management

Prescribed fire is the intentional application of fire to wildland natural fuels, under specific environmental conditions, to accomplish planned land management objectives. Historically, Native Americans used fire liberally to accomplish improved travel conditions, improve berry production, clear land, confound enemies, and for hunting. Today, prescribed fire can be used as a part of forest management to satisfy many different land management objectives. Though it is not generally considered a timber stand improvement practice, it can in some circumstances be used to accomplish many of the same goals as weeding or cleaning. While commonly prescribed, it is one of the most complicated and complex operations to implement.

Integrated Resource Management Considerations

- Prescribed burns can impact wetland areas and water quality if not carefully planned and conducted.
- Prescribed burns should be planned to avoid nesting seasons and other critical wildlife use periods.
- Prescribed burning can reduce the number of snags, den trees, and amount of course woody debris on a site.
- While prescribed fire can be used to treat nonnative invasive plants, it does not in and of itself eradicate them. Some temporary control is likely, but difficulties sustaining long-term control are confounded by the:
  - patchiness of understory and mixed-severity fuels and fires
  - persistent seed banks of nonnative invasive plants
  - ability of many species to rapidly increase after fire (fire equipment can transport seed to new locations and burned areas can be ideal seed beds)

  Prescribed fire, while not effective on its own, can be part of an integrated management strategy.
- Smoke and blackened vegetation can affect visual quality in sensitive areas.
- Burning in standing timber may affect merchantability, since pulp and paper industries cannot accept charred wood.
- Prescribed burning, particularly firebreak construction, can adversely impact cultural areas.
- Repeated intense burns may affect soil productivity. When conducting prescribed burns, use low- or moderate-burning intensity so that the minimum amount of forest floor is consumed consistent with meeting the objectives of the burn, especially for dry, sandy soils or shallow soils over bedrock.

TO BURN OR NOT TO BURN?

Prescribed fire is a versatile tool in land management. In managing forests in Wisconsin, however, sometimes it is not the best choice. If any of these situations exist, the use of prescribed fire is not a viable option:

- Federal or state regulations prohibit burning.
- Local ordinances or zoning rules prohibit burning.
- Safety factors cannot be mitigated to ensure personnel safety.
- Containment risk factors exceed suitable limits.
- Endangered resources or natural communities are subject to harm, or their status is in doubt.
- The natural community or timber type being managed is not adapted to fire. In Wisconsin, oak is most closely associated with prescribed fire. Most other timber types are incompatible with fire (i.e., northern hardwoods, central hardwoods, etc.).
- Fire behavior or fire effects will not meet the objectives for the burn area (e.g., if the goal is to top kill buckthorn three to four inches in diameter, it is unlikely that a fire with one to two foot flame length would be able to safely generate enough intensity to accomplish the goal).
- Local residences would be in jeopardy.
- Smoke sensitivity issues cannot be mitigated satisfactorily.

PLANNING AND DESIGN

Figure 17-2: A pre-burn briefing conducted prior to every prescribed fire addresses a number of critical items.

Prescribed burn plans generally involve a written document that addresses a number of factors. The plan should clearly describe the existing vegetation on the burn area, and the desired future condition. The plan should also spell out the specific weather conditions and ignition patterns required to achieve the desired fire behavior. Any issues relating to adjacent lands, communities, structures, roads, smoke management, and traffic control needs should also be addressed. Finally, the plan should identify the people and equipment needed to safely complete the burn, and include a detailed contingency plan for reacting to any emergency.

Burn Plan Management

- Consult with local Wisconsin DNR personnel trained and experienced in prescribed burning for pertinent assistance in planning and conducting burns.
- Check local fire regulations and obtain a burning permit from the Wisconsin DNR or your local municipal or township authorities, as needed.
- Consider protection of the largest coarse woody debris from fire, if practical.
- Include cultural resource information in both wildfire suppression and prescribed burn plans. Important information includes:
  - Locations of known cultural resources.
  - Locations of high probability areas for the occurrence of cultural resources.
- Identify occurrences of nonnative invasive species, and evaluate the effects fire is likely to have on them. Identify any need to treat infestations prior to burning, or any integrated pest management (IPM) treatments to be used in conjunction with burning to prevent new infestations (see 8.1, 8.3 and 8.4).

Land Management Objectives

Achieving land management objectives are the primary consideration for conducting prescribed burns. These objectives are varied and diverse. Some examples are:

- **Fuel reduction to reduce the risk of catastrophic wildland fire.** This objective is especially important in forests in proximity to urban areas. Reducing fuel loads is one of the most effective elements of any fire prevention and protection program.
- **Site preparation for natural seeding or mechanical replanting forests.** Prescribed burning is one of the least expensive and most environmentally sound ways to accomplish this practice. Nutrients are released into the soil during burning to further enhance the re-establishment of a new forest.
- **Restoration of fire dependent ecosystems.** Fire is a natural and necessary component of some ecosystems, such as native prairies and oak savannah. Periodic fire is required for regeneration and growth of fire adapted species within these systems. Prescribed burning assists in restoring and maintaining these rare plant and animal communities.
- **Improvement of wildlife habitat.** Fire and wildlife have a long and intimate association both in and out of the forest environment. Prescribed fire is rarely lethal to wildlife and helps habitats by increasing browse – creating edge and increasing productivity.
- **Controlling vegetative competition.** Examples would include burning to decrease woody vegetation in grass duck nesting fields, or to control maple sprouts while favoring more desirable oak seedlings.
- **Controlling forest insects and diseases through the use of fire.** Certain pathogens and insects can be controlled through the timely use of prescribed fire.
- **Improved pasture conditions for livestock is possible through prescribed burning.** Research has shown forage for livestock can be improved in quality and quantity with timely burning.
- **Control of nonnative invasive plants and other competing vegetation** can be accomplished, in some cases, by exploiting sensitivities to fire.
- **Enhance desired aesthetic qualities** by favoring specific plant species, or enhancing herbaceous components.

Factors Influencing Fire Behavior

A prescribed fire is designed around a carefully developed burning prescription designed to generate the specific fire behavior needed to accomplish the intended land management objective. The following are key components that must be considered.

FUEL

Fuel is defined simply as any combustible material. Wildland fuels consist of live and dead plant materials. Some factors of wildland fuel affect the prescribed burn planning.

- **Fuel types** are classified by the primary carrier of the fire. Light fuels are grasses, leaves and small twigs, which burn rapidly and completely. Heavy fuels – made up of branches, limbs and trees – burn hotter, longer and more slowly.
- **Fuel moisture** is the amount of water in a fuel. The higher the moisture the slower a fuel will burn. Both live and dead fuel moisture has to be considered before burning. Light fuels take on and lose moisture much faster than heavy fuels.
- **Fuel loading** (see Figure 17-3) is a very important consideration in planning a prescribed burn. The fuel load is the quantity of fuel available for combustion. The higher the fuel load, the more intense a given fire.
- The horizontal continuity of fuels is important to predict the spread of a prescribed fire. **Uniform fuels** are continuously distributed over a given area. **Patchy fuels** would indicate uneven distribution of fuels.
- The vertical arrangement of fuels is also important. **Ground fuels** are fuels able to burn under the surface of the ground (i.e., deep duff, tree roots, peat soils). **Surface fuels** are combustible materials on the surface (i.e., grass, leaves, shrubs, stumps). **Aerial fuels** are the fuels located above the surface in the canopy including leaves, needles, branches, snags, and tree crowns.

Figure 17-3: Light fuels tend to burn rapidly and completely. They also dry out much faster than heavier fuels when the relative humidity decreases.

WEATHER CONDITIONS

Weather conditions are another important consideration. Weather conditions must be closely monitored before and during prescribed burning. Both predicted and actual weather will influence the decision to burn. Some basic weather parameters that must be evaluated in the development of a burning prescription include:

- **Temperature:** A measure of warmth that directly influences fuels. Higher ground and fuel temperatures make the fire burn hotter and faster.
- **Wind:** The primary factor influencing the rate and direction of fire spread. Wind encourages the combustion process and spread of fire by increasing the supply of oxygen, drying out fuels and carrying firebrands ahead of the main fire.
- **Relative Humidity:** The ratio of the amount of moisture in the air to the amount of moisture the air could carry at saturation. Fuels and the air are constantly exchanging moisture. Light fuels, such as grass, gain and lose moisture quickly with changes in relative humidity. A **low relative humidity** means the air will take moisture from light fuels, making it easier to ignite and burn rapidly. Heavy fuels exchange moisture with the air much slower, and respond to changes in the relative humidity much slower.

TOPOGRAPHY

Topography is the configuration of the earth's surface, including its relief and position of its natural land features. Topographical influences on the behavior of a fire can be predicted. Several topographic terms are important to understand in relationship to fire behavior.

- **Aspect:** The direction a slope faces. A south facing slope will absorb more of the radiant heat of the sun, therefore, the fuels on that slope will have a lower fuel moisture allowing for easier ignition and rapid spread of fire. North facing slopes will have wetter fuels, therefore, less intense fire.
- **Slope:** The steepness of a hillside. Fires burn more rapidly uphill than downhill. The steeper a slope, the faster a fire burns uphill. Slope also causes concern where burning materials can roll downhill and ignite fires below the main fire.
- **Elevation:** The height of terrain above mean sea level. Elevation can play an important role in the types and conditions of fuel. Fuels at lower elevation generally dry out earlier in the year than higher elevation fuels.
- **Shape:** The rugged topographic features of the landscape, such as box canyons, ridges and saddles. These features can affect the rate, direction and intensity of a fire burning near them.

OPERATIONAL CONSIDERATIONS

Once the decision to conduct a prescribed burn has been made, the next step is to evaluate a number of operational considerations that are key to conducting a successful burn.

Fire Spread Patterns

The direction of fire spread, relative to the wind direction, is an important factor in managing the fire behavior relative to the land management objectives of the burn. Fire spread can be categorized into three basic types: backing fire, head fire, and flank fire.

BACKING FIRE

Backing fire is a fire that backs into the prevailing wind or downslope. Fires of this type transfer heat to adjacent fuels through radiation. Backing fires produce short flame lengths, slow rates of spread, and low smoke densities but with poorer smoke dispersal. **Backing fires burn fuels for a longer duration and at higher temperatures, and consume more total fuel than flanking fires.** Overall prescribed burn costs per acre are higher because of the longer time needed to complete a burn. Backing fires work well when wind velocities are low and from a constant direction. Burning downward on slopes has a similar effect as backing fires in flat areas.

HEAD FIRE

A **head fire** is a fire that burns with the wind or upslope. This type of fire spread transfers heat to adjacent fuels by convection. Wind drives convective heat into fuels downwind – lowering fuel moistures, raising fuel temperatures, and lowering ignition temperatures. Head fires burn fastest, hottest and with the longest flame lengths. **Head fires are the most difficult to control because of the greater potential for firebrands to ignite fuel outside the burn area.** Head fires transfer less heat to the surface with greater smoke volumes than backing or flanking fires. Containment is critical with this kind of fire, especially as wind speed and the amount of fuel increases.

FLANK FIRE

Flank fire is a fire spread that burns at oblique angles to the prevailing wind direction or slope direction. Flanking fires transfer heat through both radiation and convection. **Rates of spread, flame lengths, and fire intensity are between the extremes of head fire and backing fire.** Spotting can still occur with flanking fire, but at shorter ranges. Flanking fires are set parallel to control lines on a prescribed fire and spread at right angles to the wind or slope.

Ignition Patterns

Specific ignition patterns are used for each type of fire spread. The ignition pattern and ignition sequence are key to achieving the objectives of the burn, and meeting the containment requirements of the burn area with a minimum of risk.

BACKING FIRE IGNITION PATTERN

This firing pattern (see Figure 17-4) involves lighting a fire along the upwind side of an established control line, and letting it back into the wind. It is commonly used in closed canopy forests. **The advantages of this pattern include ease of control, low intensity, low rates of spread, and low scorch of trees and shrubs.** It is also a good method for controlling undesirable species with longer heat retention in the soil and roots. The negatives are slow moving fire, increased costs per acre, and patience.

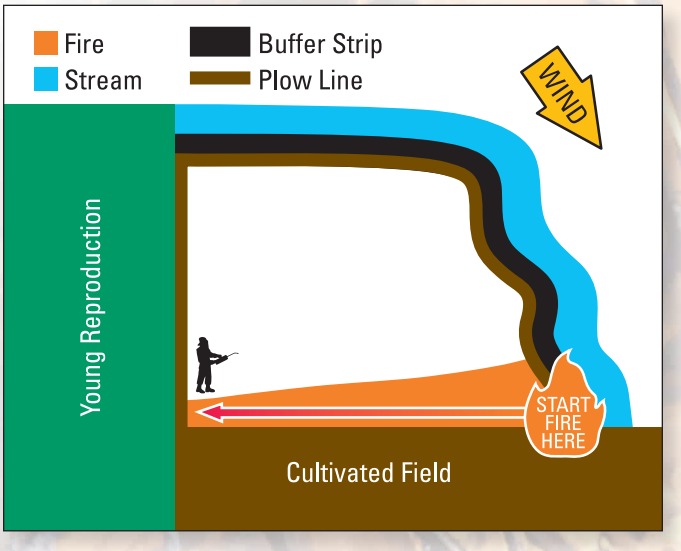


Figure 17-4: Backing Fire Ignition Pattern

STRIP HEAD FIRE IGNITION PATTERN

Strip head fire ignition (see Figure 17-5) involves igniting a series of short duration head fires, by moving perpendicular to the wind from one side of the prescribed burn area to the other. The first strip is initiated at the downwind end of the burn area, and each progressive upwind strip of head fire burns into the area already blackened by a previously burned strip. Adjusting the width of the strip adjusts the intensity of the fire. This pattern is commonly used in grassy areas where greater control is needed. **The advantages of this ignition pattern are that it is fast, inexpensive, can be used on large areas, and helps alleviate some smoke management concerns.** The smoke rises faster and to greater heights. The disadvantages are fast rates of spread, increased spotting potential, and greater burning intensities.

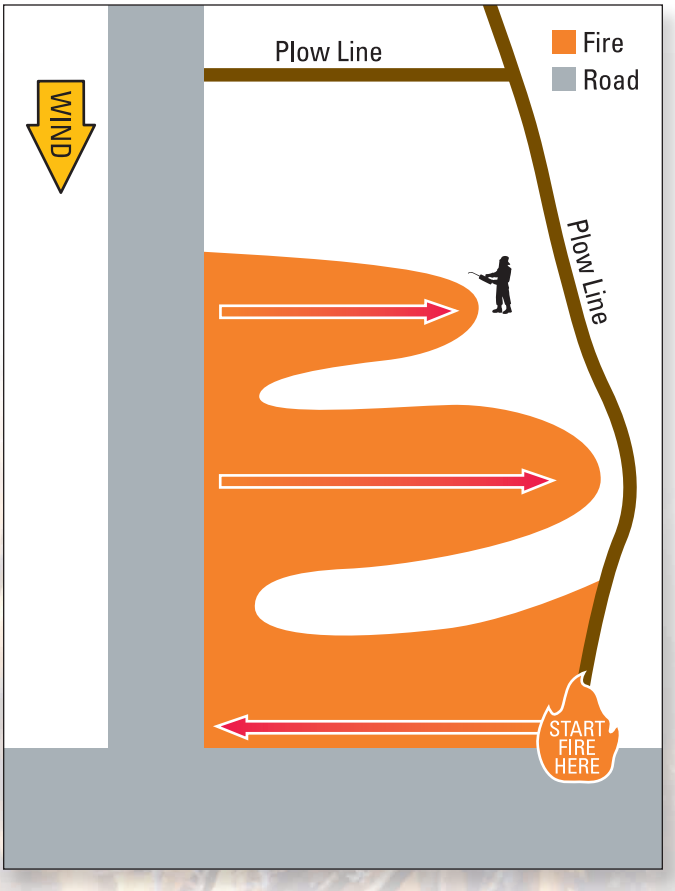


Figure 17-5: Strip Head Fire Ignition Pattern

FLANK FIRE IGNITION PATTERN

Flank firing ignition (see Figure 17-6) involves firing parallel with and into the wind or with slope. It can be used in a variety of situations from large broadcast burns to an underburn in closed canopy forests. Multiple ignition personnel can be used for large area burns. **The advantages of this ignition pattern are safety (no head fire), moderate burn intensities, and relatively low costs.** The disadvantages are a greater need for coordination and timing, and the potential that a wind shift could quickly endanger the safety of the ignition personnel, and threaten the control of the burn.

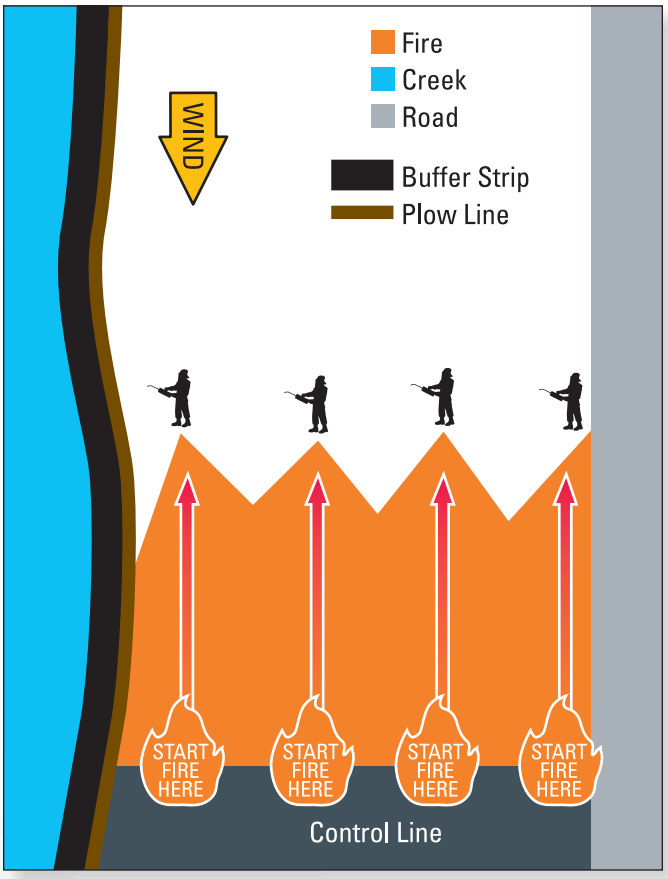


Figure 17-6: Flank Fire Ignition Pattern

CIRCULAR FIRE IGNITION PATTERN

The circular pattern, also called the ring firing pattern or the perimeter firing pattern, (see Figure 17-7) is a common ignition pattern that involves lighting fire around the perimeter of a burn area with the fire converging toward the center. **This pattern is most commonly used because of the ease of coordination, safety and speed.** It can be the most cost-effective burn pattern. A backing fire is first lit along an established firebreak on the downwind side of the burn area. A flanking fire is then initiated up the sides of the burn area along firebreaks. When the backing fire has burned out an area of sufficient width, a head fire is ignited along the upwind edge of the burn area. The separate fires then converge in the middle of the burn unit. **This pattern also allows for maximum smoke lift and dispersion.** The disadvantages of this pattern are high fire intensities in some areas of the burn, and the difficulty and danger involved in stopping the head fire, should the burn have to be aborted.

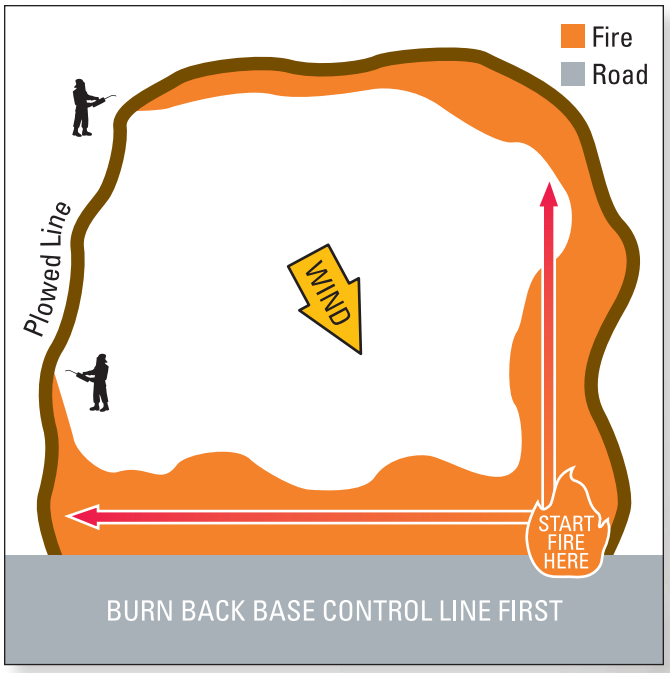


Figure 17-7: Circular Fire Ignition Pattern

SPOT FIRING IGNITION PATTERN

Spot (or dot) firing (see Figure 17-8) involves the setting of many small fires that burn together quickly. **This pattern of ignition controls the intensity of the resulting fire.** This pattern can be effective in either grass or forested areas.

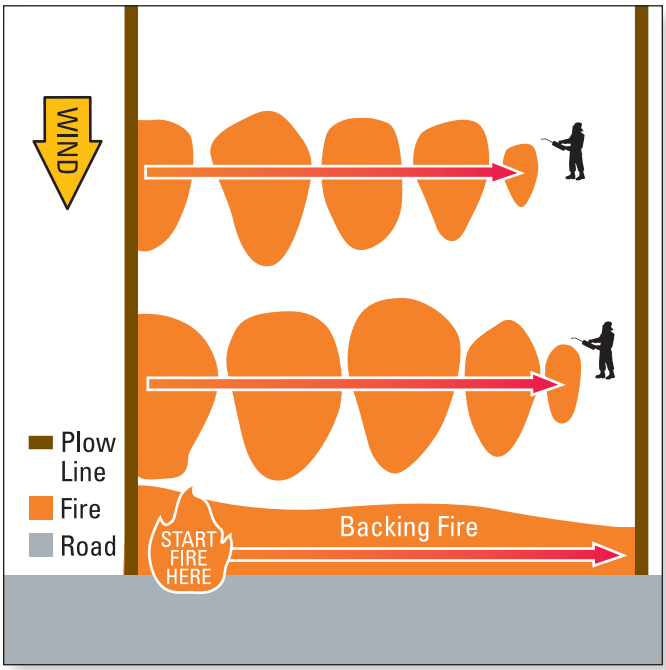


Figure 17-8: Spot Firing Ignition Pattern

Figure 17-9: Igniting a backing fire along a freshly prepared firebreak in a hardwood stand.

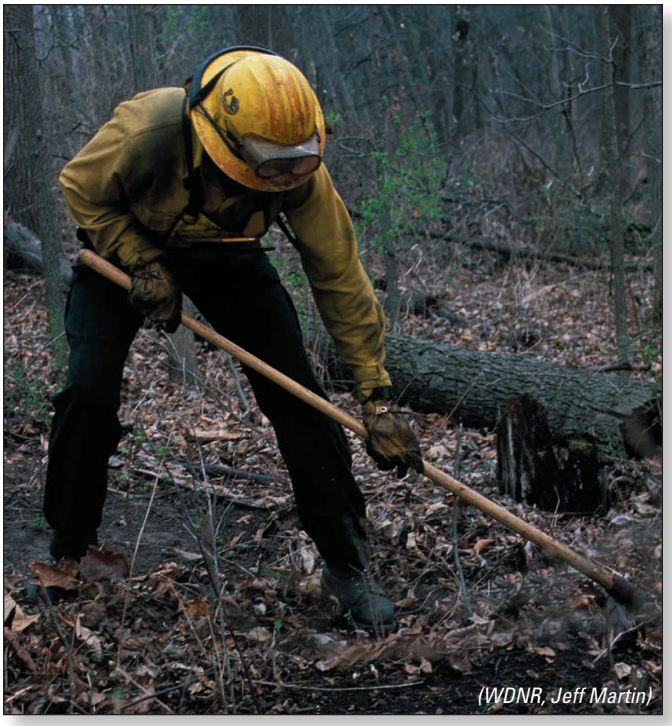


Figure 17-10: Constructing a mineral soil firebreak prior to a prescribed burning in a Wisconsin woodland.

Figure 17-11: Igniting one side of the burn area where a circular (or perimeter) ignition pattern was used.

Firebreaks

Confining prescribed fire to the areas that are intended to burn is the most critical element to the operational phase of a prescribed fire. A firebreak is a natural or constructed barrier able to stop or check fire spread, and to provide a control line from which to work. An effective firebreak must interrupt the continuity of the fuel bed, and provide containment of the fire under prescribed weather conditions.

- **Natural and artificial firebreaks** are existing features of the landscape. Natural firebreaks include lakes, streams, rivers, wetlands, snow banks, and rockslides. Artificial firebreaks include roads, ditches, trails, and tilled farmland. Utilization of such firebreaks can lower the costs of containment and aid burning operations. When using roads as firebreaks, smoke management must be considered, and traffic control measures may be required.
- **Wet lines or foam lines** can be used as firebreaks where there are environmental or cultural resource concerns. Wet lines and foam lines are inexpensive and easily constructed with common firefighting tools. A wet line is constructed by spraying water on fuels immediately prior to ignition. A foam line is constructed with chemically treated water. Class A foam additives raise the efficiency of water by lowering its surface tension, making it three to five times more effective in wetting fuels. Approved Class A foams are biodegradable and environmentally safe. Foam lines are also more persistent and visible than plain water. The disadvantages to these firebreaks are that they require additional crewmembers, equipment and large amounts of water. Wet lines and foam lines will also evaporate in fine fuels, requiring a more cautious initiation of firing.
- **Mowed firebreaks** are the least desirable of firebreaks because they do not remove all of the fuel. Mowed firebreaks must be very wide (25 to 50 feet) to be effective – even in grass fuel types. The cut vegetation should be removed or blown to the outside of the firebreak prior to fire ignition. These firebreaks can be prepared in advance, but still require increased patrols and surveillance by control crews to prevent fires from escaping. Wet lines and foam lines are usually used in conjunction with mowing to ensure safety and control of the burn.

Figure 17-12: Localized fuel concentrations can result in "hot spots" with increased fire intensity.

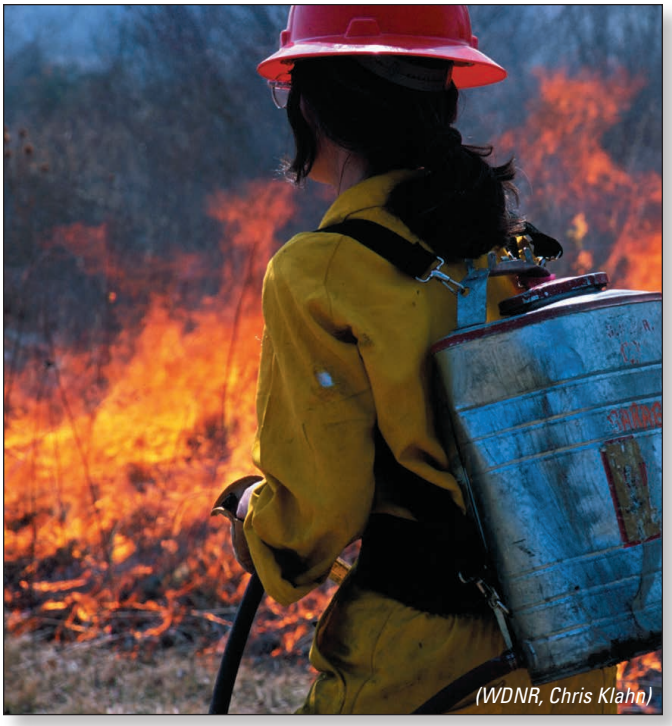


Figure 17-13: With secure firebreaks, stable weather, and well-executed firing patterns, hand tools like backcans, swats and shovels may be all that are needed by foot patrols to contain a burn.

Figure 17-14: Fires that crown-out in conifers can throw sparks great distances, which could cause a prescribed burn to escape control.

Figure 17-15: Although this type of plowed firebreak is more common on wildfires than prescribed burns, a bare mineral soil break provides one of the best anchors for ignition lines.

- **Burned firebreaks or black line firebreaks** involve the use of controlled fire to create a firebreak. Burned firebreaks are constructed prior to burning the whole prescribed fire area. Fire suppression crews must extinguish both sides of a line of fire to construct this type of break. The technique involves a lot of hot, difficult work by lots of firefighters, as well as large quantities of water or foam, since it requires setting and extinguishing fires two different times on the same land area.
- **Bare ground or mineral soil firebreaks** are constructed in areas lacking natural firebreaks. The construction of a mineral soil firebreak involves physically removing all fuels by rotovating, bulldozing, plowing, or disking with machinery to expose bare soil. The constructed firebreak width should be one and one-half times the flame length exposed to the firebreak. A typical constructed firebreak is from six to 15 feet wide. Mowing vegetation from six to 20 feet adjacent to the firebreak can diminish flame lengths along firebreaks and effectively increases the size of the firebreak (see 8.2).

Figure 17-16: Mop-up involves extinguishing all burning materials in the burn unit, such as this old log and stump.

Managing Firebreaks and Accesses

- Construct firebreaks outside of cultural resource areas. Use cultural resource professionals or tribal representatives to help determine firebreak locations.
- Construct firebreaks only deep enough and wide enough to control the spread of the fire.
- Avoid construction of firebreaks for fire management that result in drainage directly into a waterbody.
- Provide adequate filter strips when constructing firebreaks that expose bare soil near wetlands.
- Use firebreak construction methods in wetlands that do not expose bare soil whenever practical. These may include wet lines, existing constructed or natural barriers, foam, or retardants. If techniques result in exposure of bare soil, such areas must be restored if wetland hydrologic functions are impacted.
- Employ suitable water diversion structures on firebreaks, approaches to water crossings, or on roads and trails found within the riparian management zone to divert water off of the right-of-way before it reaches the waterbody (see 8.4 and 8.6).
- Monitor the effectiveness of cultural resource management practices during prescribed burns and wildfire suppression activities.
- Control access to sensitive cultural resources.

BMP: Managing Firebreaks and Accesses

- Where possible, locate bladed firelines on the contour. Construct waterbars as needed to direct surface water off firelines and into undisturbed forest cover. Recommended specifications for building waterbars and their spacing can be found in Chapter 12: Forest Roads, Drainage Structures, pages 12-12 and 12-13.

Protecting Water Quality

- Establish unburned zones that do not contain firebreaks to protect water quality in situations where steep slopes, highly erodible soils, or the likelihood of substantial organic matter removal are present.
  - Follow manufacturer recommendations.
  - Avoid cleaning fire retardant application equipment in lakes, streams and wetlands.

BMPs: Protecting Water Quality

- Carefully select fireline locations and consider weather, fuel, soil, and topographic conditions in and around the burn area to minimize impacts on water quality.
- Avoid burns that remove forest floor litter to prevent exposing soil in riparian management zones and on slopes where eroded soil may wash to surface waters.
- Avoid burning piles of slash in riparian management zones.
- Use natural or existing barriers (e.g., roads, streams, and lakes) where possible, or mowed, raked, and wet lines for firelines where bladed or plowed firelines will erode soil and degrade water quality.
- Avoid plowed and bladed firelines in riparian management zones except where necessary to control wildfire.
- Avoid applying chemical fire retardants over surface water. Prevent chemical fire retardants from flowing into surface water.

Smoke Management Considerations

Smoke can contribute to air quality concerns. A prescribed burn should be conducted in ways that minimize adverse environmental effects, and are in compliance with local and state air quality regulations. The following are some considerations relative to smoke management:

- Moist fuels produce more smoke than dry fuels.
- Head fires produce more smoke than slower backing fires.
- Smoke problems are more pronounced at night than during daylight. Burn during the day to maximize convective lift. However, burning during the day will create more intense fire that is more difficult to control.
- Stable air mass conditions help to restrict smoke convection and dispersion. Burn in slightly unstable air mass conditions.
- Check for possible restricted air space that smoke could impact, especially around airports and/or military bases.
- Check for smoke sensitive areas (nursing homes, schools and residential areas) and avoid sending smoke that would impact them. Notify sensitive receptors of burning plans as a common courtesy.
- Estimate and predict smoke duration and concentration to assess the risks of burning.
- Use test fires to confirm smoke behavior.
- Have an emergency plan to extinguish the fire if smoke conditions change adversely.
- Comply with all local and state air quality regulations.
- Avoid smoke on any public roadway.

Safety Considerations

- Safety should be the foremost consideration on every prescribed fire. The protection of lives, including firefighters, is the primary concern for all fire managers. Safety is promoted through training, removal of hazards, and the use of personal protective equipment. Firefighters have been injured and killed on the most innocent of prescribed fires.
- Everyone involved with prescribed fire should be wearing full personal protective clothing for his or her safety. Clothing and equipment worn should include all of the following:
  - Hard hat or helmet
  - Leather gloves
  - Nomex or other fire resistant shirt and pants
  - Leather boots
  - Goggles

The 10 Standard Fire Orders were developed in 1957 by a task force studying ways to prevent firefighter injuries and fatalities. Shortly after the Standard Fire Orders were incorporated into firefighter training, the 18 Situations That Shout Watch Out were developed. These 18 situations are more specific and cautionary than the Standard Fire Orders and described situations that expand the 10 points of the Fire Orders. If firefighters follow the 10 Standard Fire Orders and are alerted to the 18 Watch Out Situations, much of the risk of firefighting can be reduced.

10 STANDARD FIRE ORDERS

Fire Behavior

1.....Keep informed on fire weather conditions and forecasts.
2.....Know what your fire is doing at all times.
3.....Base all actions on current and expected behavior of the fire.

Fireline Safety

4.....Identify escape routes and make them known.
5.....Post lookouts when there is possible danger.
6.....Be alert. Keep calm. Think clearly. Act decisively.

Organizational Control

7.....Maintain prompt communications with your forces, your supervisor and adjoining forces.
8.....Give clear instructions and ensure that they are understood.
9.....Maintain control of your forces at all times.

If One Through Nine (Above) are Considered, Then...

10.....Fight fire aggressively, having provided for safety first.

The 10 Standard Fire Orders are firm. WE DON'T BREAK THEM; WE DON'T BEND THEM. **All firefighters have a right to a safe assignment.**

18 SITUATIONS THAT SHOUT WATCH OUT

1.....Fire not scouted and sized up.
2.....In country not seen in daylight.
3.....Safety zones and escape routes not identified.
4.....Unfamiliar with weather and local factors influencing fire behavior.
5.....Uninformed on strategy, tactics and hazards.
6.....Instructions and assignments not clear.
7.....No communication link between crewmembers and supervisors.
8.....Constructing line without safe anchor point.
9.....Building line downhill with fire below.
10.....Attempting frontal assault on fire.
11.....Unburned fuel between you and the fire.
12.....Cannot see main fire, not in contact with anyone who can.
13.....On a hillside where rolling material can ignite fuel below.
14.....Weather gets hotter and drier.
15.....Wind increases and/or changes direction.
16.....Getting frequent spot fires across line.
17.....Terrain or fuels make escape to safety zones difficult.
18.....Feel like taking a nap near fireline.

Pre-burn Briefing

A pre-burn briefing is necessary before every burn. All participants must be present before any prescribed fire activities can commence. The briefing should cover the following topics:

- Hand out maps to all participants.
- Review current weather and expected fire behavior.
- Explain the burn plan, and describe the ignition pattern to be used.
- Ensure everyone understands how to communicate. Test all radios.
- Check all equipment to ensure that they are all operating properly.
- Identify a burn boss. Assign personnel and equipment:
  - Assign specific control crew segments of the burn perimeter.
  - Assign an ignition crew and review firing sequence.
  - Observe weather conditions.
- Identify water fill sites to be used.
- Cover contingency plans in case of spot fires/breakouts.

Figure 17-17: Wearing full personal protective clothing is necessary for the safety of all crewmembers.

- Check for appropriate personal protective clothing and equipment.
- Review appropriate safety procedures.
- Ask for questions – clarify if necessary.
- Conduct a test fire to confirm fire behavior and smoke dispersal.

COMMON DENOMINATORS OF FIRE BEHAVIOR ON TRAGEDY FIRES

A **tragedy fire** is a fire that caused serious injuries or death(s):

- Most incidents happen on smaller fires, or on isolated portions of larger fires.
- Most fires are innocent in appearance before unexpected wind shifts in direction and/or speed results in flare-ups or extreme fire behavior. In some cases, tragedies occur in the mop-up stage.
- Flare-ups generally occur in deceptively light fuels, such as grass and light brush.
- Fires run uphill – surprisingly fast in chimneys, gullies and on steep slopes.
- Some suppression tools, such as helicopters or air tankers, can adversely affect fire behavior. The blasts of air from low flying helicopters and air tankers have been known to cause flare-ups.

Figure 17-18: A fire crew reviewing escape routes and safety zones prior to a prescribed fire.

POST-OPERATIONAL CONSIDERATIONS

Post-burn Monitoring

The fire is not over until all of the burn area is completely extinguished, the fuel is cold, and there is no smoke being produced. There are generally three steps to post-burn assessment:

- **Perimeter monitoring** of the burn area must be continuous from the onset of burning until the burn boss declares the fire out. Perimeter monitoring must ensure that the fire is kept within the burn unit boundaries. This activity is most critical as the main fire front passes a given area. At least one person must be kept back to periodically patrol the perimeter of the burn until it is declared out, even if the rest of the burn team moves on to other burn areas.
- **Mop-up** is the action of extinguishing all burning materials in a burn unit. Mop-up is the hard work of prescribed burning. It involves the most time and effort of all of the activities on a prescribed fire. Mop-up is not complete until the burn boss declares the fire out.
- **Abandonment standards should include 100 percent extinguishment** of burning or smoldering materials. Wisconsin state statues prohibit leaving a fire that is not extinguished completely.

Fire Effects Evaluation

The goal of any prescribed fire is to accomplish a land management objective. After the prescribed fire, an effective evaluation should be conducted to measure the success in meeting the stated objective. Post-burn evaluations are the key to improved future prescribed fire prescriptions. Evaluations should include pre-burn, burn and post-burn operations to improve all aspects of the prescribed burning. The following are some, but not all, important items that should be evaluated: 1) success in vegetative manipulation; 2) prescribed versus actual results; 3) post-burn vegetative condition; 4) accidents; 5) fire control problems; 6) smoke management problems; 7) burning pattern effectiveness; 8) cost effectiveness; and 9) corrective actions needed.

- **Assess the condition of cultural resources** that may have been affected by prescribed burning or wildfire suppression activities.
- **Field inspect the burned area** to identify cultural resources that may not have been previously identified, but have been newly exposed by the fire.
- **Remove temporary fire management features** that are inappropriate to the historic character of adjacent cultural resources.
- **Restore water source sites** used for fire management activities as soon as possible following control, or after the completion of mop-up activities.
- **Monitor the burned area for the presence of insects** that commonly infest trees stressed by fire. Salvage may be appropriate if populations of insects such as bark beetles (conifers), ambrosia beetles (hardwoods), or red turpentine beetle (pine) threaten the health residual trees.
- **Monitor the burned area and access routes for nonnative invasive plants**, and take steps to eradicate any that have been introduced by activities related to the burn. Fire equipment may need to be cleaned before it is moved from an infested site into an area that is free of problem invasives (see 8.4 and 8.5).

BMPs: Post-operational Considerations

- Do not clean chemical application equipment in surface water, or in locations that drain directly into surface water.
- Use erosion control measures for firelines that could erode soil into lakes, streams, and wetlands. Erosion control measures include revegetating bare soil and installing waterbars. Placing sod back into plowed furrows at appropriate intervals can act as waterbars (see Chapter 12: Forest Roads, Soil Stabilization, pages 12-16 and 12-17).
- Maintain soil stabilization practices until the site is fully revegetated and stabilized.
- Use mowing or other practices that do not expose soil as alternatives to blading or disking for maintaining firebreaks where erosion may degrade water quality.

BMPs: Invasive Species

- 8.1 Incorporate invasive species awareness, identification, and prevention education into fire training (e.g., fire effects and prescribed fire training).
- 8.2 Avoid placing firebreaks in infestations of invasive species.
- 8.3 Incorporate invasive species considerations into the planning of prescribed burns.
- 8.4 Avoid spreading invasive seeds and other propagules from infested to non-infested areas during prescribed fire activities.
- 8.5 Following a prescribed burn, rehabilitate soil disturbance related to burn activities, especially bladed or plowed firebreaks, where invasive species establishment is likely.

Figure 17-19: A late spring burn can be an effective way to kill young garlic mustard plants. Repeated prescribed fire or other methods may be necessary to control the newly germinated plants the following year.

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

DEPARTMENT OF NATURAL RESOURCES, BUREAU OF FOREST PROTECTION

Information on burning permits, wildfire activity, fire weather forecasts, and fire departments.
dnr.wi.gov – keywords "forest fire"

FIRE MANAGEMENT HANDBOOK

This handbook from the Wisconsin DNR contains information on fire suppression tactics and training, and the use of prescribed fire, along with technical information on the Wisconsin Division of Forestry Fire Management Program.

FIREWISE

Information on ways to protect homes located in fire prone areas.
www.firewise.org

NATIONAL FIRE PLAN

Information on the impact of wildfires on communities and the environment.
www.forestsandrangelands.gov/resources/overview/

NATIONAL INTERAGENCY FIRE CENTER

Wildland fire information, fire statistics, and links to other agencies.
www.nifc.gov

NATURE CONSERVANCY

Information on the use of prescribed fire and training.
www.nature.org/ourinitiatives/regions/northamerica/unitedstates/illinois/volunteer/prescribed-fire-training.xml

NORTHERN PRAIRIE WILDLIFE RESEARCH CENTER

Information on the use of fire in wildlife management.
www.npwrc.usgs.gov

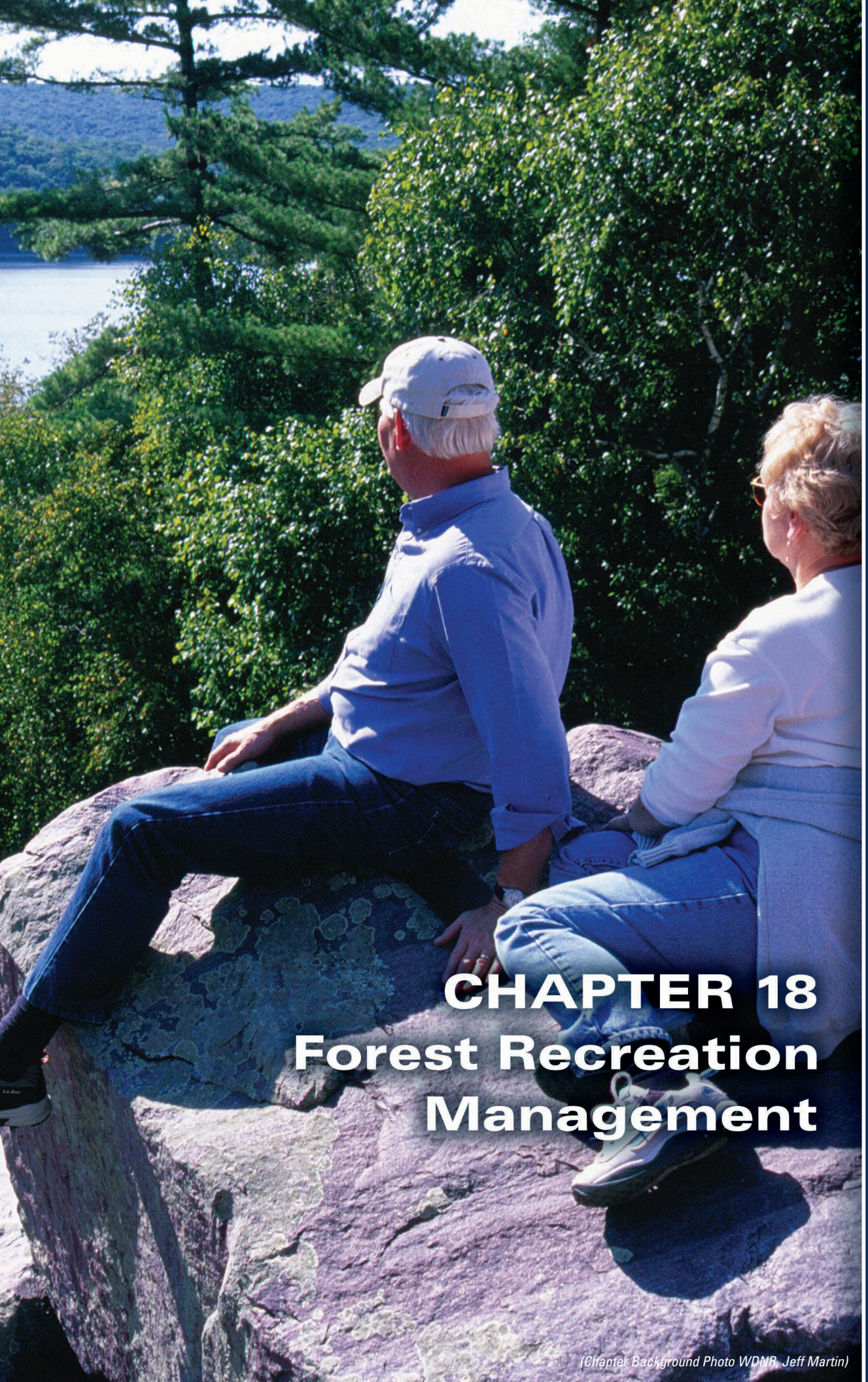
U.S. FOREST SERVICE, FIRE AND AVIATION MANAGEMENT

Information about wildfire activity and situation reports, fire management, training, fire use, and fire prevention.
www.fs.fed.us/fire

WILDLAND FIRE INCIDENT MANAGEMENT FIELD GUIDE

This publication from the National Coordinating Group covers all aspects of wildfire management and safety.
www.nwcg.gov/publications

NOTES



18

CHAPTER 18
Forest Recreation Management

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 18
FOREST RECREATION MANAGEMENT

Forest recreation management involves the selection, development, operation, and maintenance of recreation areas to provide quality outdoor experiences for the recreation user.

Forest-based recreation is frequently a primary objective of private forestland ownership. University of Wisconsin-Extension research indicates that the most popular recreational pursuits of private forest woodland owners include hunting, camping, snowmobiling, hiking, fishing, ATV riding, wildlife watching, off-road bicycling, cross-country skiing, and berry picking. Proper forest recreation management can enhance the recreation experience, while at the same time, complementing a number of other landowner objectives.

Integrated Resource Management Considerations

- Forest recreation related development can impact **riparian areas and wetlands** if not carefully planned and constructed. Improper location, careless construction, and overuse of recreation sites can damage vegetation needed to retain sediments and stabilize banks and shorelines.
- **Soil productivity** can be reduced when soils are compacted, rutted, displaced, or eroded. Some equipment used in developing recreation sites can cause these kinds of soil damage. Soil damage can also be caused by recreational vehicles (e.g., ATVs, pickups, dirt bikes, snowmobiles when there is not enough snow, mountain bikes), horses, or by the trampling of too many hiking boots.
- Poorly designed and/or overused recreational developments adjacent to waterbodies have the potential to impact **water quality**. Wisconsin's Forestry Best Management Practices (BMPs) for Water Quality and local zoning regulations are important considerations. Information on Wisconsin's Forestry BMPs can be found at: ***dnr.wi.gov – keywords "water quality forestry BMPs."***
- Recreational activities can introduce and/or spread a variety of **invasive species**. Planning for recreational development should include plans for monitoring and controlling invasives. A complete list of recreational user BMPs for invasive species can be found at: ***www.wisconsinforestry.org initiatives/other/invasive-species-bmps recreation-bmps***.

  Here are a few examples of BMPs for limiting the spread and introduction of invasive species for recreational users:
  - Plan activities to limit the potential for the introduction and spread of invasive species.
  - Avoid traveling through or working in small, isolated populations of invasive plants.
  - Clean equipment, shoes and clothing upon leaving infested areas.
  - Minimize soil disturbance.
  - Do not plant known invasive plants.
  - Inform and educate users of an area about common invasive species.
  - Provide invasive species training opportunities for staff, contractors and volunteers.

Figure 18-1: A simple boot cleaning once you leave an area with invasive plants can help minimize the introduction and spread of invasive plants to other areas.

Figure 18-2: Multiple-use trail systems are common in many public and industrial forestlands. These areas often receive a lot of traffic, and may need special protective measures to guard against soil erosion and other site damage.

- Trails, campsites and other recreational developments can increase **wildlife** viewing opportunities, but careful planning is needed to avoid degradation of unique habitats, and adversely impacting rare or sensitive species through increased human use.
- **Visual quality** is normally a primary consideration in the development of recreational areas. Care must be taken to ensure that construction methods and standards, maintenance activities, levels of use, and potential user conflicts are also considered in order prevent visual degradation of both the developed area and the adjacent surroundings.
- Carefully designed **timber harvests** can present opportunities for later use of haul roads and landings for recreational purposes.
- **Cultural areas** can provide excellent recreational/educational opportunities, but protection from possible overuse, vandalism, theft, and other potential problems associated with increased human use must be carefully considered.

PLANNING AND DESIGN

Well thought out recreation areas are easy to use, inviting and make sense. You may consider hiring a landscape architect to assist with planning for more extensive developments. As you plan your own recreation development, think back to sites you have used that worked well. Recall what their orientation was. For example, beaches generally should face south or west, but the snow on ski trails last longer facing north or east. Sketch out your plan on topographic maps and air photos to consider the relationships between different recreation uses, forest cover, slope, orientation, and other factors. Discuss plans with others that have already done similar work, and consider their comments. Keep an open mind and re-examine your initial thoughts before committing to a set plan. Up-front planning can save you time and money.

- **Recreation management begins with an assessment of an owner's values and goals for the forestland.** Some things to think about include:
  - What are the desired activities?
  - Is enough space available for the desired activities?
  - Can uses be separated by season or distance? For example, can hunting trails be used for cross-country skiing trails in the winter? Is your desired hunting experience compatible with ATV trails?
  - What activities are occurring on adjoining land?
  - Who may be using the forestlands? Are they private or public lands?
  - How long will the land be held? Can significant development be justified?
  - Will the activity increase the spread of nonnative invasive plants or invasive insects and diseases?
  - Can hazards such as defective or dead trees be mitigated to minimize the risk of injury from tree failure? Consider creating a hazard tree management plan if you are inviting people to camp, congregate or remain stationary in a location where tree failures could injure visitors.

Figure 18-3: A snowshoer wanders the woodlands of northern Wisconsin.

- **Consider other resource activities that may be compatible** with recreational development, and integrate planning whenever possible. Forest management activities, for example, can be part of an effort to develop recreational opportunities. Consider laying out harvest roads to accommodate trail development, and include site remediation as part of the timber sale contract. Revenues generated can be used to fund efforts to enhance the habitat value of landings and create wildlife viewing areas.

- **Environmental considerations** should be part of the planning process. Recreational development should be environmentally responsible. Consider soil types, topography and water resources. Resources are available from a number of sources to assist in providing information and technical advice (see the resources at the end of the chapter for more information). Efforts should also be made to identify any threatened and endangered species or rare habitats that may occur on sites to be developed (see Chapter 3: Wildlife Habitat and Biodiversity).

Figure 18-4: Bird watching is a popular activity throughout Wisconsin's forestland.

- **An assessment of the "carrying capacity" of the land is a key element** of recreation management planning. Different activities have specific spatial needs, and similarly, the lands ability to sustain a particular level of use varies by activity. Responsible planning is required to care for the site and meet the expectations of the user. Consider limiting the quantity of activities in order to provide a higher quality experience. Seek advice from landscape architects or other qualified planners for large-scale or intensive development. These professionals can save a great deal of money and frustration.
- **Consider how to address conflicts between users and groups of users.** You may have to separate uses by space or scheduling to avoid conflicts. Depending on ownership, you may need to consider providing law enforcement, trail patrols, and emergency medical treatment.
- **Maintenance** of a recreation area is seen as part of the recreation experience by some. Others want to minimize this task and maximize their recreation time. Maintenance needs, such as the mitigation of trees that could be hazardous, should be considered as plans are developed. Generally, well-planned and constructed facilities are easier and less costly to maintain. Check with other operators of recreation areas for advice on surface finishes, trail construction, mowing equipment, etc.
- **Cultural resources** like Native American burial sites or work sites, logging camps, or homestead sites can be very interesting and also provide historical insights. Planning for recreational development should address cultural resource issues in terms of both protection and interpretation. Existing cultural resource inventories should be reviewed early in the planning process. If no information is available, field inspections should be conducted before development plans are finalized to determine presence or absence of cultural resources. If cultural resources are present in the development area, it may be possible to modify construction plans to reduce or eliminate damage to the resources. Cultural resource professionals can help determine the best approaches to the mitigation of potential damage (see the Resource Directory for sources of cultural resource assistance).

- **Check with local authorities to ensure any planned developments meet code and zoning requirements.** Working with local zoning and code enforcement personnel before planning gets too far along can help you avoid costly re-work later. They are also familiar with local recreation sites, and can be a valuable source of information.
- **Handicapped access needs** should be evaluated and made part of the planning process – particularly if public use is anticipated.

Figure 18-5: An urban park provides the opportunity for some city dwellers to experience a local forest.

- **How will you pay for your development?** Funding through the Wisconsin Forest Landowner Grant Program (WFLGP) or federal cost-sharing assistance programs may be available for forestry projects that enhance recreational, historic or aesthetic features on private property. Activities eligible for financial assistance must be included in a Wisconsin DNR-approved Forest Stewardship Plan for the land. Contact your local Wisconsin DNR forester or Wisconsin DNR Service Center for additional information and application materials. Grants may also be available from state and federal agencies to assist with the development of recreation sites on publicly-owned land. For more information go to: ***dnr.wi.gov – keyword "WFLGP."***

Figure 18-6: A turkey hunter in southern Wisconsin.

OPERATIONAL CONSIDERATIONS

LIABILITY – CAN I BE SUED?

Landowners, including governmental bodies and non-profit organizations that own, lease or occupy land, or have a recreational agreement with another owner, have certain protections against liability under Wisconsin's Recreation Use Statute, 895.52. This important law says that landowners do not have a duty to inspect the property, keep it safe, or give warning of an unsafe condition. Only when a landowner acts maliciously or fails to disclose a known hazard, may he/she be liable. The law covers nearly every outdoor recreation activity, except organized team sports. Discuss this statute with your insurance provider as you consider risk management for your property. For more information, visit: ***learningstore.uwex.edu/assets/pdfs/G3326.PDF***.

Construction

- Install and maintain appropriate erosion control structures to protect water quality and soil productivity (see Chapter 12: Forest Road Construction and Maintenance).
- Use "fill-only" construction techniques in the area of the cultural resource.
- Do not allow surfaces in archaeologically sensitive areas to erode, slump or wash out. Implement temporary stabilization methods to preserve the shape, slope, elevation, and contours of archaeological sites and historic features. Stabilization should not alter the historic character of the cultural resource.
- If practical and feasible, avoid cultural resource areas when constructing recreational facilities. If it is not possible to completely avoid a cultural resource, minimize or eliminate soil disturbance and erosion in the vicinity of the resource.
- The *Wisconsin DNR Trails Handbook* can be of assistance when planning trails. It includes guidance on marking and signing, trail width, surfacing material, grades, and on-going maintenance. It also provides detailed diagrams as well as signage suggestions. The *Wisconsin DNR Department Design Standards Handbook* can be used as a guide to the development of general recreational facilities. It has chapters that include picnic areas, swimming beaches, trails, camp areas, parking lots, and fishing facilities, and provides guidance on developing facilities that are accessible. For more information or to obtain copies of these handbooks, contact the Bureau of Parks and Recreation by visiting: ***dnr.wi.gov – keyword "parks."***
- When landscaping sites, make sure to choose plants that are appropriate to your area and are quality stock. Plant according to specifications, and provide adequate follow-up care. Do not use nonnative invasive plant species.

BMP: Invasive Species

6.4 Select plant materials that are site appropriate to favor establishment and vigor.

Figure 18-7: Trail construction should consider invasive plants. The honeysuckle shrub adjacent to this trail and other invasive plants may spread or invade new areas dues to the disturbance.

Operations

- When operating within a riparian management zone, confine recreational off-highway vehicle use and other nonfoot traffic to trails that are designed, constructed and maintained using guidelines for skid trails and forest roads. Refer also to appropriate guidelines in Chapter 13: Timber Harvesting and Chapter 12: Forest Road Construction and Maintenance.
- All sites need to be inspected periodically. Look at your recreation site from a critical perspective. It is easy to overlook conditions that you see every day, so ask an associate or even a customer for critical feedback on your maintenance program. This work will pay off in reduced risk and improved understanding of the way others see your facility. At minimum, you need to inspect for diseased and defective trees from the standpoint of creating a hazardous situation, surface irregularities, signage, and other safety related conditions in your recreation area. In areas that will receive a lot of traffic (pedestrian or vehicular), periodically inspect the facility to determine whether a cultural resource is being damaged by public use of the area. If so, special protective measures may be desirable.
- Monitor recreation areas for the introduction of nonnative invasive species, and take action to control them as necessary.
- Consider developing a firewood management policy to minimize the risk of introducing invasive insects and diseases.
- If your facility is for-profit, you will want to consider marketing. There are a number of local, regional, state, and national associations and agencies eager to assist with the promotion of recreation facilities. The easiest way to get started is to contact your local Chamber of Commerce or Visitor and Convention Bureau.

Figure 18-8: This camper is being inspected for gypsy moth. Inspecting vehicles and other recreational equipment before leaving a site will help slow the spread of invasive species.

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

COUNTY FORESTS AND COUNTY PARKS

County Forestry and Parks Departments also operate recreational sites, and are a great source if you need additional advice.

DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION (DATCP)

The Wisconsin DATCP - Division of Food and Recreational Safety is responsible for managing programs that enforce applicable State administrative codes for the inspection and licensure of restaurants, hotels, bed and breakfast establishments, public swimming pools including water park attractions, and campgrounds in Wisconsin. By visiting the Wisconsin DATCP website, you can find more information on definitions and licensing along with links to the Wisconsin State Statutes and Administrative codes pertaining to recreational and educational camps.

datcp.wi.gov/Pages/Programs_Services/RecreationalFacilities.aspx

DEPARTMENT OF TOURISM

The Wisconsin Department of Tourism provides guidance and leadership to Wisconsin's tourism industry, and ensures that tourism is a top contributor to the state's economy and quality of life.

industry.travelwisconsin.com

FEDERAL AGENCIES

The Forest Service and National Park Service provide publications to guide the development and maintenance of recreation sites.

www.fhwa.dot.gov/environment/recreational_trails/publications/index.cfm

UNIVERSITY OF WISCONSIN EXTENSION

The "Wisconsin Idea" promotes connections between people and the university. Extension agents and staff are available to assist with business ventures and with planning.

www.uwex.edu

WISCONSIN ASSOCIATION OF CAMPGROUND OWNERS (WACO)

WACO, a non-profit association, is a federation of private Wisconsin campgrounds dedicated to the promotion, usage, growth, and improvement of campgrounds in the State of Wisconsin.

www.wisconsincampgrounds.com

WISCONSIN COUNCIL ON FORESTRY

The council directed the process to develop Best Management Practices (BMPs) for Invasive Species, including BMPs for Preventing the Spread of Invasive Species by Outdoor Recreation Activities in Wisconsin. Other topics of invasive BMPs include: Forestry, Urban Forestry and Transportation and Utility Corridors.

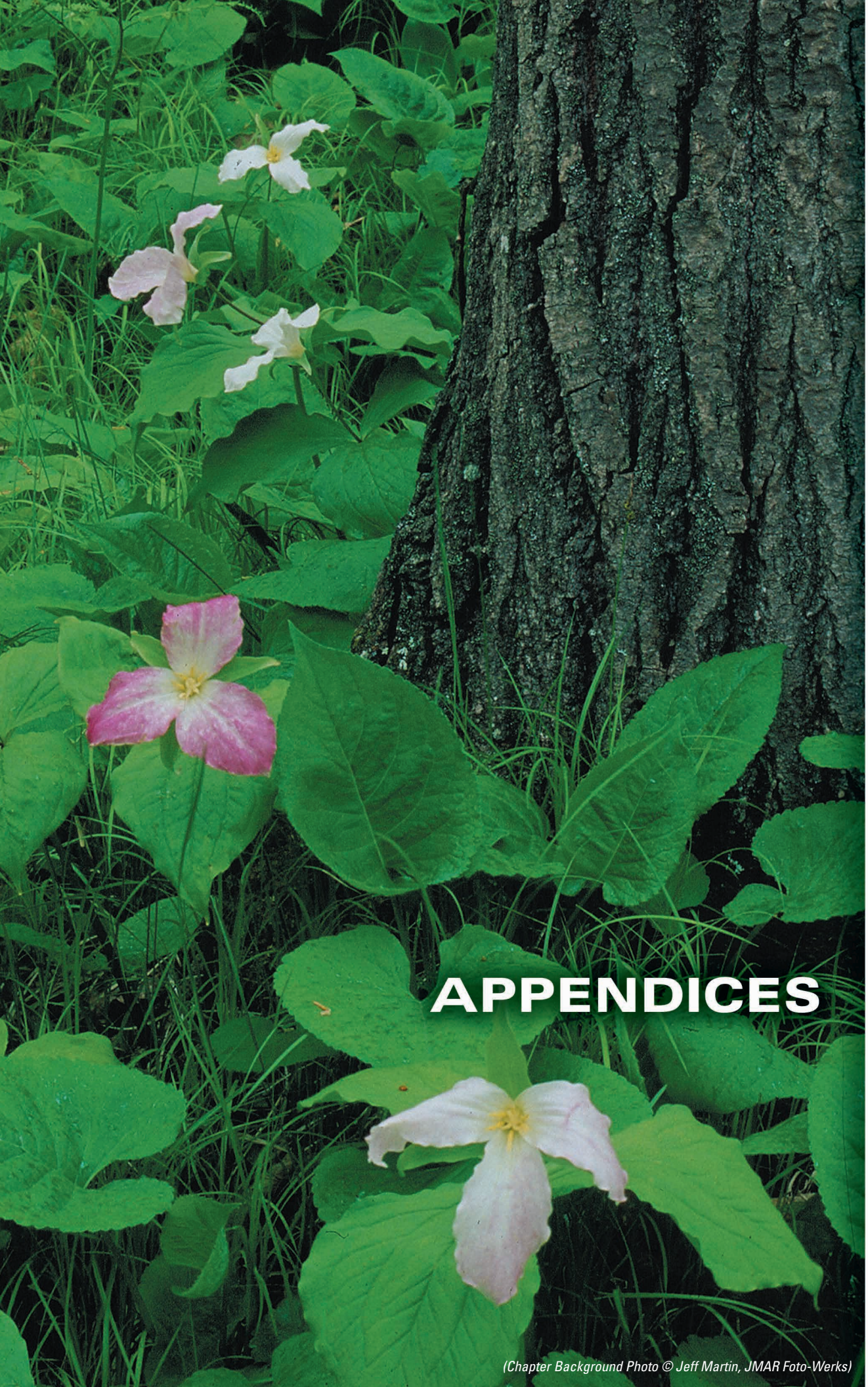
wisconsinforestry.org

WISCONSIN DEPARTMENT OF NATURAL RESOURCES (DNR)

Wisconsin DNR staff can offer practical advice on many aspects of forest recreation planning.

- ADA considerations
- Drinking water, wastewater, water regulation and zoning
- Recreational facility operations
- Grants and loans

For more information on these topics, to contact the Bureau of Parks and Recreation or to find a park or state forest near you visit: ***dnr.wi.gov – keyword "parks."***



APPENDICES

(Chapter Background Photo © Jeff Martin, JMAR Foto-Werks)

APPENDIX A: TREE MARKING AND RETENTION GUIDELINES

APPENDIX B: SAMPLE TIMBER SALE CONTRACT

APPENDIX C: FOREST CERTIFICATION

APPENDIX D: REGULATIONS RELATING TO FOREST MANAGEMENT

APPENDIX E: PERMITS

APPENDIX F: CITED REFERENCES

APPENDIX G: RESOURCE DIRECTORY

APPENDIX H: GLOSSARY

APPENDIX A: TREE MARKING AND RETENTION GUIDELINES

The information in this Appendix was taken from the Wisconsin DNR *Silviculture Handbook, 2431.5*, Chapter 24 (dated December 2012). For more detail on the information outlined here, you can review Chapter 24 of the *Silviculture Handbook* on the Wisconsin DNR website at: ***dnr.wi.gov – keyword "silviculture."***

The purpose of Chapter 24 is to:

- Provide silvicultural guidelines for selecting trees to retain and remove to accomplish specific stand management objectives.
- Provide recommendations for stand-level tree and snag retention to accomplish sustainable forest management goals.
- Recommend content of written marking guidelines for prescription implementation.
- Clarify concepts and considerations related to why and how trees are selected and marked, including appropriate silvicultural methods.
- Clarify silvicultural terminology.

TIMBER MANAGEMENT – CROP TREE SELECTION

Timber crop trees are trees selected to become a component of a future commercial harvest. These trees are selected for retention and their crowns released from competition to optimize tree vigor, and focus growth on the most desirable trees. Sawtimber crop trees are the best quality, high vigor trees of desirable species that are targeted for (near) final harvest; they will be grown to rotation age or maximum desired size class.

General sawtimber crop tree selection criteria:

- Low risk of mortality or failure (main stem breakage)
- Good crown vigor
- Good timber quality
- Desirable species

Crop tree management is an important part of most marking operations. The number of crop trees to retain and the desired residual stand density depend on management objectives, silvicultural methods, forest type and species, stand and tree condition, and site. In addition to timber crop trees, identify and retain other trees to provide multiple benefits. The selection of trees for retention strongly influences which trees will be cut.

TIMBER MANAGEMENT – SELECTING TREES TO CUT AND THE STANDARD ORDER OF REMOVAL

Before selecting trees to cut, identify desired residual stand composition and structure, and tree retention criteria (including both timber and non-timber goals and objectives). If all trees except seed trees or reserve trees will be cut, then specify seed or reserve tree objectives and characteristics, and the removal of all other trees to a minimum diameter (usually one inch DBH). For partial cuts, the characteristics of trees to cut are also delineated.

If timber management is a primary goal, and stand management objectives include the promotion of stand and tree vigor, and the production of high quality sawtimber products, then the selection of trees to cut should apply the following order of removal to achieve the desired residual stand composition and structure.

Order of removal:

1. High risk of mortality or failure (unless retained as a wildlife tree)
2. Release crop trees
3. Low crown vigor
4. Poor stem form and quality
5. Less desirable species
6. Improve spacing

The order of removal may vary somewhat depending on landowner goals, stand management objectives, and silvicultural treatment. For example, a shelterwood seed cut or the presence of exotic invasive species may elevate the removal of undesirable species. The order of removal should be clearly stated in writing prior to any marking and cutting operations.

Application of the order of removal:

The order of removal is most commonly applied during intermediate treatments, particularly thinning, and uneven-aged selection treatments.

- First, determine desired residual stand composition and structure, including crop tree characteristics and tree retention criteria (objectives, characteristics, number, and distribution), and target residual stocking.
- Then, select and mark trees to cut following the order of removal and until the desired residual stocking is achieved.

For example, during a free thinning applied to a small sawtimber stand managed only for timber production, first mark for removal all high risk trees and check residual stocking. If stocking exceeds target residual, next identify sawtimber crop trees and mark the least desirable adjacent trees to provide one- to three-sided crown release. Check residual stocking. If stocking exceeds target residual, next mark for cutting low vigor then poor quality trees. Often, target residual stocking will be achieved during this step. If not, then continue to mark, focusing on undesirable species, tree spacing, and the lowest vigor and poorest quality trees that remain, until target residual density is attained. Marking stops when actual residual stocking is near the target objective stocking.

In addition to timber crop trees, other trees are typically retained to achieve non-timber management objectives (e.g., cavity trees for wildlife). Criteria for selection and retention should be specified before marking. Selecting these trees for retention may require periodic departure from strict application of the order of removal (e.g., retain some high risk trees as cavity trees and future snags for wildlife habitat). In some cases, it may be necessary to mark these trees to ensure that they will not be cut.

TIMBER MANAGEMENT – GENERAL CRITERIA TO EVALUATE RISK, VIGOR, QUALITY, SPECIES, AND SPACING FOR TREE SELECTION

The following are definitions and specifications for terms used in crop tree selection and order of removal guidelines. Additional criteria and guidelines may be delineated for specific cover types and species.

Risk is the probability that a tree will die or fail (main stem will break) within a specified time period. It is an estimate of probable mortality or failure within the next cutting cycle.

- **High Risk:** Tree has any of the following:
  - Tree infected with canker rot fungus (see species specific criteria in other publications).
  - Canker affects greater than 50 percent of the stem's circumference.
  - Butternut canker affects greater than 20 percent of combined circumference of the stem and root collar.
  - White pine blister rust canker located where stem failure would cause a loss of greater than 50 percent of the crown.
  - Horizontal crack on a canker's face.
  - Open crack on main stem is in contact with another defect, such as decay, a canker, or a weak union (V-shaped).
  - Crack goes completely through the stem or is open (bark and wood fibers split) for greater than five feet of length.
  - Two open cracks occur on the same stem segment.
  - Cavity and associated decay affects greater than 40 percent of the stem's cross-sectional area.
  - Decay in main stem results in less than one inch of sound wood for every six inches in diameter (two inches for every six inches if a cavity is present).
  - Leaning tree with horizontal crack, long vertical crack, or buckling wood on the underside of the tree.
  - Leaning tree with recent root lifting.
  - More than 33 percent of roots severed, decayed, or otherwise compromised.

- Signs of cambium miners, such as two-lined chestnut borer or bronze birch borer.
- Greater than 50 percent of the crown is dead.
- Greater than 75 percent of the leaves subnormal in size or abnormal in color (this does not include color changes caused by nutrient deficiencies, fungal leaf spots, or other causes where crown recovery is expected).

- **Moderate Risk:** Tree has any of the following:
  - Canker affects 10 to 49 percent of the stem's circumference.
  - Cavity and associated decay affects 10 to 39 percent of the stem's cross-section.
  - 10 to 33 percent of roots severed, decayed or otherwise compromised.
  - 10 to 49 percent of the crown is dead.

- **Low Risk:** Tree has no signs of defect or could have all of the following:
  - Canker affects less than 10 percent of the stem's circumference.
  - Cavity and associated decay affects less than 10 percent of the stem's cross-section.
  - Less than 10 percent of roots severed, decayed or otherwise compromised.
  - Less than 10 percent of the crown is dead.

Vigor refers to active healthy well-balanced growth of individual trees. It describes the tree's potential to grow at a rapid rate and increase volume. Vigor is evaluated based on tree crown class, size and condition.

- **Low Vigor:** Suppressed trees, not free to grow. Dominant, codominant, or intermediate trees with a poor silhouette, poor leaf condition, and many branch stubs on upper and middle bole (see "High Risk"). In hardwoods, a concentric crown less than half full; in conifers, a poor crown/length ratio.

- **Moderate Vigor:** Dominant, codominant or intermediate trees with a fair silhouette and fair leaf condition. In hardwoods, a one-half to three-quarters full concentric crown; in conifers, a fair crown/length ratio.

- **Good Vigor:** Dominant or codominant trees with a good silhouette and healthy leaves. In hardwoods, a full concentric crown; in conifers, a good crown/length ratio.

Quality (timber) refers to stem form, soundness and potential timber value of individual trees. Timber quality is evaluated based on log length, diameter and defect.

- **Poor Timber Quality:** Useable length far short of the average for the site; DBH/length ratio poor; permanently sub-merchantable in length; or heavy crook or sweep will not cut out.

- **Moderate Timber Quality:** Useable length fairly commensurate with site; DBH/length ratio fair; usable length stopper on upper bole; or moderate crook or sweep will not cut out.

- **Good Timber Quality:** Useable length commensurate with site; DBH/length ratio good; no usable length stoppers; and slight crook or sweep will cut out. Good hardwood sawtimber quality includes the potential for at least one 16 foot butt log of tree Grade 2 or better.

The effects of defects on timber quality can vary significantly, depending on the type and severity of a defect, tree species, and site factors. Due to this complexity, information specific to defect types and tree species is not described here.

Species selection is based on sustainable landowner property goals, stand management objectives, site quality, silvics, and stand condition. Desirable sawtimber crop trees are well-adapted to the site and of commercial value.

Spacing refers to the distance between stems and crowns of desirable trees, and the equal distribution of growing space.

WILDLIFE TREE AND SNAG RETENTION CRITERIA

- Large trees for habitat structure (e.g., nest trees).
  - Some low risk, good vigor trees to sustain long life.
  - Some moderate to high risk, moderate to low vigor (declining) trees to provide near-term future snags and coarse woody debris.
  - Desirable species; strive for species diversity.
- Mast trees for food.
  - Low risk.
  - Good crown vigor.
  - Strive for species diversity; hard-mast producers generally preferred over soft-mast producers.
- Cavity (den) trees for shelter.
  - With cavities in bole.
  - Larger diameter cavity trees are particularly desirable.
  - Strive for species diversity.
- Snags for habitat, shelter and food.
  - Larger diameter snags are particularly desirable.
  - Strive for diversity in species and level of decay.

Large trees are at least 12 inches DBH, and preferably greater than 18 inches DBH. Large trees greater than 18 inches DBH are uncommon. However, they provide structural diversity that increases the availability of habitat niches and can benefit an array of wildlife. Important structural features include: tall canopies that contribute to vertical stratification, large crowns and branches, and loose, furrowed bark. Importantly, the development of large trees is required for the recruitment of large cavity trees, snags and down coarse woody debris.

Mast trees are living trees that produce fruit and nuts that are consumed as food by wildlife. Large crowned vigorous trees generally produce the most mast. Increasing numbers of mast trees facilitate increased populations of some species.

Cavity (den) trees are living trees that are partially hollow and used by wildlife for shelter. Large diameter cavity trees, especially those greater than 18 inches DBH, can provide the greatest array of benefits. Increasing the number and size of cavity trees facilitate increased populations of some species.

Snags are standing dead trees. Snags benefit many species of wildlife – especially large diameter snags – which can provide the greatest array of benefits. Eventually, snags become downed coarse woody debris that also benefits wildlife and other ecosystem processes. Increasing the number and size of snags facilitates increased populations of some species. Other than the physical space occupied, snags do not compete with living trees. Retain all snags present that do not provide a threat to human safety. Those that are determined to be a threat can be cut and retained on-site as coarse woody debris.

RESERVE TREES

Reserve trees are living trees, greater than or equal to five inches DBH, retained after the regeneration period under even-aged or two-aged silvicultural systems. They can be dispersed uniformly or irregularly, as single trees or aggregated groups or patches (usually less than two acres), or any mixture thereof. They are retained well beyond stand rotation, and for purposes other than regeneration. Reserve trees may be harvested eventually or retained to complete their natural lifespan (becoming a snag and then coarse woody debris). Synonyms include standards, legacy trees, and green tree retention.

The characteristics of desirable reserve trees are highly variable and depend on the intended benefits, the species present, stand condition, and site. Desired compositional and structural attributes may be present when trees are selected and stands are rotated, or additional time may be required for development.

Typical characteristics of desirable individual reserve trees include:

- Large size (tree height, diameter, crown dimensions) for the species and site.
  - If large trees are lacking, then potential future large trees can be selected.
- Older trees with large size and rough bark.
- A mix of vigorous and declining trees.
  - Vigorous trees of long-lived species can enable long-term retention and potentially yield a variety of benefits.
  - Declining trees can provide current and future cavity trees, as well as future snags and down coarse woody debris.
- A mix of species, including locally uncommon species and mast trees.

The development and maintenance of large structures (vigorous trees, cavity trees, snags, down woody debris) and species diversity is typically encouraged.

Generally poor candidates for individual reserve trees include:

- Relatively small (height, diameter, crown), suppressed to intermediate trees.
- Relatively young trees within the stand.

These smaller, younger trees are retained in reserve groups and patches along with larger, older trees.

RESERVE TREES, MAST TREES, CAVITY TREES, AND SNAGS – RECOMMENDATIONS FOR RETENTION IN MANAGED STANDS

Sustainable forest management is implemented within a framework defined by landowner goals and objectives, ecosystem condition and potential, and sustainable silvicultural systems and practices. Forests are cultivated to provide a variety of socio-economic and ecological benefits. Sustainable forest management integrates multiple management goals and objectives into most silvicultural systems and the management of most stands and landscapes.

Most stands that are actively managed include timber production as a management goal (often in concert with other goals). Tree retention typically focuses on crop tree selection and regeneration methods. To satisfy multiple objectives and provide multiple benefits, retain additional trees to achieve non-timber management objectives. Integrate the following recommendations for tree and snag retention into the management of most forest stands:

- **Even-aged Rotations**
  - Retain three or more, preferably large, snags per acre if available.
  - Retain reserve trees and/or patches at five to 15 percent crown cover or stand area, including large vigorous trees, mast trees, and cavity trees. Reserve trees and patches are not cut during stand rotation. Harvesting may occur in the future or may be foregone to achieve other benefits.
- **Even-aged Intermediate Treatments**
  - Retain three or more, preferably large, snags per acre if available.
  - Retain three or more, preferably large, cavity trees per acre if available.
  - Retain three or more, preferably large, mast trees per acre if available.
  - If previously established, manage reserve trees and patches. Management may include timber harvesting or passive retention. Consider retaining three or more trees per acre to develop into large, old trees and to complete their natural lifespan. These trees may also satisfy cavity and mast tree recommendations. These trees will often become large snags and coarse woody debris.

- **Uneven-aged Systems**
  - Retain three or more, preferably large, snags per acre if available.
  - Retain three or more, preferably large, cavity trees per acre if available.
  - Retain three or more, preferably large, mast trees per acre if available.
  - Consider retaining three or more trees per acre to develop into large, old trees and to complete their natural lifespan. These trees may also satisfy cavity and mast tree recommendations. These trees will often become large snags and coarse woody debris.

In cases where these recommendations for retention are not applied, then sound reasons and expected impacts of deviation should be documented.

When applying retention recommendations, be sure to consider:

- Individual trees can provide multiple benefits and fulfill the intent of more than one of the above recommendations. For example, three large oak trees with cavities could satisfy the mast tree and cavity tree recommendations, as well as the large, old tree consideration.
- Retention of both vigorous and declining trees will provide an array of benefits.
- In general, species diversity is encouraged when selecting trees to retain.
- Large trees and snags are greater than 12 inches DBH, and preferably greater than 18 inches DBH.
- Trees retained can be scattered uniformly throughout a stand or irregularly dispersed, as single trees, groups and patches. Retention in aggregated patches (0.1 to two acres) generally provides the most benefits. The general recommended strategy is to retain irregularly distributed patches along with scattered groups and individuals.
- Patches retained can satisfy multiple benefits. For example, at stand rotation, an unharvested buffer along a stream may satisfy Forestry BMPs for Water Quality and reserve tree retention recommendations.
- Retaining down coarse woody debris that is already present. Minimize disturbance including crushing, fragmenting and displacing existing down course woody debris except on roads, skid trails and landings.
- Retain as many snags as possible. Retention of snag diversity (species and size) can potentially provide the greatest array of benefits. Snags that are determined to be a threat to human safety can be cut and retained on site as coarse woody debris.
- Clearly designate, in writing and/or by marking, which trees should be retained prior to any cutting operations.

AREA (ACRES)	DIAMETER (FEET)	SQUARE (FEET)
0.1	74	66 x 66
0.25	118	104 x 104
0.5	167	148 x 148
0.75	204	181 x 181
1.0	236	209 x 209
1.5	288	256 x 256
2.0	333	295 x 295

Patch Sizes for Retention and Approximate Dimensions (Circular and Square)

APPENDIX B: SAMPLE TIMBER SALE CONTRACT[1]

This Contract is entered into, by and between _____(Seller), and _____(Purchaser). Contact information is listed in par. 53 of this agreement.

The Seller hereby authorizes the Purchaser to enter upon the following described lands (the Premises) for purposes of cutting and removing timber marked or otherwise designated by the Seller:

County:_____ Town Name:_____

Town:_____ N; Range_____; Section_____; Legal Description(s):_____

Town:_____ N; Range_____; Section_____; Legal Description(s):_____

Those Premises are further described on the map(s) or diagram(s) attached to and made a part of this Contract.

FOR AND IN CONSIDERATION of the following terms and conditions, the Seller and the Purchaser mutually agree:

CONTRACTING PARTIES

1. CONTRACTING PARTIES.

a. Seller and Purchaser. In this Contract, the Seller and the Purchaser include their respective officers, employees, agents, directors, partners, representatives, successors, heirs and members.

b. Purchaser Ceases to Exist. If the Purchaser ceases to exist, in fact or by law, the Seller may terminate this Contract without waiving any remedies available to it and take all action necessary to assure its performance.

c. Subcontracting. This Contract or work under it may not be assigned or subcontracted in part or in whole without prior written approval from the Seller and may be changed or amended only in writing. The Purchaser agrees to notify the surety, if any, of any such change or amendment.

ENTIRE CONTRACT

2. ENTIRE CONTRACT. This Contract, together with specifications in the request for bids as well as reference to parts and attachments, shall constitute the entire agreement and any previous communications or agreements pertaining to this Contract are hereby superseded. Any amendments to this Contract shall be in writing, signed and dated by both parties.

3. ATTACHMENTS. Any and all attachments to this Contract shall be made a part of this Contract and be fully complied with, including:

a. Map(s) or Diagram(s) of Sale Area;

b. Payment Schedule and Conditions of Payment;

c. Other: _____

_____

CONTRACT PERFORMANCE, PERIOD, EXTENSIONS AND TERMINATION

4. PERFORMANCE.

a. Commencement. Cutting and removal of timber in conformance with this Contract may commence and continue only after the signing of this Contract by both parties and only after submission and maintenance of all bonds, certificates or statements required under it.

1 *Where options are listed with "OR," strike the option(s) that do(es) not apply.*

b. Contract Oversight. Cutting and removal of timber purchased under this Contract shall be conducted in conformance with this Contract and in a good and workmanlike manner with reasonable diligence to assure completion of all performance within the Contract period specified in par. 5. The Purchaser shall notify the Seller or the Seller's Agent 36-48 hours prior to commencing harvest of the timber designated herein and upon completion of the cutting. In the event that the harvest is temporarily discontinued for more than one week, the Purchaser agrees to notify the Seller or the Seller's Agent _____ (Agent's name) both upon discontinuance and resumption of harvest. Notification under this paragraph may be made by telephone to _____ (phone number). The Seller or the Seller's Agent may require an onsite meeting before commencement of harvesting.

c. Inspection. The Seller retains the right of ingress and egress to and on the sale area and may inspect the sale area and trucks hauling forest products from or traveling on the sale area at any time. If the inspection reveals any violations of this Contract the Seller shall promptly notice the Purchaser. Upon notice from the Seller, the Purchaser shall promptly take measures to remedy the violation.

d. Access. The Purchaser has no access or privilege to go upon the Seller's property other than to comply with this Contract and may not authorize access or use to others except for the sole purpose of performing this Contract.

5. **CONTRACT PERIOD.**

a. All work under this Contract shall be completed between the signing of the Contract by both Parties and _____ (Contract ending date), FOR TIME IS OF THE ESSENCE. Contract amendments or extensions may not be relied upon by the Purchaser for the purpose of completing performance under this Contract.

b. The Seller may temporarily suspend operations under this Contract due to excessive property damage, wet conditions or at other reasonable[2] times upon notice to the Purchaser or other persons operating on the sale area under this Contract with subsequent equitable adjustment of this Contract as mutually agreed upon by the parties.

6. **CONTRACT EXTENSIONS.** If extensions of this Contract are deemed reasonable by the Seller, the stumpage price agreed upon herein shall be adjusted as follows:

a. First six-month extension: 0% increase

b. Second six-month extension: 5% increase

c. Additional six-month extensions: 10% increase

d. Other applicable charges or fees: _____

7. **TERMINATION.** The Seller may terminate this Contract by oral or written notice to the Purchaser upon its breach. Upon such notice, the Purchaser shall cease all operations on and immediately leave, and not return to, the Seller's property unless otherwise provided by the Seller.

DOWNPAYMENT, BOND, REMEDIES AND DAMAGES

8. **DOWNPAYMENT.** The Purchaser has given the Seller a down payment in the form of cash, a certified check, or other form acceptable to the Seller in the amount of $_____ [if none, enter "zero"] to commit to completion of the timber sale in a timely manner as specified in the Contract.

9. **BOND.**

a. A performance bond in the Seller's favor in the amount of $_____, in cash, by surety bond, or in any other form accepted by the Seller, shall be submitted by the Purchaser no later than _____ to be retained by the Seller to assure full and complete performance of the Contract by the Purchaser to the Seller's satisfaction. Failure to submit the bond shall be considered a breach of this Contract and subject the Purchaser to liability for damages. The Purchaser agrees that the bond shall be forfeited to the Seller as

2 *"Reasonable" in this contract is defined as fair, proper, just, moderate, and suitable under the circumstances, not arbitrary or capricious.*

liquidated damages upon the Seller's determination that a condition or term of this Contract has been breached by the Purchaser, unless the Seller chooses and can reasonably determine the actual damages suffered as a result of the breach of the Contract. Damages assessed under this Contract are the responsibility of the Purchaser and may be deducted from this performance bond and otherwise collected by the Seller.

b. The Purchaser agrees that the performance bond may be retained by the Seller until all performance under this Contract has been completed to the Seller's satisfaction and the Seller determines the performance has been so completed. If the Seller determines the performance has not been completed satisfactorily and in conformance with this Contract, the performance bond may be retained by the Seller until the Seller can determine damages caused by the lack of performance. Only in the event the Purchaser provides written notice of sale completion to the Seller shall the Seller have sixty (60) days to determine that performance has been completed as required under this Contract.

10. REMEDIES.

a. If timber or other forest products not specifically described in this Contract or designated by the Seller for cutting are cut, unreasonably damaged or removed by the Purchaser, the Seller may pursue any and all remedies for the unlawful use of the Seller's property and the cutting, unreasonable damage or removal of property without consent, including the seeking of criminal or civil charges for theft, timber theft or criminal damage to property, in addition to any Contract remedies for breach.

b. If the Seller or Purchaser seeks damages for breach of this Contract through court proceedings, and if either party prevails in such proceedings, in whole or in part, then the non-prevailing party agrees to pay all of the prevailing party's actual and reasonable expenses, including attorneys and expert witness fees.

c. The Seller agrees to mitigate the damages for breach by offering the timber for resale if it determines the timber is saleable based upon its volume or quality.

d. The Seller may, when it deems it reasonable and in the best interest of the Seller, allow the Purchaser to continue performance under the Contract and the Purchaser shall pay as liquidated damages double the mill value as determined by the Seller for the timber or other forest products cut, removed or damaged without authorization under or in violation of this Contract. The Seller's permission to continue cutting shall not be considered a waiver of breach nor prevent it from considering such breach for purposes of asserting any other remedies available to it. It is agreed that the double mill scale sum is a reasonable estimate of the probable damages suffered by the Seller and shall not be construed as or held to be in the nature of a penalty.

11. DAMAGES. The damages to be paid to the Seller upon the Purchaser's failure to perform this Contract include, but are not limited to:

a. The difference between the Purchaser's bid value of timber not cut and removed under this Contract and the value returned to the Purchaser. The Seller agrees to mitigate the damages for breach by offering the timber for resale within 12 months if the Seller determines the timber is salable based upon its volume or quality.

b. Triple average current stumpage rate value established under the authority given in s. 77.91 (1), Wis. Stats., for timber cut, removed or unreasonably damaged without authorization under or in violation of this Contract. The Seller's decision to assess triple damages as provided here and to allow the Purchaser to continue performance under this contract shall not be construed as a waiver of other contract performance requirements.

c. All costs of sale area cleanup or completion of performance not completed by the Purchaser.

d. All costs of resale of timber not cut and removed as required under this Contract.

e. The Purchaser agrees that if the timber identified in this Contract for cutting is to be resold due to a breach of this Contract, the Seller is not obligated to give oral or written notice to the Purchaser of the resale.

f. Additional damage provisions: _____

_____

_____

PRODUCTS TO BE REMOVED

12. No forest products may be removed from the Premises until the Purchaser pays for the products or guarantees payment for the products to the satisfaction of the Seller.

13. Title to stumpage and any forest products cut under this Contract shall remain with the Seller until payment is received. Title to stumpage and cut products that are not cut and removed before the end of the Contract period, even though paid for, shall revert to the Seller, and the Seller shall be under no obligation to return payments to the Purchaser.

14. During the period of this Contract, the Purchaser is authorized and shall cut, remove and pay for the timber or forest products marked or designated as follows: _____

_____

_____

_____

SALE TYPE, SCALING, HAULING AND PAYMENTS

15. SALE TYPE[3] [select one of the following three choices and strike the others]

LUMP SUM SALE:

The Purchaser agrees to pay Seller an amount of $_____, to be paid in full prior to the commencement of timber cutting, based on the volume estimates and unit values in Par. 17 Timber Products Table. The Seller is not obligated to return the payment or any portion of it in the event the Purchaser fails to remove all timber or forest products authorized for removal.

OR

SCALED PRODUCTS SALE:

FLAT RATE METHOD. The payment as established by the Price per Unit in Par. 17 shall be based on sawtimber, cordwood, or piece product volume as measured by product dimensions. **The price paid per board feet, cord, ton, or piece is a flat rate regardless of the quality, final destination or use of the cut product.** Hardwood less than 10.6 inches in diameter at the small end of the log, inside the bark (d.i.b.), shall be measured as cordwood and 10.6 inches or greater d.i.b. as sawtimber. For conifers, the division between cordwood and sawtimber is 9.6 inches d.i.b. Sawtimber with 50% or more cull shall be measured as cordwood. The volume shall be measured by _____ (name), an agent of the Seller / the Purchaser / the primary processing facility (the Mill or its agent) to whom the Purchaser delivers the product and to whom the cut product is sold [strike the choices that do not apply].

OR

SCALED PRODUCTS SALE:

GRADED PRODUCT METHOD. The payment as established by the Price per Unit in Par. 17 shall be based on the volume of *graded* products including fuel wood, pulpwood, sawbolts, sawtimber by grade, veneer by grade, piece products (such as posts and utility poles) by grade, and comingled products by grade. **In addition to product dimension, the price paid depends upon the quality or intended use of the cut product or type of processing facility the cut product is destined.**[4]

The volume and grade shall be determined by _____ (name), an agent of the Seller / the Purchaser / the primary processing facility (the Mill or its agent) to whom the Purchaser delivers the product and to whom the cut product is sold [strike the choices that do not apply].

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*3 **Lump sum** and **scaled products-flat rate** methods are the most commonly accepted sale types. Landowners may have difficulty in finding purchasers willing to enter into graded product method sales, which are more difficult to administer.*

4 For example, cordwood delivered to a paper mill would be paid for as pulpwood. Cordwood delivered to a sawmill would be paid for as sawbolts or sawlogs.

16. HAULING PROCEDURE[5] AND PAYMENT SCHEDULE FOR SCALED SALES [select one of the following two choices and strike the other]

ON SITE SCALE. No products may be hauled from the Seller's property until scaled and paid for or payment has been arranged to the Seller's satisfaction in writing. Removing products otherwise shall be a violation of this Contract and considered theft.

OR

MILL SCALE. The Purchaser shall keep a record of each load removed and its destination. Addresses of the Mills where wood products are to be delivered shall be given to the Seller before cutting begins. The Purchaser shall provide Mills with the Seller's name and address for each load and request Mills to provide copies of the mill scale slips to the Seller within _____ days of receipt of the wood products. Failure to keep a record of any load and its destination shall be a violation of this Contract and considered theft. Payments shall be made according to the following schedule [pick one of the following three choices and strike the others]:

The Purchaser shall pay the Seller for the products delivered to the Mill, as measured on the mill scale slip, within _____ days of delivery. The Purchaser shall include copies of the mill scale slips with payments.

OR

Payment to the Seller shall be made in advance of hauling, with the value of the measured volume on the mill scale slips deducted from the Purchasers stumpage payment balance. The Seller agrees that advance stumpage payments shall not be used for any purpose other than the stumpage account and that any excess payments shall be returned to the Purchaser within 60 days after the last load is hauled from the Seller's property.

OR

The Mill shall make payments for delivered products directly to the Seller within _____ days of delivery by the Purchaser. Copies of the mill scale slips shall be included with payments to the Seller.

17. TIMBER PRODUCTS TABLE.

The Purchaser agrees to pay the Seller the unit price for the volume of product by species that is harvested. In the case of lump sum sales, the unit prices shall be used for sale add-ons or calculation of damages.

Species to be Harvested	Product (Sawtimber, Cordwood, Posts, Poles, Biomass, etc.)	Estimated Volume	Price per Unit (MBF[6], Cord, Piece, etc.)	Total Value of Estimated Volume
			TOTAL ESTIMATED VALUE:	

5 Information about an additional "Ticket System" for log hauling is also available from DNR, but is seldom used on private lands.

6 "MBF" means "thousand board feet."

18. Sawtimber volumes shall be determined by the Scribner Decimal C system (required for land enrolled under the Managed Forest Law or Forest Crop Law programs in Wisconsin).

19. Cord means 128 cubic feet[7] of wood, air and bark assuming careful piling. Peeled cordwood shall be converted to standard cords using the Wisconsin DNR conversion specifications published in chapter NR 46.30 (1) (d), Wisconsin Administrative Code.

20. Weight volumes shall be in tons, meaning 2,000 pounds per ton, U.S. measure. For Products measured by weight but paid for by cord the weights shall be converted to standard cords using one of the following[8]:

a. the Wisconsin DNR conversion specifications published in chapter NR 46.30 (1) (g)
b. the following weight conversions agreed to by the Seller and the Purchaser:

SPECIES	WEIGHT/CORD	SPECIES	WEIGHT/CORD

21. The volumes of timber indicated in this Contract or other appraisal or cruise documents of the Seller are estimates. The Seller gives no warranty or guarantee respecting the quantity, quality or volume of marked or otherwise designated timber or forest products on the sale area.

UTILIZATION AND OPERATIONS

22. STUMP HEIGHT; TOPS. Tree stumps shall be cut as close to the ground as practical, otherwise maximum stump height shall not exceed stump diameter; and for stumps ten or more inches in diameter, stumps shall not exceed 10 inches in height. For sales including cordwood products, trees shall be utilized to a 4" minimum top diameter. For sales including biomass products, utilization of tops shall follow guidelines established in *Wisconsin's Forestland Wood Biomass Harvesting Guidelines*, a 2014 publication of the Wisconsin Council on Forestry and the Wisconsin DNR. Title to tops shall remain with the Seller and may not be utilized by the Purchaser, or at the Purchaser's direction, unless otherwise specified in this Contract.

23. WASTE. The Purchaser agrees to complete all operations and performance as described in this Contract without waste or nuisance on the sale area or any other property of the Seller or adjoining land used in conjunction with the harvest and use reasonable care not to damage trees not designated or marked for cutting. Young trees bent or held down by felled trees shall be promptly released.

24. ZONE COMPLETION. The Purchaser agrees to complete all operations on each portion of the sale area or each zone as designated on the sale area map, or other attachments or in the cutting requirements before beginning cutting in the next portion or zone, unless agreed to otherwise by the Seller.

25. DIGGERS HOTLINE. The Purchaser is responsible to contact the diggers hotline, or other informational sources performing similar services, prior to digging or conducting other activities on the property which may result in contact with utility or service lines or facilities.

26. ROADS, LANDINGS, MILL SITES, CAMPSITES, EROSION CONTROL, BEST MANAGEMENT PRACTICES (BMPs).

a. When not otherwise designated by the Seller, the location of roads, landings, mill sites and campsites on Seller's property are subject to advance approval and under the conditions established by the Seller. All restoration, cleanup or repair of roads, bridges, fences, gates, landings, mill sites and campsites, or the cost of the cleanup, if not completed by the Purchaser to the reasonable satisfaction of the Seller, is the responsibility of the Purchaser.

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7 Mills may measure cordwood with a 4" trim allowance, resulting in 133 cubic feet.
8 Proposed weight conversions should be included in the timber sale prospectus.

b. Logging debris accumulated at landing areas shall be scattered within the sale area to the reasonable satisfaction of the Seller.
c. Berms constructed on the Seller's property shall be leveled to restore the area to the Seller's satisfaction unless they are constructed at the direction of the Seller under sub d.
d. Roads and landings shall be graded or closed upon the request of and to the Seller's satisfaction upon completion or termination of this Contract.
e. Other restoration requirements (e.g., seeding, gravel, rutting, culvert removal, etc.): _____

_____

f. The Purchaser agrees to comply with the Best Management Practices (BMP) guidelines as described in *Wisconsin's Forestry Best Management Practices for Water Quality* published by the Wisconsin DNR, publication FR-093. Identify BMPs of particular concern: _____

_____

_____

_____

_____

g. The Purchaser agrees to take precautions to prevent the spread of invasive species as described in Wisconsin Department of Natural Resources' invasive species guidelines. Identify species and actions of particular concern:

_____

_____

_____

_____

27. SOIL DISTURBANCE AND RUTTING

a. The Purchaser agrees to take all steps and precautions to avoid and minimize soil disturbances, such as soil compaction and rutting. If soil disturbances occur, the Purchaser agrees to work cooperatively to mitigate and repair any and all instances of soil disturbance.
b. Excessive soil disturbance (as defined in Table 1) shall not be permitted. Purchaser agrees to contact Seller in the event of an excessive soil disturbance.

Table 1. Thresholds for soil disturbances.

TIMBER SALE INFRASTRUCTURE	SOIL DISTURBANCES ARE EXCESSIVE IF:
Roads, Landings, Skid Trails, and General Harvest Area	• A gully or rut is six inches deep or more and is resulting in channelized flow to a wetland, stream, or lake.
Roads, Landings, and Primary Skid Trails	• In a riparian management zone (RMZ) or wetland, a gully or rut is six inches deep or more and 100 feet long or more. • In an upland area (outside of RMZ), a gully or rut is 10 inches deep or more and 66 feet long or more.
Secondary Skid Trails and General Harvest Area	• A gully or rut is 6 inches deep or more and 100 feet long or more.

NOTE: *The depth is to be measured from the original soil surface to the bottom of the depression. If individual lug depressions are visible, the depth would be measured to the lesser of the two depths (the "top" of the lug). The length is measured from the start of the "too deep" section to the end of the "too deep" section. Measurements are not cumulative.*

c. Prior to sale completion the Purchaser shall mitigate and repair soil disturbances to the Seller's satisfaction.
d. Other restoration requirements (e.g., repair of soil disturbance or rutting on recreational trails used for skidding):
(1)_____
(2)_____

28. OTHER APPROVALS. Logging roads that intersect town, county or state roads or highways must have the intersections approved by the proper authorities prior to construction and cleared of all unsightly debris at the time of construction. The Purchaser agrees to apply for and obtain all approvals. The Purchaser also agrees to fully comply with all terms and conditions of intersection approvals.

29. SURVEY MONUMENTS. The Purchaser agrees to comply with s. 59.635, Wis. Stats., regarding perpetuation of landmarks and pay for the cost of repair or replacement of property or land survey monuments or accessories which are removed, destroyed or made inaccessible.

30. FOREST FIRE PREVENTION. The Purchaser agrees to take reasonable precautions to prevent the starting and spreading of fires. Those precautions include, but are not limited to:
a. A minimum of one fully charged 5 pound or larger ABC fire extinguisher with a flexible spout shall be carried on each off road logging vehicle.
b. All chain saws and all non turbocharged off road logging equipment used in the operation shall be equipped with spark arrestors that have been approved by the U.S. Forest Service. Such arrestors may not be altered in any manner or removed and shall be properly maintained.
c. If a fire occurs, the Purchaser agrees to promptly report the fire and cooperate in the control and suppression of the fire.
d. The Purchaser shall comply with requests regarding forest fire prevention and suppression made by the Seller and take all reasonable precautions to prevent, suppress and report forest fires. Those requests may include ceasing or modifying operations.
e. The Purchaser shall be responsible for damage and forest fire suppression costs, including that provided in ss. 26.14 and 26.21, Wis. Stats., caused by their operation under this Contract.
f. Other: _____
_____

31. SLASH REMOVAL. Slash as defined in s. 26.12, Wis. Stats., shall be disposed of as follows:
a. Slash falling in any lake or stream, in a right of way or on land of an adjoining landowner shall be immediately removed from the waters, right of way or adjoining land. Tops from felled trees may not be left hanging in standing trees. All trees shall be completely felled and not left leaning or hanging in other trees.
b. Other: _____
_____

32. CLEANUP AND USE OF SALE AREA.
a. The Purchaser shall remove equipment, tools, solid waste and trash remaining on the sale area or Seller's property or adjoining land used in conjunction with the harvest upon completion of performance under this Contract, termination of this Contract due to breach by the Purchaser or when requested by the Seller.
b. No residence, dwelling, permanent structure, or improvement may be established or constructed on the sale area or other property of the Seller.

33. HAZARDOUS MATERIALS. The Purchaser agrees to properly use and dispose of all petroleum and hazardous products, including but not limited to oil, oil filters, grease cartridges, hydraulic fuel and diesel fuel. Any on site spillage must be properly reported, removed and cleaned up by the Purchaser in accordance with applicable statutes and rules of the State of Wisconsin.

34. ADDITIONAL UTILIZATION AND OPERATION REQUIREMENTS AND INSTRUCTIONS:

a. Between April 15 and August 15 all pine products must be removed from the site within two weeks, regardless of when they were harvested.
b. Oak wilt prevention: where oak trees are present, no cutting is allowed between _____ and _____.
c. No trees or products over 16 feet in length may be skidded within the cutting area without written permission of the Seller.
d. Other (If none, state None.) _____

_____

_____

_____

_____

_____

NOTICE OF INTENT TO CUT AND COMPLIANCE WITH LAWS

35. SECTION 77 NOTICE AND REPORT. The Seller / Purchaser [select one] shall file required cutting notices and cutting reports to the responsible DNR forester for lands that are under the Forest Crop Law and Managed Forest Law programs.

36. SECTION 26 NOTICE. The Seller / Purchaser [select one] shall file a declaration annually[9] with the county clerk in any manner acceptable to the county of his or her intentions to cut forest products pursuant to section 26.03, Statutes, and comply with all other notice requirements, laws and ordinances with respect to work under this Contract.

37. OTHER PERMITS. The Seller and Purchaser shall work together on acquiring other necessary permits (such as wetland or stream crossing permits).

38. APPLICABLE LAW. This Contract shall be governed by the laws of the State of Wisconsin. The Purchaser shall at all times comply with all federal, state, and local laws, ordinances and regulations in effect during the Contract period.

TITLE, BOUNDARY LINES AND ACCESS

39. TITLE. The Seller warrants that the Seller has clear and unencumbered title to the stumpage subject to this Contract.

40. BOUNDARY LINES. The Seller guarantees to have the boundaries marked with paint or other suitable means before any timber is harvested.

41. ACCESS. The Seller agrees to secure entry and right-of-way to the Purchaser on and across the area covered by this Contract, including access via land owned by a third-party if necessary.

LIABILITY AND INSURANCE

42. The Purchaser agrees to protect, indemnify and save harmless the Seller and the Seller's employees and agents from and against all causes of action, claims, demands, suits, liability or expense by reason of loss or damage to any property or bodily injury to any person, including death, as a direct or indirect result of timbering operations under this Contract or in connection with any action or omission of the Purchaser, who shall defend the Seller in any cause of action or claim.

9 County cutting notices expire by law on December 31 and so must be renewed annually.

43. Unless the Purchaser is exempted by the Seller from this coverage requirement as an independent contractor, as defined in s. 102.07(8)(b), Stats., and as determined by the Seller based on an affidavit submitted to it, the Purchaser agrees to elect to maintain worker's compensation insurance coverage for the cutting operation under this Contract and any and all employees engaged in cutting on the Seller's land during the period of this Contract regardless of any exemptions from coverage under chapter 102, Wis. Stats. The Purchaser must provide an original certificate of insurance naming the Seller as a certificate holder so the insurance carrier can notify the Seller should the insurance expire.

44. The Purchaser agrees to furnish the Seller with a certificate of public liability insurance covering the period of logging operations on the Seller's property for:

a. $1,000,000 single limit liability for personal injury or $1,000,000 bodily injury per person and $1,000,000 per occurrence; and
b. $100,000 property damage.

45. The Purchaser shall notify the Seller in writing, immediately upon any change in or cancellation of insurance coverage required by this Contract.

46. The Purchaser is an independent contractor for all purposes including Worker's Compensation and is not an employee or agent of the Seller. The Seller agrees that the undersigned Purchaser, except as otherwise specifically provided herein, shall have the sole control of the method, hours worked, time and manner of any timber cutting to be performed hereunder. The Seller reserves the right only to inspect the job site for the sole purpose of insuring that the cutting is progressing in compliance with the cutting practices established under this Contract. The Seller takes no responsibility for supervision or direction of the performance of any of the harvesting to be performed by the undersigned Purchaser or it's employees. The Seller further agrees to exercise no control over the selection and dismissal of the Purchaser's employees.

47. OSHA COMPLIANCE, DANGER TREES. The Purchaser is responsible to comply with, and assure compliance by all employees or subcontractors with, all Occupational Safety and Health Act (OSHA) requirements for the health and safety of Purchaser's employees, including provisions relating to danger trees. In addition, the Purchaser agrees to notify, and obtain agreement from, the Seller if the Purchaser intends to modify performance required under this Contract for the purpose of compliance with OSHA requirements. Not withstanding OSHA regulations, the Purchaser agrees to apply appropriate safety precautions.

48. ACTS OF GOD. Neither party shall be liable for defaults or delays due to acts of god or the public enemy, acts or demands of any government or governmental agency, strikes, fires, flood, accidents or other unforeseeable causes beyond its control and not due to its fault or negligence. Each party shall notify the other in writing of the cause of such delay within five days after the beginning thereof. If such uncontrollable circumstances continue for 30 days and prevent either party from complying with the terms of this agreement, either party shall have the option of terminating upon ten days notice to the other.

TRAINING (Recommended)

49. TRAINING REQUIREMENT. The Purchaser is responsible for ensuring that the actual logging contractor engaged in performance of this Contract holds a current logging safety training certificate issued by the Forest Industry Safety & Training Alliance (FISTA) or equivalent safety training acceptable to the seller. Purchaser agrees to provide documentation to Seller that training has been attained prior to initiating sale.

FOREST CERTIFICATION (if applicable)

50. CERTIFICATION STANDARD AND CERTIFICATE. The land management area encompassed by this timber sale is certified to the following forest certification standards (mark as applicable and provide valid certificate numbers):

___ American Tree Farm System® (ATFS) Certificate # _____
___ Forest Stewardship Council® (FSC®) Certificate # _____
___ Sustainable Forestry Initiative® (SFI®) Certificate # _____
___ (Other Standard) _____ Certificate # _____

51. CHAIN OF CUSTODY. Forest certification chain of custody provided by the Seller under the preceding certificates ends at the stump, log landing or roadside.

52. APPROVED CUTTING NOTICE. In the event that land management area encompassed by this timber sale participates in the Wisconsin Managed Forest Law Certified Group, the Seller agrees to provide the Purchaser with a copy of the Wisconsin DNR approved Cutting Notice (DNR Form 2450-32), either submitted by a forestry professional registered with the Wisconsin DNR, or reviewed and approved by the Wisconsin DNR at the landowner's request.

CONTACT INFORMATION

53. CONTACT INFORMATION:

(NOTE: Separate from this form, the Seller and Purchaser are encouraged to provide one another with their Social Security Number or Federal Employer ID Number, needed to file tax returns or other financial documents.)

SELLER

Name:_____
Address:_____
_____
_____
Phone:_____
Cellular Phone:_____
Email:_____

PURCHASER

Name:_____
Address:_____
_____
_____
Phone:_____
Cellular Phone:_____
Email:_____

We have read and understand this entire Contract comprised of _____ pages.

SELLER

Date:_____ By:_____

PURCHASER

Date:_____ By:_____

APPENDIX C: FOREST CERTIFICATION

As of 2016, more than 7.5 million acres (48 percent) of Wisconsin's private and public forestlands have achieved third-party certification by one or more forest certification systems. The forest certification programs active in Wisconsin include the American Tree Farm System® (ATFS), a program of the American Forest Foundation, Forest Stewardship Council® (FSC®), and the Sustainable Forestry Initiative® (SFI®). Forestland enrolled in a forest certification system must conform to the system's standards for responsible forest management. The goal of each system is to ensure that on-the-ground forest management meets a set of rigorous, comprehensive measures of sustainable forest management and environmental protection.

HOW DOES CERTIFICATION HELP PROMOTE SUSTAINABLE FORESTRY?

Forest certification systems are market-based, non-regulatory means to assure end users that the wood products they purchase have been grown, managed, and harvested in socially acceptable and environmentally responsible ways. The performance indicators that have been developed by each system serve to provide a common understanding of what sustainable forest management is, and a way to measure whether a landowner or land manager is achieving that goal. These market-based solutions provide landowners, land managers and the forest products industry with an economic incentive to pursue sustainable forest management as a means to maintain existing markets, and to expand market share as demand for certified products grows.

FOREST CERTIFICATION SYSTEMS: SUMMARY AND OVERVIEW

THE AMERICAN TREE FARM SYSTEM

The American Tree Farm System® (ATFS), started in 1941, was the first program in the United States to have measurable standards and to recognize landowners who met those standards. This program grew out of the forest products industry's need to demonstrate to the public that their management practices were sustainable. You can learn more about the ATFS and their Standards of Sustainability at: ***www.treefarmsystem.org/certification-american-tree-farm-standards***.

The ATFS 2015 - 2020 Standards of Sustainability has eight standards that are used to evaluate sustainable forest management. Each standard has performance measures and indicators, which further define the requirements of the standard and are used by the auditor(s) to determine compliance.

Standard 1..... Commitment to Practicing Sustainable Forestry
Standard 2..... Compliance with Laws
Standard 3..... Reforestation and Afforestation
Standard 4..... Air, Water, and Soil Protection
Standard 5..... Fish, Wildlife, Biodiversity and Forest Health
Standard 6..... Forest Aesthetics
Standard 7..... Protect Special Sites
Standard 8..... Forest Product Harvests and Other Activities

ATFS EXAMPLE*

An example of a complete section of the Standard (2) with one of the Performance Measures (2.1) and one of the Indicators (2.1.1) within the ATFS requirements:

Standard 2: Compliance with Laws

Forest management activities comply with all relevant federal, state and local laws, regulations and ordinances.

Performance Measure 2.1: **Landowner shall** comply with all relevant federal, state, county, and municipal laws, regulations, and ordinances governing forest management activities.

- *Indicator 2.1.1*: *Landowner shall comply with all relevant laws, regulations and ordinances and will correct conditions that led to* ***adverse regulatory actions****, if any.*

* *The example provided for each of the certification systems describe how each system addresses compliance with laws.*

THE FOREST STEWARDSHIP COUNCIL

The Forest Stewardship Council® (FSC®) grew out of concerns over tropical deforestation. The first General Assembly of the FSC® in 1993 was a meeting of loggers, foresters, environmentalists, and sociologists who were determined to act because the Rio Earth Summit in 1992 failed to produce an agreement to stop deforestation. Their goal was to develop a system that would create a market-driven approach to create demand for sustainably sourced forest products. You can learn more about the FSC® and their principles and criteria at: ***us.fsc.org/en-us/certification/forest-management-certification***.

The FSC® has 10 principles which are used to evaluate sustainable forest management. Each principle is defined by a number of criteria and indicators which are assessed to verify compliance.

Principle 1	Compliance with Laws and FSC® Principles
Principle 2	Tenure and Use Rights and Responsibilities
Principle 3	Indigenous Peoples' Rights
Principle 4	Community Relations and Worker's Rights
Principle 5	Benefits from the Forest
Principle 6	Environmental Impact
Principle 7	Management Plan
Principle 8	Monitoring and Assessment
Principle 9	Maintenance of High Conservation Value Forests
Principle 10	Plantation Management

FSC® EXAMPLE*

An example of a complete section of the principle (1) with one of the criteria (1.1) and two of the Indicators (1.1a and 1.1.b) within the FSC® requirements:

Principle 1: Compliance with Laws and FSC® Principles

Forest management shall respect all applicable laws of the country in which they occur, and international treaties and agreements to which the country is a signatory, and comply with all FSC® Principles and Criteria.

Criteria 1.1: Forest management shall respect all national and local laws and administrative requirements.

Indicators:

- *1.1.a: Forest management plans and operations demonstrate compliance with all applicable federal, state, county, municipal, and tribal laws, and administrative requirements (e.g., regulations). Violations, outstanding complaints or investigations are provided to the Certifying Body (CB) during the annual audit.*
- *1.1.b: To facilitate legal compliance, the forest owner or manager ensures that employees and contractors, commensurate with their responsibilities, are duly informed about applicable laws and regulations.*

* *The example provided for each of the certification systems describe how each system addresses compliance with laws.*

THE SUSTAINABLE FORESTRY INITIATIVE

The SFI® program is committed to continuously improve responsible forest management. SFI® program participants must meet or exceed applicable water quality laws and regulations, with measures to manage and protect water wetlands and riparian zones on certified lands. They must continually evaluate habitat and biodiversity impacts from forest activities – which leads to improved habitat quality, and protection of imperiled or critically imperiled species. You can learn more about the SFI® and their standard at: ***www.sfiprogram.org/sfi-standard forest-management-standard/***.

The SFI® 2015 - 2019 Forest Management Standard has defined 13 guiding principles that are the basis for 15 objectives used to evaluate sustainable forest management. The applicable objectives depend upon the type of operation being assessed. Each objective has performance measures which are further defined by Indicators which are assessed to verify compliance.

Forest Land Management Objectives

Objective 1 ..... Forest Management Planning
Objective 2 ..... Forest Health and Productivity
Objective 3 ..... Protection and Maintenance of Water Resources
Objective 4 ..... Conservation of Biological Diversity including Forests with Exceptional Conservation Value
Objective 5 ..... Management of Visual Quality and Recreational Benefits
Objective 6 ..... Protection of Special Sites
Objective 7 ..... Efficient Use of Fiber Resources
Objective 8 ..... Recognize and Respect Indigenous Peoples' Rights
Objective 9 ..... Legal and Regulatory Compliance
Objective 10 ..... Forestry Research, Science and Technology
Objective 11 ..... Training and Education
Objective 12 ..... Community Involvement and Landowner Outreach
Objective 13 ..... Public Land Management Responsibilities
Objective 14 ..... Communications and Public Reporting
Objective 15 ..... Management Review and Continual Improvement

SFI® EXAMPLE*

An example of a complete section of Objective 9 with one of the performance measures (9.1) and three of the indicators (1, 2 and 3) within the SFI® requirements for legal and regulatory compliance:

Objective 9: Legal and Regulatory Compliance

To comply with applicable federal, provincial, state and local laws and regulations.

Performance Measure 9.1.: Program participants shall take appropriate steps to comply with applicable federal, provincial, state and local forestry and related social and environmental laws and regulations.

Indicators:

1. *Access to relevant laws and regulations in appropriate locations.*
2. *System to achieve compliance with applicable federal, provincial, state or local laws and regulations.*
3. *Demonstration of commitment to legal compliance through available regulatory action information.*

* *The example provided for each of the certification systems describe how each system addresses compliance with laws.*

RELATING CERTIFICATION STANDARDS, PRINCIPLES AND OBJECTIVES TO WISCONSIN *FOREST MANAGEMENT GUIDELINES*

When working on forest land enrolled in a forest certification system the manager is responsible to understand the applicable forest certification system's standards and their implementation. The following tables (see pages Appendix C-5 and Appendix C-6) provide a summary of ATFS standards, FSC® principles, and SFI® objectives which might apply to management practices discussed in each chapter of Wisconsin *Forest Management Guidelines*. This list is not inclusive and may change as each certification system improves and updates their standards.

FSC
www.fsc.org
FSC® C006979
The mark of responsible forestry

SUSTAINABLE FORESTRY INITIATIVE
SFI-00059

WOOD WATER RECREATION WILDLIFE
CERTIFIED TREE FARM

WHAT ARE THE DIFFERENCES?

Comparing these systems to identify the one that best fits a landowner's needs can be difficult. Each program has strengths and weaknesses depending on the type of operation being evaluated. For example, ATFS was developed specifically with family forest and non-industrial forestlands in mind; SFI® was developed with private, industry-managed lands as a primary target audience; and FSC® was developed with a focus on affecting global forest sustainability. To identify the best fit and understand the differences, it is important for landowners, managers and forest products companies to evaluate the trade-offs of each in the context of their own operations, and opportunities to access existing and emerging markets.

THE FUTURE?

A great deal has changed since the early 1900s when the concept of sustainable forest management was first discussed. As our understanding of what sustainable forest management means grows and evolves, so does forest certification and the demand of society for goods and services from sustainably managed sources. Forest certification is one way that we can evaluate management practices and measure progress towards the goal of sustainable forest management.

FOREST MANAGEMENT GUIDELINES CHAPTERS

The mark of responsible forestry

		2: Silvicultural Priciples	3: Wildlife Habitat	4: Visual Quality	5: Riparian Areas/Wetlands	6: Cultural Resources	7: Forest Soil Productivity	8: Threats to Forest Health	9: Economics	10: Forest Management	11: General Operations	12: Forest Road Construction	13: Timber Harvesting	14: Pesticide Use	15: Intermediate Silviculture	16: Forest Roads	17: Fire Management	18: Forest Recreation
ATFS • STANDARDS	1. Commitment to Practicing Sustainable Forestry	x						x		x								
	2. Compliance with Laws													x				
	3. Reforestation and Afforestation	x											x		x			
	4. Air, Water, and Soil Protection				x		x	x				x		x				
	5. Fish, Wildlife, Biodiversity and Forest Health	x	x					x								x		
	6. Forest Aesthetics			x														
	7. Protect Special Sites	x	x			x				x						x		
	8. Forest Product Harvests and Other Activities									x			x					
FSC® • PRINCIPLES	1. Compliance with Laws and FSC® Principles				x			x										
	2. Tenure and Use Rights and Responsibilities									x								
	3. Indigenous Peoples' Rights					x												
	4. Community Relations and Worker's Rights	x				x							x				x	
	5. Benefits from the Forest								x				x				x	
	6. Environmental Impact	x	x	x	x	x	x	x		x	x	x	x	x	x		x	
	7. Management Plan									x			x				x	
	8. Monitoring and Assessment	x			x			x		x			x					
	9. Maintenance of High Conservation Value Forests	x								x			x			x		
	10. Plantation Management	x	x		x		x	x		x		x		x	x		x	

Summary Table of ATFS Standards and FSC® Principles and their Relationship to Wisconsin Forest Management Guidelines Chapters

SUSTAINABLE FORESTRY INITIATIVE
SFI-00059

FOREST MANAGEMENT GUIDELINES CHAPTERS

SFI® • OBJECTIVES	2: Silvicultural Principles	3: Wildlife Habitat	4: Visual Quality	5: Riparian Areas/Wetlands	6: Cultural Resources	7: Forest Soil Productivity	8: Threats to Forest Health	9: Economics	10: Forest Management	11: General Operations	12: Forest Road Construction	13: Timber Harvesting	14: Pesticide Use	15: Intermediate Silviculture	16: Forest Roads	17: Fire Management	18: Forest Recreation
1. Forest Management Planning									x								
2. Forest Health and Productivity	x					x	x				x	x	x	x		x	
3. Protection and Maintenance of Water Resources				x													
4. Conservation of Biological Diversity including Forests with Exceptional Conservation Value	x	x					x		x						x		
5. Management of Visual Quality and Recreational Benefits			x								x						x
6. Protection of Special Sites					x				x						x		
7. Efficient Use of Fiber Resources								x				x					
8. Recognize and Respect Indigenous Peoples' Rights									x								
9. Legal and Regulatory Compliance				x			x					x					
10. Forestry Research, Science and Technology				x			x										
11. Training and Education																	
12. Community Involvement and Landowner Outreach																	
13. Public Land Management Responsibilities																	
14. Communications and Public Reporting																	
15. Management Review and Continual Improvement																	

Summary Table of SFI® Objectives and their Relationship to Wisconsin Forest Management Guidelines Chapters

NOTES

APPENDIX D: REGULATIONS RELATING TO FOREST MANAGEMENT

The list below contains state and federal regulations that relate to activities associated with forest management. Local laws and ordinances can be obtained from municipal offices. This is only a summary of laws and their provisions for your information. No warranty, expressed or implied, is made regarding the accuracy, adequacy, completeness, legality, reliability or usefulness of any information contained in this publication. To be certain of the accuracy of summaries, please consult the official language of the law that is listed.

Department employees shall not be held liable for any improper or incorrect use of the information contained in this publication. In no event shall the State of Wisconsin, the Department or Department employees be liable for any direct, indirect, incidental, special, exemplary, or consequential damages however caused and on any theory of liability, whether in contract, strict liability, or tort (including negligence or otherwise) arising in any way out of the use of this publication. Other regulations may also apply.

WISCONSIN LAWS

WISCONSIN STATE STATUTES

Wisconsin State Statutes can be viewed at: ***www.legis.state.wi.us/rsb/stats.html***.

Chapter 26, Wis. Stats. – Protection of Forest Lands and Forest Productivity

- ***S. 26.03, Wis. Stats.*** – Harvest of raw forest products. Requires that any person cutting a forest product from a private forest file a cutting notice with the county clerk prior to any harvesting.
- ***S. 26.05, Wis. Stats.*** – Timber theft. Elements of civil timber theft citation.
- ***S. 26.06, Wis. Stats.*** – Enforcement, seizure and sale of materials. Provides for seizure of forest products from state lands, FCL lands and MFL lands and penalties for transporting knowingly stolen timber.
- ***S. 26.09, Wis. Stats.*** – Civil liability for unauthorized cutting, removal or transportation of raw forest products.
- ***S. 26.12 (6), Wis. Stats.*** – Any slash which falls into or is deposited in a lake or stream, when harvesting timber or other forest products, shall be immediately removed if, in the opinion of the department, such removal is in the public interest.
- ***S. 26.205, Wis. Stats.*** – Tractors, spark arresters. Provides for standards for tractors and similar equipment necessary to prevent forest fires.
- ***S. 26.30, Wis. Stats.*** – Forest insects and diseases; department jurisdiction; procedure. Provides for various authorities to the Wisconsin DNR for forest insect and disease controls and establishment of zones of infestation control.
- ***S. 26.35, Wis. Stats.*** – Forest productivity. Requires the Wisconsin DNR to identify privately owned forest lands that are most likely to provide high forest productivity benefits to the economy of the state and target assistance to such landowners.
- ***26.38, Wis. Stats.*** – Forest grant program. Requires the Wisconsin DNR to establish grant programs for sustainable forestry practices and for the control of invasive plants.

Chapter 28, Wis. Stats. – Public Forests

- ***S. 28.05(1), Wis. Stats.*** – Timber Sales; State Forests. Requires that cutting shall be limited to trees marked or designated for cutting by a forester.
- ***S. 28.05 (3), Wis. Stats.*** – Requires the Wisconsin DNR to establish a cooperating forester program.
- ***S. 28.11, Wis. Stats.*** – Administration of County Forests. Provides for the establishment of county forests. Requires the Wisconsin DNR to investigate and approve or deny entry of county forest lands. Requires that county forest land use plans be approved by the Wisconsin DNR. Authorizes the Wisconsin DNR to make grants for county forest administration and sustainable forestry. Provides information about the exchange of fees between the county and Wisconsin DNR. Provides procedures for withdrawal of county forest land.
- ***S. 28.21, Wis. Stats.*** – Municipal Forests. In a municipal forest registered with the Wisconsin DNR, no trees shall be cut except those marked or designated for cutting by a Wisconsin DNR forester.

Chapter 29, Wis. Stats. – Wild Animals and Plants

- ***S. 29.601 (3), Wis. Stats.*** – Prohibits throwing or depositing any deleterious substances, including oil, tar, refuse, debris, decayed wood, sawdust, and sawmill refuse, into waters of the state.
- ***S. 29.604, Wis. Stats.*** – Endangered and threatened species protected. Establishes regulations for endangered and threatened wild animals and plants. Exempts forestry practices from regulations regarding endangered and threatened wild plants.

Chapter 30, Wis. Stats. – Navigable Waters, Harbors and Navigation

- ***S. 30.12, Wis. Stats.*** – Structures and deposits in natural waters. Requires permits to deposit material and place structures on the bed of navigable waterways.
- ***S. 30.123, Wis. Stats.*** – Bridges and culverts. Requires permits for the construction of bridges and culverts over navigable waterways.
- ***S. 30.18, Wis. Stats.*** – Withdrawal of water from lakes and streams. Requires permits and establishes standards for diverting water from lakes and streams.
- ***S. 30.19 (1g) (c), Wis. Stats.*** – Requires permits for grading or removing more than 10,000 square feet of topsoil from the banks of navigable waterways.
- ***S. 30.195, Wis. Stats.*** – Changing of stream courses. Requires permits for changing the course or straightening navigable streams.
- ***S. 30.20, Wis. Stats.*** – Removal of Material from Beds of Navigable Waters. This section regulates the removal of material from the beds of navigable lakes, and both navigable and non-navigable streams.
- ***S. 30.26, Stats.*** – Wild Rivers. This section designates certain rivers as wild rivers, thereby preserving them in a free flowing condition, and protecting them from development. It also directs the Wisconsin DNR to provide active leadership in the development of a practical management policy and to work with local governments, U.S. Forest Service, timber companies, county foresters, and private landowners in implementing land use practices to accomplish these management objectives.
- ***S. 30.27, Wis. Stats.*** – Lower St. Croix River preservation. Identifies the Lower St. Croix River from the dam near St. Croix Falls to its confluence with the Mississippi River as a river to include in the National Wild and Scenic Rivers Program and directs the department to establish zoning standards.
- ***S. 30.29, Wis. Stats.*** – Operation of motor vehicles in water prohibited. Prohibits the operation of motor vehicles in any navigable waters, except in limited circumstances including for agricultural uses (including forest management), when the water is frozen, for activities for which a permit is issued, and for department activities.
- ***Ss. 30.40-30.49, Wis. Stats.*** – Establishes the Lower Wisconsin State Riverway.

Chapter 59, Wis. Stats. – Counties

- ***S. 59.69 (4) (a), Wis. Stats.*** – A county may not enact an ordinance which prohibits a forestry operation that is carried out in accordance with generally accepted forestry management practices as defined in s. 823.075, Wis. Stats. See Chapter 823, Wis. Stats., and Chapter NR 1, Wis. Admin. Code, for more information.

Chapter 60, Wis. Stats. – Towns

- ***S. 60.61 (2) (a) 1., Wis. Stats.*** – A town may not enact an ordinance which prohibits a forestry operation that is carried out in accordance with generally accepted forestry management practices as defined in s. 823.075, Wis. Stats. See Chapter 823, Wis. Stats., and Chapter NR 1, Wis. Admin. Code, for more information.

Chapter 61, Wis. Stats. – Villages

- ***S. 61.35, Wis. Stats.*** – A village may not enact an ordinance or adopt a regulation which prohibits a forestry operation that is carried out in accordance with generally accepted forestry management practices as defined in s. 823.075, Wis. Stats. See Chapter 823, Wis. Stats., and Chapter NR 1, Wis. Admin. Code, for more information.

Chapter 62, Wis. Stats. – Cities

- ***S. 62.23 (7) (b), Wis. Stats.*** – A city may not enact an ordinance or adopt a regulation which prohibits a forestry operation that is carried out in accordance with generally accepted forestry management practices as defined in s. 823.075, Wis. Stats. See Chapter 823, Wis. Stats., and Chapter NR 1, Wis. Admin. Code, for more information.

Chapter 77, Wis. Stats. – Taxation of Forest Croplands/Managed Forest Land

- ***Chapter 77, Subchapter I , Wis. Stats.*** – Taxation of forest croplands. Provides for sound forest management of private forests through production of forest products with public hunting and fishing as extra public benefits, through deferred taxation and just tax revenue to the towns.

- ***Chapter 77, Subchapter VI, Wis. Stats.*** – Managed forest land. Successor to the Forest Crop Law. Provides for the management through sound forestry practices of private forests for the production of future forest crops for commercial use, recognizing the objectives of individual property owners, compatible recreational uses, watershed protection, development of wildlife habitat and accessibility of private property to the public for recreational purposes.

Chapter 94, Wis. Stats. – Plant Industry

- ***Ss. 94. 67-94.715, Wis. Stats.*** – Addresses the sale, handling and use of pesticides.

Chapter 157, Wis. Stats. – Disposition of Human Remains

- ***S. 157.70, Wis. Stats.*** – Burial sites preservation. Establishes the regulations related to the preservation of burial sites.

Chapter 160, Wis. Stats. – Groundwater Protection Standards

Establishes protection standards for groundwater to regulate pesticides and other polluting substances in groundwater.

Chapter 281, Wis. Stats. – Water and Sewage

- ***S. 281.20, Wis. Stats.*** – Orders; nonpoint source pollution. Authorizes the department to order the abatement of nonpoint source pollution.

Chapter 287, Wis. Stats. – Solid Waste Reduction, Recovery and Recycling

- ***S. 287.07, Wis. Stats.*** – Prohibitions on land disposal and incineration. Establishes standards for proper disposal of lead acid batteries, waste oil, tires and other materials.

Chapter 292, Wis. Stats. – Remedial Action

- ***S. 292.11, Wis. Stats.*** – Hazardous substance spills. Requires notification of state and local authorities of spills of hazardous substances.

Chapter 323, Wis. Stats. – Emergency Management

- ***S. 323.60, Wis. Stats.*** – Hazardous substance information and emergency planning. Establishes the authorities of the division of emergency management on hazardous spills and how other units of government respond.

Chapter 343, Wis. Stats. – Operators' Licenses

Regulates commercial drivers licenses for persons driving commercial motor vehicles, defined under 340.01(8), Wis. Stats., used for commercial transport of bulk pesticides (hazardous materials) and forest products. A copy of the CDL manual is available from:

Wisconsin Department of Transportation
Division of Motor Vehicles, Bureau of Driver Services
P.O. Box 7917, Madison, WI 53707-7917
Phone: 608-266-2237
Wisconsin CDL Hotline: 800-242-2514

Chapters 348 and 349, Wis. Stats. – Vehicles: Size, Weight and Load

- ***Ss. 348.17, 349.15 and 349.16, Wis. Stats.*** – Special or Seasonal Weight Limitations. No person shall operate a vehicle in violation of special weight limitations imposed by state or local authorities on particular highways, highway structures, or portions of highways when signs have been erected giving notice of such weight limitations.

Chapter 823, Wis. Stats. – Nuisances

- ***S. 823.075, Wis. Stats.*** – Actions against forestry operations. A forestry operation is not a nuisance if the forestry operation alleged to be a nuisance conforms to generally accepted forestry management practices. See s. NR 1.25 Wis. Admin. Code – Generally accepted forestry management practices.

WISCONSIN ADMINISTRATIVE CODE

Wisconsin Administrative Codes can be viewed at: ***www.legis.state.wi.us/rsb/code.htm***.

Copies of the above laws and rules are available from:

Wisconsin Department of Administration
Document Sales Unit
P.O. Box 7840, Madison, WI 53707-7840
Phone: 608-266-3358

Chapter ATCP 29, Wis. Admin. Code – Pesticide Use and Control

Provides standards for use, storage, sale, and commercial application of pesticides.

Chapter ATCP 30, Wis. Admin. Code – Pesticide Product Restrictions

Provides standards for use, storage, sale, and commercial application of pesticides.

Chapter ATCP 31, Wis. Admin. Code – Groundwater Regulatory Rule

Provides standards for use, storage, sale, and commercial application of pesticides.

Chapter ATCP 33, Wis. Admin. Code – Pesticide Bulk Storage

Provides standards for use, storage, sale, and commercial application of pesticides.

Chapter NR 1, Wis. Admin. Code – Natural Resources Board Policies

- ***Ss. NR 1.21-1.213, Wis. Admin. Code*** – Private forestry assistance, cooperative forestry policy, private forestry priorities for assistance, cooperating forester program. These rules address the administration of the private forestry assistance program to private, non-industrial landowners under ss. 26.35, 28.01 and 28.01, Wis. Stats., and establish priorities for servicing private forestry requests and a cooperative program with consulting foresters.
- ***S. NR 1.24, Wis. Admin. Code*** – Management of state and county forests. Establishes the Natural Resources Board's broad management objectives for the management of state and county forests.
- ***S. NR 1.25, Wis. Admin. Code*** – Generally accepted forestry management practices. Defines "generally accepted forestry management practices" to be forestry management practices that promote the sound management of a forest and includes those practices contained in the most recent version of the department publication known as *Wisconsin Forest Management Guidelines* (PUB-FR-226). Defines "sound management of a forest" to mean sustainably managing a forest with the application of ecological, physical, quantitative, managerial, economic, and social principles to the regeneration, management, utilization, protection and conservation of forest ecosystems to meet specified wildlife habitat, watershed, aesthetics, cultural and biological goals and objectives while maintaining the productivity of the forest.
- ***S. NR 1.26, Wis. Admin. Code*** – Contracting with cooperating foresters for timber sale establishment. Establishes the criteria and requirements for contracting with cooperating foresters on state timber sales.

Chapter NR 27, Wis. Admin. Code – Endangered and Threatened Species

Contains standards for the take, transportation, possession, or sale of any wild animal or wild plant on the department's lists of endangered and threatened wild animals and wild plants.

Chapter NR 37, Wis. Admin. Code – Lower Wisconsin State Riverway Aesthetic Management Specifications for Cutting and Harvest of Timber

Establishes management specifications for timber harvesting in Lower Wisconsin State Riverway.

Chapter NR 40, Wis. Admin. Code – Invasive Species Identification, Classification and Control

- Creates a comprehensive, science-based system with criteria to classify invasive species into two categories: "Prohibited" and "Restricted."
- With certain exceptions, the transport, possession, transfer and introduction of Prohibited species is banned.
- Restricted species are also subject to a ban on transport, transfer and introduction, but possession is allowed, with certain exceptions.

The Wisconsin DNR may issue permits for research or public display of any listed invasive species. For species other than invasive fish and crayfish, permits may also be issued for any other purpose.

Chapter NR 46, Wis. Admin. Code – Forest Tax Program

Establishes rules and regulations for the Forest Crop Land program and the Managed Forest Land program.

Chapter NR 47, Wis. Admin. Code – Forestry Grant and State Aid Administration

Provides for the implementation and administration of grants and state aid programs pertaining to forestry and forest resources in the state including Wisconsin's Forest Landowner Grant Program.

Chapter NR 80, Wis. Admin. Code – Use of Pesticides on Land and Water Areas of the State of Wisconsin

Establishes regulations for the application of pesticides to land and waters of Wisconsin.

Chapter NR 103, Wis. Admin. Code – Water Quality Standards for Wetlands

Provides wetland water quality standards and procedures for permitting activities within wetlands.

Chapter NR 107, Wis. Admin. Code – Aquatic Plant Management

Establishes procedures for the management of aquatic plants and control of other aquatic organisms.

Chapter NR 115, Wis. Admin. Code – Wisconsin's Shoreland Management Program

Contains the statewide minimum standards for county shoreland zoning ordinances, including the management of shoreland vegetation.

Chapter NR 116, Wis. Admin. Code – Wisconsin's Floodplain Management Program

Establishes standards for floodplain zoning ordinances.

Chapter NR 117, Wis. Admin. Code – Wisconsin's City and Village Shoreland-Wetland Protection Program

Requires cities and villages to adopt shoreland-wetland zoning ordinances, including provisions regarding silvicultural activities. Provisions for counties are found in Chapter NR 115, Wis. Admin. Code.

Chapter NR 118, Wis. Admin. Code – Standards for the Lower St. Croix National Scenic Riverway

Contains standards for municipal zoning ordinances on the Lower St. Croix River to maintain its scenic characteristics.

Chapter NR 151, Wis. Admin. Code – Runoff Management

Establishes runoff performance standards and practices designed to achieve water quality standards.

Chapter NR 216, Wis. Admin. Code – Storm Water Discharge Permits

Provides criteria for activities requiring storm water permits.

Chapter NR 302, Wis. Admin. Code – Management of Wisconsin's Wild Rivers

Provides standards for the management of state-designated wild rivers, including timber harvesting standards.

Chapter NR 320, Wis. Admin. Code – Bridges and Culverts In or Over Navigable Waterways

Establishes permitting standards for bridges and culverts.

Chapter NR 706, Wis. Admin. Code – Hazardous Substance Discharge Notification and Source Confirmation Requirements

Requires the hazardous spills be reported to the department and that actions be taken to contain, clean-up, and properly dispose of the hazardous substance.

FEDERAL LAWS

The United States Code (U.S.C.) Code of Federal Regulations (CFR) can be viewed at:

- (U.S.C.) ***www.gpoaccess.gov/uscode/***
- (CFR) ***http://ecfr.gpoaccess.gov/***

Copies of Federal Acts (Either complete CFR Volumes or single copies of daily Federal Registers) can be purchased from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402
Phone: 202-512-1800

Complete CFR Volumes also can be acquired from:

U.S. Government Bookstore
Suite 150, Reuss Federal Plaza
310 West Wisconsin Avenue, Milwaukee, WI 53203
Phone: 414-297-1304

Bald Eagle Protection Act, 16 U.S.C., Section 668
Establishes regulations protecting Bald Eagles, including restrictions on disturbing nesting activity.

Clean Water Act (CWA), 33 U.S.C., Sections 1251-1376
Establishes standards for permitting wetland alterations, including an exemption for normal silvicultural activities, including forest roads if certain design, location and use standards are satisfied.

Commercial Driver's License (CDL) Standards CFR, Title 49, Part 383

Comprehensive Environmental Response Compensation and Liability Act (CERCLA), CFR, Title 40, Parts 300-302
For information on CERCLA, call **800-424-9346**.

Endangered Species Act (ESA), 7 U.S.C. Section 136, 16 U.S.C. Section 1531
Establishes regulations for federal endangered and threatened wild animals and plants.

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), CFR, Title 40, Parts 152-186
For information on FIFRA, call **703-305-5805**.

Hazard Communication Standard (HCS), CFR, Title 29, part 1910.1200
For information on HCS, call OSHA's regional office at: **312-353-2220**.

Hazardous Materials Transportation and Training, CFR, Title 49, parts 171-177
For information on hazardous material transportation or training requirements, call **202-366-6121**.

Lacey Act, 16 U.S.C., Sections 3371-3378
Regulates the illegal transport of animals and timber across state and international borders.

Migratory Bird Treaty Act (MBTA), CFR, Title 16, Parts 703-712
Establishes protections for migratory birds, including protections for harvesting during nesting seasons.

Resource Conservation and Recovery Act (RCRA), CFR, Title 40, Parts 260-281
For information on RCRA, call **800-424-9346**.

Superfund Amendments and Reauthorization Act (SARA), CFR, Title 40, Parts 300-374
For information on SARA, call **800-424-9346**.

Workers Protection Standard (WPS) for Agricultural Pesticides, CFR, Title 40, Part 170
For information on WPS, call **703-305-7666**.

APPENDIX E: PERMITS

In addition to the BMPs described in this manual, you should be aware of existing municipal, county, state, and federal regulations relating to forest management and water quality. Many of these regulations are listed in Appendix D: Regulations Relating to Forest Management. Appendix E: Permits summarizes several permits and notices related to the regulations in Appendix D: Regulations Relating to Forest Management. This list should not be construed as complete. For more information, contact your county zoning office or Wisconsin DNR water management specialist when conducting forest management activities near streams, lakes or wetlands. If you are planning an activity near a waterbody or wetland, investigate the need for a permit at least 90 DAYS in advance of the activity.

Legal definitions of a lake, stream, navigability, and ordinary high water mark are listed in Chapter 5: Riparian Areas and Wetlands and in Appendix H: Glossary.

LOCAL PERMITS AND NOTICES

These permits and notices may be required by town, village, city, or county regulations.

BURNING PERMITS

Contact your local fire department, town chairperson, or local municipal official if you have any questions. Local ordinances may be more restrictive than state law.

COUNTY CUTTING NOTICES

Under state law, anyone harvesting timber (except for firewood, boughs or up to five Christmas trees) is required to file a cutting notice with the county clerk at least 14 days before beginning a timber harvest.

FLOODPLAIN ZONING PERMITS

When working in a mapped floodplain, permits may be required for activities including installation of stream crossings and placement of wetland fill (such as for an approach to a stream crossing). The goal of these regulations is to prevent increases in flood elevations. Contact your local county zoning administrator regarding floodplain zoning permits.

SHORELAND AND SHORELAND-WETLAND ZONING PERMITS

Permits may be required by shoreland-wetland or shoreland zoning ordinances for harvesting timber near the water, grading, placing fill in wetlands and other activities. Regulations vary by municipality. Special provisions exist on the Lower Wisconsin Riverway and the St. Croix River. The Lower Wisconsin Riverway extends from the dam at Prairie du Sac south to the Mississippi River. Information on the Lower Wisconsin Riverway is available at: ***lwr.state.wi.us*** or by calling **608-739-3188**. Standards along the St. Croix River are available from municipal offices.

WATERWAY AND WETLAND PERMITS

Wisconsin DNR waterway and wetland permits are required for activities that affect lakes, streams and wetlands. Common activities that occur during forest management that may require a permit include:

- Stream crossings of navigable waterways including bridges, culverts, fords, timber mats, and pole fords.
- Wetland crossings that do not meet the silvicultural exemption.

For more information, contact your local Wisconsin DNR water management specialist or go to: ***dnr.wi.gov – keyword "waterway."***

STATE PERMITS AND NOTICES

BURNING PERMITS

Burning permits are required by the Wisconsin DNR in many parts of the state to conduct legal and responsible burning in the outdoors. Burning permits are free and easy to obtain. They encourage the public to burn safely and are proven to be effective in protecting lives, property and natural resources from the damages of wildfires. These no-cost permits are good for the calendar year and are non-transferable. More information is available at: ***dnr.wi.gov – keywords "burn permit."***

INCIDENTAL TAKE PERMITS/AUTHORIZATION

According to s. 29.604, Wis. Stats. it is illegal to take, transport, possess, process, or sell any wild animal that is included on the Wisconsin Endangered and Threatened Species List. In addition, it is illegal to remove, transport, carry away, cut, root up, sever, injure, or destroy a wild plant on the Wisconsin Endangered and Threatened Species List on public lands. Forestry, agricultural and utility practices are exempted from the taking prohibitions of listed plant species.

The Wisconsin Endangered Species law allows the Department to authorize the taking of a protected species if the taking is not for the purpose of, but will be only incidental to, the carrying out of an otherwise lawful activity. To date, the Department has not issued an Incidental Take Permit for routine forest management activities. In most cases, take can be avoided through timing or other modifications. Contact the Bureau of Natural Heritage Conservation or visit ***dnr.wi.gov – keyword "ER"*** for information on Incidental Take Permits.

STORM WATER PERMITS

Wisconsin DNR storm water permits are required when disturbing one or more acres of land, such as during the construction, reconstruction or maintenance of roads. Storm water permits are not required for forest roads that are used solely for silvicultural purposes, if certain standards are met. For multi-use roads, a storm water permit is needed when the construction of a new road or reconstruction of an existing road will disturb one or more acres of land or when maintenance of an existing road will disturb five or more acres. Contact your local Wisconsin DNR storm water specialist or refer to ***dnr.wi.gov – keywords "storm water"*** for more information about the Wisconsin DNR's Storm Water Program.

CUTTING NOTICES AND REPORTS

Landowners that are enrolled in the Managed Forest Law (MFL) Program or the Forest Crop Law (FCL) Program must file a cutting notice (part A of Form 2450-032) with the Wisconsin DNR at least 30 days before harvesting begins (except for cutting firewood for personal use). Within 30 days of the completion of the harvest, a report (Part B of Form 2450-032) with cutting volumes must be filed with the Wisconsin DNR. For more information, contact your local Wisconsin DNR forester or refer to: ***dnr.wi.gov – keywords "forest tax."***

FEDERAL PERMITS

WATERWAY AND WETLAND PERMITS

The U.S. Army Corps of Engineers (USACE) regulates activities occurring in waterways and wetlands, including the excavation and placement of fill. When building a road or trail through a wetland, a permit may be required from the USACE. An exemption for forest roads is available, but certain design, location and use standards must be met to qualify for the exemption. Contact your local USACE program staff or visit the USACE website at: ***www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits***.

APPENDIX F: CITED REFERENCES

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Biomass, Nutrient Distribution and Litterfall in Populus, Pinus and Picea Stands on Two Different Soils in Minnesota. Perala, D. A. and D. H. Alban, Plant and Soil 64, (2): 177-192, 1982.

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Composition, Biomass and Nutrient Distribution in Mature Northern Hardwood and Boreal Forest Stands, Michigan. Rutkowski, D. R., and R. Stottlemyer, American Midland Naturalist Journal, 130: 13-30, 1993.

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APPENDIX G: RESOURCE DIRECTORY

FOREST MANAGEMENT ASSISTANCE AND EDUCATION

The Resource Directory identifies sources of information and assistance in the management of forest resources. A number of organizations and agencies are listed, along with a brief description of the types of assistance they can provide, and contact information. This directory is not exhaustive. Additional resources related to specific management activities can also be found at the end of each chapter.

Wisconsin Department of Natural Resources

FORESTERS EMPLOYED BY THE STATE OF WISCONSIN WHO ASSIST PRIVATE LANDOWNERS

Wisconsin DNR service foresters are stationed in every county. They focus on initial guidance and management planning to get landowners started with sustainable forestry. Wisconsin DNR foresters can also help get information for landowners from forest health specialists, wildlife biologists, and other resource managers at the Wisconsin DNR.

Wisconsin DNR tax law specialists are also stationed in every county to assist private landowners with all aspects of the forest tax law programs (Managed Forest Law [MFL]and Forest Crop Law [FCL]). More information on tax law programs can be found later on in this appendix.

PRIVATE ENTERPRISE FORESTERS (CONSULTING AND INDUSTRIAL FORESTERS) THAT HAVE SIGNED A COOPERATING FORESTER AGREEMENT WITH THE DEPARTMENT

Cooperating foresters voluntarily agree to observe Wisconsin DNR standards and rules whenever they assist with land management planning and timber harvesting. Cooperating foresters also agree to attend continuing education courses to stay current in the services they offer. Consulting foresters serve or represent private landowners on a contract or fee basis, which the landowner pays.

Industrial foresters are employed by wood-using industries that provide advice and assistance to private landowners to promote forestry practices approved by the companies.

You can search for a Wisconsin DNR or cooperating forester that services your county using the Forestry Assistance Locator or by using the most recent version of the directory of foresters. You can find both on the Wisconsin DNR website at: ***dnr.wi.gov – keywords "forester."***

Copies of the *Directory of Foresters* are also available from Wisconsin DNR Service Centers and Ranger Stations. You can also request one in writing or over the phone.

Wisconsin Department of Natural Resources
Division of Forestry
PO Box 7921, Madison, WI 53707
Phone: 608-267-7495

The *Silviculture Handbook*, 2431.5, can also be found on the Wisconsin DNR website at: ***dnr.wi.gov – keyword "silviculture."***

University of Wisconsin-Extension (UWEX)

Through county-based faculty, basin educators, and statewide extension specialists, UWEX offers a variety of research-based educational programs and opportunities including agriculture, forestry, wildlife, fisheries, family living, 4-H, and more.

For woodland owners and others interested in forestry, wildlife and related natural resource topics, UWEX works with many partners to provide education resources for:

- Forestry and wildlife fact sheets and publications
- Woodland owner workshops and conferences
- In-depth forestry and wildlife learning experiences through COVERTS, Master Woodland Stewards, and the Woodland Leaders Institute
- Continuing education for resource professionals
- Assistance to the forest products industry

The UWEX Caring for your Woodland website ***(woodlandinfo.org)*** has information on how to plan a visit to your local UWEX County Office, Extension publications, introductions to forest management, or information on land ownership.

For more information on programs available through UWEX, visit your local UWEX County Office or their website at: ***counties.uwex.edu.***

UWEX Regional Natural Resources Program

The University of Wisconsin's Regional Natural Resources Program includes a team of Natural Resources Educators located across the state. For more information visit: ***naturalresources.uwex.edu***.

Natural Resource Educators

UWEX Regional Natural Resources Program includes a team of Natural Resource Educators located across the state. The educators provide local and statewide education, training, and technical support for environmental and natural resource issues. To find an educator in your area, visit their website at: ***naturalresources.uwex.edu/staff/index.html***.

University of Wisconsin-Stevens Point (UWSP)

The College of Natural Resources, in collaboration with UWSP Continuing Education and Outreach, offers a variety of hands-on, emersion training programs in forestry and forest management. Topics covered in these trainings include but are not limited to:

- Northern Hardwood Forest Marking
- Log Quality, Visual Merchandizing, Internal Rate of Return, and Milling
- Tree Biology
- Plant Identification and Sampling

All of our trainings are pre-approved for Society of American Foresters and Wisconsin DNR cooperating foresters Continuing Education Units (CEUs). More information on our current programs can be found at: ***www.uwsp.edu/conted/Pages/enhanceSkills.aspx***.

The University of Wisconsin-Stevens Point offers customized in-person and online programming on a variety of professional and business development topics. More information on our customizable trainings can be found at: ***www.uwsp.edu/conted/Pages/Forestry-Customized-Training.aspx***.

Haley Frater
CNR Outreach Program Manager • College of Natural Resources • Stevens Point, WI 54481-3897
Phone: 715-346-4176 • **Email:** haley.frater@uwsp.edu

University of Wisconsin-Madison

UWEX Cooperative Extension is a partnership of Wisconsin counties, the University of Wisconsin, and the U.S. Department of Agriculture to extend research-based knowledge to people where they live and work. UWEX provides equal opportunities and programming including Title IX requirements.

Department of Forest and Wildlife Ecology • 1630 Linden Drive, Madison, WI 53706
Phone: 608-262-9975 • **Fax:** 608-262-9922 • ***forestandwildlifeecology.wisc.edu***

United States Department of Agriculture (USDA)

FOREST SERVICE NORTHEAST AREA

The U.S. Forest Service provides technical assistance through its State and Private Forestry Northeast Area (NA) Office. The NA website offers a vast selection of forestry publications from organizations around the country. • ***www.na.fs.fed.us/pubs***

It includes links to publications for the following:

- riparian forest management
- wildlife/hunting
- tree identification
- seedling suppliers
- forest health and protection
- tree planting
- special forest products
- timber sales
- glossaries of forestry terms
- recreation
- income tax and estate planning
- silviculture
- and much, much more!

FARM SERVICE AGENCY (FSA)

www.fsa.usda.gov

FSA is the USDA agency into which were merged several predecessor agencies, including the Agricultural Stabilization and Conservation Service (ASCS). FSA is primarily tasked with the implementation of farm conservation and regulation laws around the country. The FSA of each state is led by a politically appointed State Executive Director (SED).

NATURAL RESOURCES CONSERVATION SERVICE (NRCS)

The NRCS, formerly known as the Soil Conservation Service (SCS), is an agency of the USDA that provides technical assistance to farmers and other private landowners and managers.

www.nrcs.usda.gov

FOREST INDUSTRY SAFETY TRAINING ALLIANCE (FISTA)

FISTA provides training programs on logging and other forestry activities for forestry professionals, woodland owners, special interest groups, municipalities, and others. The content of the classes is based off the national Sustainable Forestry Initiative (SFI®) standard.

Jennie Baker (FISTA Office Coordinator)
FISTA
3243 Golf Course Road
Rhinelander, WI 54501
Phone: 1-800-551-2656
Email: jennie.baker@fistausa.org
fistausa.org

GATHERING WATERS

Gathering Waters is a land conservation organization formed in 1994 to assist land trusts, landowners and communities in their efforts to protect Wisconsin's land and water resources. Established by a coalition of land trusts, Gathering Waters serves as an education and technical assistance center for both land trusts and landowners. But their mission goes far beyond training and providing expert advice on land conservation issues. Gathering Waters works directly with concerned landowners and existing land trusts statewide to preserve Wisconsin's natural heritage and rural landscape.

Gathering Waters
211 South Paterson Street, Suite 270
Madison, WI 53703
Phone: 608-251-9131 • ***www.gatheringwaters.org***

Wisconsin Woodland Owners Association (WWOA)

The Wisconsin Woodland Owners Association (WWOA) is a nonprofit [501(c)(3)], educational membership association for the private woodland owners of Wisconsin. WWOA offers year-round educational opportunities for novice and experienced private woodland owners who want to become better stewards of their woodlands. If you are passionate about caring for your woodlands, join WWOA to learn from soon to be friends near and far about how they care for their land. We learn as much from each other as we do from natural resource professionals.

WWOA's website found at: ***wisconsinwoodlands.org*** provides a calendar of events, timely news, a wealth of resources and links.

Like our Facebook page at: ***www.facebook.com/WisconsinWoodlands/*** to keep informed about news and activities. WWOA publishes a quarterly award-winning magazine, *Wisconsin Woodlands*, that members receive as a benefit of membership. We sponsor local field days, workshops, regional conferences, and our wonderful annual meeting each year in September. Local WWOA chapters are a great way to learn more about local issues and visit neighboring woodland properties. WWOA also offers the Women of WWOA gatherings twice a year, Growing Your Legacy information, a co-sponsored newsletter with the Wisconsin Tree Farm Committee, a Forestry Leader Scholarship at UW-Stevens Point for future foresters, and a variety of volunteer opportunities. For a free information packet with a sample of our magazine, contact:

Wisconsin Woodland Owners Association
PO Box 285, Stevens Point, WI 54481
Phone: 715-346-4798 • **Email:** wwoa@uwsp.edu
www.wisconsinwoodlands.org

American Tree Farm System® (ATFS)

The ATFS is a nationwide program encouraging private forest owners to do an effective job of growing trees as a crop. You may have seen a green and white ATFS sign on your travels around Wisconsin. ATFS is sponsored by professional foresters working for government agencies, industry and as consulting foresters. ATFS inspectors must meet minimum education and experience requirements.

If interested in becoming an ATFS tree farmer, contact the Wisconsin Tree Farm Committee or your local Wisconsin DNR forester. They will arrange to have a state, private or industrial forester look at your property to prepare a tree farm management plan. Once certified as an ATFS tree farm, you can display the sign and subscribe to the *American Tree Farmer* magazine. You will receive notices of field days, conferences, conventions, and study tours on forestry. Certified ATFS tree farm landowners are also eligible to compete in annual Outstanding Tree Farmer competitions. For information on tree farming in Wisconsin, contact:

Wisconsin Tree Farm Administrator
PO Box 285,
Stevens Point, WI 54481
Phone: 715-252-2001
Email: witreefarm@gmail.com
witreefarm.org

CULTURAL RESOURCE ASSISTANCE

ARCHAEOLOGICAL CONSULTANTS

The state historic preservation office maintains lists of archaeological consultants to help the public to locate an archaeologist to fit their needs.
www.wisconsinhistory.org/records/article/cs2835

BURIAL SITES PRESERVATION

Wisconsin Historical Society
Burial Sites
816 State Street, Madison, WI 53706
Phone: 808-342-7834 or 608-264-6507

DEPARTMENTAL ARCHAEOLOGIST, DNR

2300 North Dr. Martin Luther King Jr. Drive
Milwaukee, WI 53212
Phone: 414-263-8617

HISTORIC STRUCTURES

Wisconsin Historical Society
Historic Preservation
816 State Street, Madison, WI 53706
Phone: 608-264-6512

STATE ARCHAEOLOGIST

Wisconsin Historical Society
816 State Street, Madison, WI 53706
Phone: 608-264-6496

TRIBAL HISTORIC PRESERVATION OFFICERS

www.wisconsinhistory.org/Records/Article/CS3145

WISCONSIN ARCHITECTURE AND HISTORY INVENTORY

The Wisconsin Historical Society website allows you to search the National and State Register of Historic Places.
www.wisconsinhistory.org/ahi

NON-TIMBER PRODUCTS

Aromatics, berries and wild fruits, cones and seeds, forest botanicals, honey, mushrooms, nuts, syrup, and weaving and dyeing materials are some of the many alternative forest products that people grow and harvest. Special products like these can provide opportunities for entrepreneurs to supplement their incomes. The broader economic framework that results can ultimately help to preserve and protect sustainable forests.

For more information, see *Non-timber Products in the United States*, 2002, edited by E. T. Jones, R. J. McLain and J. Weigand. University Press of Kansas.
kansaspress.ku.edu/978-0-7006-1166-9.html

The following website lists additional books, articles and publications, many of which can be downloaded. Both rural and urban forests are addressed.
www.forestandwoodland.org/non-timber-forest-products.html

Wisconsin Walnut Council

The Wisconsin Walnut Council is a state chapter affiliate of a nationwide organization involved with hardwood management. The council conducts periodic field trips, and is a source of information on growing all types of hardwood trees.
www.wiscwalnutcouncil.org/indexwisc.html

SOURCES OF MAPS AND PLANNING TOOLS

Aerial Photography

DEPARTMENT OF NATURAL RESOURCES (DNR)

The Wisconsin DNR coordinates an aerial photography project for forestry planning. Flights are repeated at least once every ten years for each county. High-resolution prints and enlargements are available for purchase.

Information for ordering prints and enlargements for each county can be found on the DNR website.
dnr.wi.gov – keywords "aerial photography"

USDA

Landowners working with the Farm Service Agency (FSA) on farm programs have access to aerial photographs maintained by the USDA. Contact your local FSA Office for details.
www.fsa.usda.gov/programs-and-services/aerial-photography/index

TERRASERVER AERIAL PHOTOS

Visit the TerraServer-USA website which provides free public access to a vast data store of aerial photographs and topographic maps of the United States. The TerraServer website is easy to navigate by selecting a location on a map or entering the name of a place, and is designed to work with common computer systems and web browsers over slow speed communications links.
www.terraserver.com

Other Digital Mapping Resources

The Wisconsin Land Information Clearinghouse is an internet gateway to geospatial data, land and reference information, and the Wisconsin agencies that produce or maintain these items.
www.sco.wisc.edu/wisclinc

Links are provided for the following themes:

- Internet map services (online maps built in a web browser)
- Political and administrative boundaries
- Image and base maps
- TIGER and line data (maps from the U.S. Census Bureau)
- Water and hydrography
- Infrastructure
- Natural resources and environment
- Soils and geology

Two federal mapping resources link users to extensive libraries of mapping data from agencies around the country:

- The **U.S. Geological Survey (USGS)** is responsible for building, maintaining and applying The National Map. It provides public access to high-quality geospatial data and information from multiple partners. You can view The National Map by using your web browser (no special software or download required).
  nationalmap.gov

- The U.S. government maintains a web-based portal for one-stop access to maps, data and other geospatial services. The website helps to simplify information so everyone can easily find geospatial data, as well as learn more about geospatial projects underway.
  www.data.gov

Topographic Maps

U.S. GEOLOGICAL SURVEY

The United States Geological Survey (USGS) provides science for a changing world by delivering reliable and impartial information that describes the Earth, its natural processes, and its natural species. This information is used to manage water, biological, energy, and mineral resources, and to enhance and protect our quality of life. The USGS works with every state in the country, cooperating with more than 2,000 organizations to provide information for resource managers in the public and private sectors.
Phone: 1-800-USA-MAPS • ***store.usgs.gov/maps***

LOCAL LIBRARIES

Check with your local library for the availability of maps.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY (WGNHS)

The WGNHS, a part of the University of Wisconsin Extension, is an interdisciplinary organization that conducts natural resources surveys and research to produce information used for decision-making, problem-solving, planning, management, education, and development. For more information, contact:

Wisconsin Geological and Natural History Survey
3817 Mineral Point Road
Madison, WI 53705-5100
Map Sales: 608-263-7389
Information: 608-262-1705
www.uwex.edu/wgnhs

SOIL SURVEYS, SOIL INTERPRETATION, AND EROSION CONTROL

Wisconsin Natural Resources Conservation Service (NRCS)

Published soil survey reports for most Wisconsin counties are available through your local NRCS or county Land Conservation Department offices. Soil survey reports include:

- Detailed soil maps on an aerial photo background
- Descriptions of the soils
- Soil use and management information
- Recreational development information
- Soil property and interpretation information in table format

More information about soil survey reports is available at: ***www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey***.

Web Soil Survey Mapping Portal

websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Soils Lab Analysis

University of Wisconsin Soil and Plant Analysis Labs are located in Madison and Marshfield.
uwlab.soils.wisc.edu

WISCONSIN WETLAND INVENTORY AND DIGITAL DATA

The Wisconsin Wetland Inventory was established in 1978 to help protect wetlands. The DNR was directed to map the state's wetlands and the initial inventory was completed in 1984. Wetland maps are available for the entire state. You can obtain map copies or learn more about the Wisconsin Wetland Inventory by visiting the DNR website at: ***dnr.wi.gov – keywords "wetland inventory."***

DNR DIGITAL MAPPING RESOURCES

The Wisconsin DNR web mapping applications display various types of information in map format. A complete list of web mapping applications available can be found at the DNR website.
dnr.wi.gov – keyword "maps"

Statewide and Landscape Level Tools

WISCONSIN WILDLIFE ACTION PLAN

Wisconsin Wildlife Action Plan (2006). Department of Natural Resources, Madison, Wisconsin. Wisconsin's Wildlife Action Plan (WWAP) identifies native animals that are in greatest need of conservation, along with the habitats (natural communities) and places (ecological landscapes) they use.

The plan is part of a nationwide effort to outline steps needed to conserve wildlife and habitat before they become more rare and costly to protect. The plan is available online with tools to quickly access information from the plan. These web pages provide lists of Species of Greatest Conservation Need (SGCN) by ecological landscape and natural community type, as well as the places in the state that offer the best opportunities to maintain these species and their habitats. These pages are closely integrated with other Wisconsin DNR web pages for ecological landscapes, natural communities, and rare species information.
dnr.wi.gov – keywords "wildlife action plan"

ECOLOGICAL LANDSCAPES OF WISCONSIN HANDBOOK

Wisconsin is comprised of 16 ecological landscapes, each with its own unique ecological characteristics and management opportunities. These landscapes have been used as a geographical framework for numerous Wisconsin planning efforts.

The *Ecological Landscapes of Wisconsin Handbook* is a comprehensive guide to all 16 ecological landscapes. The handbook is designed as a planning resource, highlighting important ecological considerations and providing information about each ecological landscape's physical environment, biology, and socio-economic resources. Management opportunities to sustain species, natural communities, and other ecologically important features in Wisconsin are suggested using a statewide, regional and continental perspective. In addition, the best locations in the State are identified at which to apply these management opportunities.

The handbook also includes extensive background information, summaries of important management opportunities, useful maps, and descriptions of Wisconsin's natural communities. For additional information, coordinate the handbook with the *Wisconsin Wildlife Action Plan* as well as other tools.
dnr.wi.gov – keyword "landscapes"

WISCONSIN ALL-BIRD CONSERVATION PLAN

The Wisconsin All-bird Conservation Plan synthesizes the requirements and conservation issues of 116 priority bird species, and provides recommendations for habitat protection, restoration, and management that will have the greatest impact on bird populations.
www.wisconsinbirds.org/plan/

WISCONSIN LAND LEGACY REPORT

Wisconsin Land Legacy Report: An inventory of places to meet Wisconsin's future conservation and recreation needs, Wisconsin DNR, Madison, WI, 2006. This report identifies places across the state believed to be most critical to meeting current and future conservation and recreation needs.
dnr.wi.gov – search "land legacy"

DRIFTLESS AREA INITIATIVE

Natural Resources Conservation Service (NRCS) uses the Environmental Quality Incentives Program (EQIP) to provide technical and financial assistance to help producers accelerate installation of conservation practices in the Driftless Area. The initiative focuses on restoring coldwater stream corridors. Common practices include protecting streambanks from erosion, adding fences to keep livestock out of streams, removing obstructions in the water, adding stream crossings and fish ladders, and managing habitat for wildlife. Information on the Driftless Area Landscape Conservation Initiative can be found at the NRCS website.
www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/initiatives

FINANCIAL INCENTIVE PROGRAMS

Wisconsin offers landowners two important categories of financial incentives to help reduce the expenses of owning and caring for woodlands:

- State forest tax laws that help reduce property taxes.
- Cost-sharing programs that are available from state and federal sources, which reimburse landowners for allowable conservation project expenses.

Cost-sharing Programs

The Wisconsin Forest Landowner Grant Program (WFLGP) provides financial assistance for stewardship practices on private land. A wide array of practices are eligible for cost-sharing including management plan development, tree planting, and forest improvement. Contact your local Wisconsin DNR forester for details. The Wisconsin DNR foresters also help landowners with the following federal cost-sharing programs offered by USDA:

- Conservation Reserve Program (CRP)
- Environmental Quality Incentives Program (EQIP)
- Conservation Stewardship Program (CSP)

Wisconsin Department of Natural Resources
Division of Forestry
PO Box 7921, Madison, WI 53707
Phone: 608-267-7508

More information is available from the Wisconsin DNR website at: ***dnr.wi.gov – keyword "WFLGP."***

FOREST TAX PROGRAMS

Statewide, more than three million acres are enrolled in a forest tax program. Wisconsin's forest tax laws encourage sustainable forest management on private lands by providing a property tax incentive to landowners. Two different forest tax law programs currently exist: the Managed Forest Law (MFL) and the Forest Crop Law (FCL). The FCL program was enacted in 1927 and enrollment was closed on January 1, 1986. MFL was enacted in 1985 and is the only forest tax program that is open to enrollment.

Together with landowner objectives, MFL incorporates timber harvesting, wildlife management, water quality, and recreation to maintain a healthy and productive forest. Sustainable forest management benefits Wisconsin's economy, hunting, fishing, wildlife, recreation, soils, waterways, and air quality, and renews our beautiful forests for everyone to enjoy.

To participate in the MFL program, landowners designate property as "Open" or "Closed" to public access for recreation, and commit to a 25- or 50-year sustainable forest management plan. The plan sets the schedule for specific forestry practices which landowners must complete. In return, MFL participants make a payment in lieu of regular property taxes. For more information, visit ***dnr.wi.gov – keywords "MFL" or "forest tax."***

The DNR manages a group certification program for non-industrial forestland enrolled in the MFL. MFL group certification focuses on Wisconsin DNR's administration of the group and quality of management on member land. Third-party auditors determine if the MFL group conforms to American Tree Farm System® (ATFS) and Forest Stewardship Council® (FSC®) principles and performance measures. More information on MFL group certification can be found by visiting the Wisconsin DNR website. ***dnr.wi.gov – keywords "MFL certified group"***

The FCL, now closed to enrollment, was an earlier forest tax incentive program. If you are buying forestland, you may come across FCL land. Contact your local Wisconsin DNR tax law specialist for details.

FISH AND WILDLIFE HABITAT, WETLAND PROTECTION

The Department of Natural Resources (DNR) and other agencies and organizations can help you manage and restore fish and wildlife habitat, and protect wetlands. Wisconsin DNR offices can also provide current listings of designated trout streams (and their tributaries) and designated trout lakes.

DNR WILDLIFE BIOLOGIST STATE-WIDE CONTACTS

To contact a DNR wildlife biologist visit ***dnr.wi.gov*** – ***keyword "contact"*** and select ***"search for DNR staff."*** Once at the staff directory, enter ***"wildlife biologist"*** for the subject and select your county to find one that serves your area.

ARMY CORPS OF ENGINEERS

Regulation Branch, St. Paul District
190 Fifth Street East, Suite 700
St. Paul, MN 55101-1638
Phone: 651-290-5807
www.mvp.usace.army.mil

NATURAL RESOURCES CONSERVATION SERVICE

United States Department of Agriculture
Natural Resources Conservation Service
8030 Excelsior Drive, Suite 200
Madison, WI 53717
Phone: 608-662-4422
www.wi.nrcs.usda.gov

U.S. DEPARTMENT OF AGRICULTURE'S CONSERVATION RESERVE PROGRAM

USDA, Farm Service Agency
6515 Watts Road, Suite 100, Madison, WI 53719
Phone: 608-276-8732
www.nrcs.usda.gov/wps/portal/nrcs/main/wi/programs

U.S. FISH AND WILDLIFE SERVICE

Region 3: Great Lakes-Big Rivers
Federal Building
1 Federal Drive, Fort Snelling, MN 55111-4056
www.fws.gov/midwest

PARTNERS FOR FISH AND WILDLIFE

4511 Helgesen Drive
Madison, WI 53718-6747
Phone: 608-221-1206

WISCONSIN WATERFOWL ASSOCIATION

P.O. Box 427
Wales, WI 53183
Phone: 1-800-524-8460
www.wisducks.org

ENDANGERED, THREATENED OR SPECIAL CONCERN SPECIES

U.S. FISH AND WILDLIFE ENDANGERED SPECIES

Wisconsin Field Office
2661 Scott Tower Drive
Green Bay, WI 54229-9565
Phone: 920-866-1717
www.fws.gov/midwest/GreenBay/endangered/index.html
National: www.fws.gov/endangered

WISCONSIN DEPARTMENT OF NATURAL RESOURCES, BUREAU OF NATURAL HERITAGE

101 South Webster Street
Madison, WI 53707-7921
Phone: 608-266-7012
dnr.wi.gov – keyword "NHC"

FOREST HEALTH PROTECTION

Contact a Wisconsin DNR forest health specialist.

FOREST HEALTH SPECIALISTS

To contact a Wisconsin DNR forest health specialist, visit the DNR website for contact information of a specialist in your area.
dnr.wi.gov – keywords "forest health staff"

INSECT AND DISEASE IDENTIFICATION

University of Wisconsin Plant Disease Diagnostics Clinic
pddc.wisc.edu/

UNIVERSITY OF WISCONSIN PEST DIAGNOSTIC LAB

www.entomology.wisc.edu/diaglab/entodiag.html

PESTICIDE APPLICATOR TRAINING AND LICENSING FOR STATE CERTIFICATION

University of Wisconsin-Madison
Department of Agronomy, Pesticide Applicator Training
1575 Linden Drive, Madison, WI 53706-1597
Phone: 608-262-7588

NOTIFICATION OF SPILLS: REPORT ALL SPILLS TO THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES

24-hour Emergency Hotline Number 1-800-943-0003
dnr.wi.gov – keyword "spills"

NONNATIVE INVASIVE SPECIES

Nonnative invasive species can be a serious concern for forest regeneration and growth, as well as impacting wildlife habitat and recreation.

For information on invasive species:
dnr.wi.gov – keywords "invasive species"

Invasive species staff:
dnr.wi.gov – keywords "invasive species staff"

Invasive Plants Association of Wisconsin:
www.ipaw.org

Plant Conservation Alliance, Weeds Gone Wild:
www.nps.gov/plants/alien/

PESTICIDE USE

WISCONSIN DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION

The Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) is the first point of contact about pesticide use and regulations. They also manage the pesticide applicator certification and licensing in the state of Wisconsin. Information on the pesticide clean sweep program and worker protection standards can also be obtained through Wisconsin DATCP.

Wisconsin DATCP
2811 Agriculture Drive, PO Box 8911
Madison, WI 53708-8911
Phone: 608-224-4500
datcp.wi.gov

FOR INFORMATION ON ENVIRONMENTAL AND HEALTH EFFECTS OF PESTICIDES

U.S. Environmental Protection Agency - Region 5
77 West Jackson Boulevard
Chicago, IL 60604-3590
Phone: 800-621-8431
www.epa.gov/pesticide-science-and-assessing-pesticide-risks

WATER CROSSINGS

PERMIT REQUIREMENTS AND DESIGN STANDARDS; INSTALLATION OF BRIDGES AND CULVERTS, CONTACT:

The nearest Wisconsin DNR water management specialist can help you through the permitting process for water crossings. The Wisconsin DNR website has complete information about waterway and wetland permits.
dnr.wi.gov – keyword "waterway"

FOR DESIGN ASSISTANCE, CONTACT:

Natural Resources Conservation Service (NRCS)
Wisconsin State Office
8030 Excelsior Drive, Suite 200
Madison, WI 53719-2726
Phone: 608-662-4422
www.wi.nrcs.usda.gov

FOREST CERTIFICATION

AMERICAN TREE FARM SYSTEM® (ATFS)

ATFS is the oldest third-party forest certification in the world. The ATFS was established in 1941 in response to the need to protect forest resources on private lands, provide advice and assistance to forest owners, and ensure the continued supply of wood and other forest products. ATFS has certified 20.5 million acres of privately owned forestland and more than 74,000 family forest owners. ATFS has been successful in helping forest owners protect water resources, enhance wildlife habitat, and create recreational opportunities – all while harvesting wood in sustainable ways. Some ATFS certified forests are now in their third or fourth generation of sustainable harvests on the same land. • ***treefarmsystem.org***

FOREST STEWARDSHIP COUNCIL® (FSC®)

FSC® is an international nonprofit, multi-stakeholder organization established in 1993 to promote responsible management of the world's forests. Its main tools for achieving this are standard setting, independent certification, and labeling of forest products. This offers customers around the world the ability to choose products from socially and environmentally responsible forestry. • ***www.fsc.org***

SUSTAINABLE FORESTRY INITIATIVE® (SFI®)

SFI® is a nonprofit, charitable, independent organization with more than 195 million acres certified to its forest certification standard in the United States and Canada. The rigorous, science-based SFI® standard covers key values such as protection of biodiversity; species at risk and wildlife habitat; sustainable harvest levels; protection of water quality; and prompt regeneration. All SFI® certifications require independent, third-party audits and are performed by internationally accredited certification bodies. ***www.sfiprogram.org***

PRESCRIBED BURNING

BURNING PERMITS

On lands under Wisconsin DNR protection, contact local Wisconsin DNR service centers, ranger stations, and emergency fire wardens. More information on burn permits can be found on the Wisconsin DNR website.
dnr.wi.gov – keywords "burn permit"

On lands under U.S. Forest Service (USFS) protection, contact USFS district ranger stations or fire wardens.
www.fs.fed.us/organization/Chequamegon-Nicolet%20National%20Forest

On lands outside of Wisconsin DNR or USFS protection, permits might be required from the local township (see government listings in your local telephone directories).

FIRE WEATHER

Current fire weather forecasts, fire danger ratings, and burning permit regulations are available via links on the Wisconsin DNR website.
dnr.wi.gov – keyword "fire"

BURNING ASSISTANCE

If you need help conducting prescribed fires, see the Directory of Foresters for the names of consultants that offer prescribed burning services.
dnr.wi.gov – keywords "coop forester"

NOTES

APPENDIX H: GLOSSARY

A

ANGLE OF REPOSE
The maximum slope or angle at which a material, such as soil or loose rock, remains stable (stable angle).

ARCHAEOLOGICAL SITE
A geographic location where archaeological artifacts, features and other materials are found.

B

BANK
The land surface abutting the bed of any navigable waterway which, either prior to any project or alterations of land contours, or as the result of the proposed project or alteration, slopes or drains without complete interruption into the waterway (NR 340.02(2)).

BASAL AREA (BMPs for Water Quality Definition)
The cross-sectional area four-and-one-half feet above ground in square feet of all trees with a diameter of five inches or greater.

BASAL AREA (Forestry Definition)
1. The cross-sectional area of a single stem, including bark, measured at breast height (four-and-one-half feet above ground).
2. The cross-sectional area of all stems in a stand expressed per unit of land area.

BASEFLOW
The portion of streamflow which comes from groundwater.

BEST MANAGEMENT PRACTICES (BMPs)
Practical and economically-achievable practices for preventing or reducing nonpoint source pollution.

BIOLOGICAL DIVERSITY (Biodiversity)
The spectrum of life forms and ecological processes that support and sustain them. Biodiversity occurs at four interacting levels: genetic, species, community, and ecosystem.

BOARD FOOT
The amount of wood contained in an unfinished board one inch thick, 12 inches long, and 12 inches wide.

BROAD-BASED DIP
A surface drainage structure specifically designed to drain water from an access road while vehicles maintain normal travel speeds.

BRUSH BARRIER
A sediment control structure created of slash materials, piled at the top slope of a road or at the outlets of culverts, turnouts, dips, and waterbars.

BUFFER AREA
A designated area around a stream or waterbody of sufficient width to minimize entrance of forestry chemicals (fertilizers, pesticides and fire retardants) into the waterbody.

C

CAVITY TREE
A hollow tree used for the roosting and reproduction of wildlife.

CHECK DAM
A small dam constructed in a gully to decrease the flow velocity, minimize channel scour, and promote deposition of sediment.

CLEARCUTTING
A silvicultural system in which all merchantable trees are harvested within a specified area in one operation to create an even-aged stand.

CLIMAX FOREST
An ecological community that represents the culminating stage of a natural forest succession for its locality and environment.

COARSE WOODY DEBRIS
Stumps and fallen trunks or limbs of more than six inch diameter at the large end.

CO-DOMINANT TREE
A tree whose crown helps to form the general level of the main canopy in even-aged stands, or in uneven-aged stands, the main canopy of the tree's immediate neighbors, receiving full sunlight from above and comparatively little from the sides.

COMMUNITY
An assemblage of plants and animals living together and occupying a given area.

CONTOUR
An imaginary line on the surface of the earth connecting points of the same elevation. It also applies to a line drawn on a map connecting the points of the same elevation. The steeper the slope, the closer the contour lines will be.

CORD
A stack of wood that measures four feet high, four feet wide, and eight feet long (128 cubic feet).

CORDUROY
Logs placed over a wetland to reinforce the natural root mat for the purpose of stabilizing the road foundation.

CROWN (BMPs for Water Quality Definition)
A convex road surface that allows runoff to drain to either side of the road prism.

CROWN (Forestry Definition)
The part of a tree bearing live branches and foliage.

CROWN CLASS
A category of tree based on its crown position relative to those of adjacent trees.

CULL
Any item of production (e.g., tree, log, lumber, seedling) rejected because it does not contain certain specifications of usability or grade.

CULTURAL RESOURCE
An archaeological site, cemetery, historic structure, historic area, or traditional-use area that is of cultural or scientific value.

CULVERT
A metal, wooden, plastic, or concrete conduit through which water can flow under or across roads.

CUMULATIVE EFFECT
The impact on the environment that results from the incremental impact of an action when added to other past, present and reasonably foreseeable future actions regardless of what agency or person undertakes such action.

CUT-AND-FILL
Earth-moving process that entails excavating part of an area and then using the excavated material for adjacent embankments or fill areas.

D

DIAMETER (AT) BREAST HEIGHT (DBH)
The diameter of the bole of a tree measured at four-and-one-half feet (1.37 meters) from the ground.

DISKING (Harrowing)
A mechanical method of scarifying the soil to reduce competing vegetation and prepare a site to be seeded or planted.

DOMINANT CROWN CLASS
A tree whose crown extends above the general level of the main canopy, receiving full light from above and partial light from the sides.

DRAINAGE STRUCTURE
Any device or land form constructed to intercept or aid surface water drainage.

DUFF
The accumulations of needles, leaves and decaying matter on the forest floor.

E

ECOSYSTEM
A spatially-explicit, relatively homogeneous unit of the earth that includes all interacting organisms and components of the abiotic environment within its boundaries.

ENDANGERED SPECIES
A species threatened with extinction throughout all or a significant portion of its range.

ENVIRONMENT
The sum of all external conditions affecting the life, development and survival of an organism.

ERODIBLE SOILS
Soils that are likely to have high soil loss when exposed to water runoff. Soils having a Natural Resources and Conservation Service (NRCS) erosion hazard rating of "moderate" or "severe" should be considered erodible. Erosion hazard ratings for different soil types are listed in "Woodland Suitability" tables in NRCS soil survey manuals. Generally, forest soils occurring on 15 to 35 percent slopes have a moderate rating, and soils occurring on greater than 35 percent slopes have a severe rating. Contact your local NRCS office for more information.

EROSION
The process by which the surface of the earth is worn away by the action of wind or water in the form of rain drops, surface runoff or waves.

F

FELLING
The process of cutting down standing trees.

FILL SLOPE
The surface formed where earth is deposited to build a road or trail.

FIRE RETARDANT
Any substance, except plain water, that by chemical or physical action reduces the flammability of fuels or slows their combustion rate.

FIREBREAK
Naturally-occurring or human-made barrier to the spread of fire.

FIRELINE
A barrier used to stop the spread of fire constructed by removing fuel or rendering fuel less flammable by use of retardants.

FLOODPLAIN
Land which has been or may be covered by flood water during the regional floods (floods expected to occur once in every 100 years).

FORD
Submerged stream crossing where the streambed may need to be reinforced to bear intended traffic.

FOREST COVER TYPE
1. A category of forest usually defined by its vegetation, particularly its dominant vegetation as based on percentage cover of trees.
2. The plant species forming a plurality of composition across a given area.

FOREST FILTER STRIP
Area between a steam and construction activities that achieves sediment control by using the natural filtering capabilities of the forest floor and litter.

FOREST HEALTH
The perceived condition of a forest derived from concerns about such factors as its age, structure, composition, function, vigor, presence of unusual levels of insects or disease, and resilience to disturbance.

FOREST MANAGEMENT
The practical application of biological, physical, quantitative, managerial, economic, social, and policy principles to the regeneration, management, utilization, and conservation of forests to meet specified goals and objectives while maintaining the productivity of the forest.

FOREST ROAD
A temporary or permanent road connecting the most remote parts of the forest to existing public roads. They provide access to forestlands for timber management, fish and wildlife habitat improvement, fire control and a variety of recreational activities.

FORWARDING
The operation of moving timber products from the stump to a landing for further transport.

G

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 nonwoven manner to form a blanket-like product.

GRADE (Gradient)
The slope of a road or trail expressed as a percent of change in elevation per unit of distance traveled.

H

HABITAT
1. A unit area of environment.
2. The place where an animal, plant or population naturally or normally lives and develops.

HABITAT TYPE
1. A land or aquatic unit consisting of an aggregation of habitats having equivalent structure, function and responses to disturbance.
2. An aggregation of units of land capable of producing similar plant communities at climax.

HABITAT TYPE CLASSIFICATION SYSTEM
A site classification system based on the floristic composition of plant communities. The system depends on the identification of potential climax associations, repeatable patterns in the composition of the understory vegetation, and differential understory species. It groups land units with similar capacity to produce vegetation. The floristic composition of the plant community is used as an integrated indicator of those environmental factors that affect species reproduction, growth, competition, and community development. A system used to classify forest plant communities and the sites on which they develop.

HARVESTING (Logging)
The process of gathering a timber crop. It includes felling, skidding/forwarding, on-site processing, and removal of products from the site.

HIGH WATER MARK
See "ORDINARY HIGH WATER MARK."

I

INTEGRATED PEST MANAGEMENT (IPM)
Selection, integration and use of management actions based on scientific knowledge of forest systems, including insects and pathogens, in order to achieve desirable economic, ecological and sociological forest management goals.

INTERMITTENT STREAM
A stream that flows only after rainfall or snowmelt, and, therefore, is dry most of the year.

INVASIVE SPECIES
Nonnative species including hybrids, cultivars, subspecific taxa, and genetically modified variants whose introduction causes or is likely to cause economic or environmental harm or harm to human health, and includes individual specimens, eggs, larvae, seeds, propagules and any other viable life stages of such species.

L

LAKE
A still waterbody which (1) is navigable; (2) has an ordinary high water mark; and (3) has a bed and banks and is a "reasonably permanent" body of water although it may dry up during periods of drought.

LANDING (Log Deck)
A place where trees and logs are gathered in or near the forest for further processing or transport.

LARGE WOODY DEBRIS (Forestry BMPs for Water Quality)
Large logs, generally at least 12 inches in diameter with an anchored root ball, that have fallen into streams creating stable structures and a diversity of cover conditions and habitat for aquatic organisms.

LEAVE TREES
See "RESERVE TREES."

LOGGING DEBRIS
See "SLASH."

LUMP SUM SALE
A timber sale in which the buyer and seller agree on a total price for marked standing trees, or for trees within a defined area before the wood is removed.

M

MANAGEMENT GOAL
A broad, general statement (usually not quantifiable) that expresses a desired state or process to be achieved.

MANAGEMENT OBJECTIVE
A concise, time-specific statement of measurable planned results that correspond to pre-established goals in achieving a desired outcome.

MANAGEMENT PRESCRIPTION
A set of management practices and intensities scheduled for application on a specific area to satisfy multiple goals and objectives.

MERCHANTABILITY
Trees of size and quality suitable for commercial marketing and utilization.

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.

MULCHING
Providing any loose covering to protect exposed forest soils such as grass, straw, bark, or wood fibers, to help control erosion.

N

NAVIGABLE
A waterway is navigable if it has bed and banks, and it is possible to float a canoe or other small craft in the waterway on a regular reoccurring basis – even if only during spring runoff.

NONNATIVE INVASIVE SPECIES
Plant species accidentally or intentionally introduced from another country or geographic region, having the ability to significantly displace desirable vegetation or reduce crop yields. These plants may also be termed "exotic," "alien" or "weedy." They are likely to cause economic or environmental harm, or harm to human health.

NONPOINT SOURCE POLLUTION
Occurs when rainfall or snowmelt runoff moves across the ground, carrying pollutants into streams, lakes, wetlands, and groundwater. For example, soil can become a pollutant when water runoff moves across a road and carries large amounts of soil into a waterbody.

O

OPERABILITY
Level of merchantable volume per acre.

ORDINARY HIGH WATER MARK
The point on the bank or shore up to which the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation, or other easily-recognized characteristic.

ORGANIC DEBRIS
Particles of vegetation or other biological material that can degrade water quality by decreasing dissolved oxygen and by releasing organic solutes during leaching.

OUTSLOPE
Shaping the road surface to cause drainage to flow toward the outside shoulder.

OVER MATURE
1. A tree or even-aged stand that has reached the stage of development when it is declining in vigor and health, and reaching the end of its natural life span.
2. A tree or even-aged stand that has begun to lessen in commercial value because of size, decay or other factors.

OVERSTORY
That portion of the trees in a forest forming the uppermost canopy layer.

P

PERENNIAL STREAM
A stream that flows throughout most (i.e., greater than 50 percent) of the year.

POLETIMBER
Hardwood trees ranging in size from five to 11 inches DBH, and conifers ranging in size from five to nine inches DBH.

PRESCRIBED BURNING
The controlled application of fire to wildland fuels in either their natural or modified state, under specified environmental conditions. These conditions allow the fire to be confined to a predetermined area, while at the same time producing the fire intensity and rate of spread required to attain planned resource management objectives.

PRIMARY TYPE
Forest type named after the tree species that is being managed for a harvest cycle, and usually comprises more than 50 percent of the stand.

R

RAKING
A mechanical method of removing stumps, roots and slash from a future planting site.

REGIONAL FLOOD
A flood which is expected to occur on a particular lake, river or stream once every 100 years (also known as a "100-year flood").

RESERVE TREES
Scattered, living individual trees and/or groups of trees left unharvested within a stand for reasons other than the purpose of regeneration. Synonyms may include leave trees, green tree retention, and standards.

RIPARIAN AREA
The area of land and water forming a transition from aquatic to terrestrial ecosystems along streams, lakes and open water wetlands.

RIPARIAN MANAGEMENT ZONE (RMZ)
Land and vegetation areas next to lakes and streams where management practices are modified to protect water quality, fish and other aquatic resources. These areas are complex ecosystems that provide food, habitat and movement corridors for both aquatic (water) and terrestrial (land) communities as well as helping to minimize nonpoint source pollution impacts to surface water.

RIPRAP
Rock or other large aggregate that is placed to protect streambanks, bridge abutments, outflow of drainage structures, or other erodible sites from runoff or wave action.

ROTATION
In even-aged silvicultural systems, the period between regeneration establishment and final cutting. Rotation may be based on many criteria including culmination of mean annual increment, mean size, age, attainment of minimum physical or value growth rate, and biological conditions.

RUT
Depressions made by the passage of a vehicle or equipment.

S

SAPLINGS
Trees ranging from one to five inches DBH.

SAWBOLT
A small diameter log that does not meet the minimum specifications for a "sawlog," but is sorted for sawing rather than being used for chips, pulpwood or fuel. Dimension lumber cut from sawbolts is generally used for low value products such as two inch by four inch studs or wood pallets.

SAWLOG
A cut forest product meeting the minimum specifications for "Sawlog - Board Feet" in Chapter NR 46.02 (22), Wisconsin Administrative Rules.

Position in Tree	Butt or upper
Minimum Diameter[1] Small End: Hardwoods	10.6"
Minimum Diameter[1] Small End: Conifers	9.6"
Minimum Length Without Trim[2]	8' (except walnut and cherry which are 4')
Sweep Allowance[3]	___ of diameter small end for each 8' length
Maximum Scale Deduction for Unsound Defects	50%
Clear Cuttings Free of Knots or Other Defects	No requirements.
Sound or Unsound Surface Defect Limitations	Diameter of knots, rot, holes, etc., may not exceed $^1/_3$ the diameter of the log at the point of occurrence.
Sound End Defects	No requirements.

1 Diameter inside bark.
2 The maximum trim allowance is 8". Cut products that exceed the 8" trim allowance will be classified as misbucked, and will be scaled as sawlogs at the next whole foot increment.
3 Sweep is defined as the maximum departure distance of a line drawn between the ends of a log from the nearest surface of the log.

SAWTIMBER, LARGE
Standing trees larger than 15 inches in diameter at four-and-one-half feet above the ground.

SAWTIMBER, SMALL
Standing hardwood trees 11 to 15 inches in diameter at four-and-one-half feet above the ground, and conifer trees nine to 15 inches in diameter at four-and-one-half feet above the ground.

SEDIMENT
Soil that has eroded from the land surface, often by overland water flow, that is then transported and deposited away from its original location.

SHEARING
A site preparation method that involves the cutting of brush, trees or other vegetation at ground level using tractors equipped with angled or V-shaped blades.

SILT FENCE
A temporary barrier used to intercept sediment-laden runoff from small areas.

SILVICULTURAL PRESCRIPTION
A planned series of treatments designed to change current stand structure to one that meets management goals and objectives. The prescription normally considers ecological, economic and societal constraints.

SILVICULTURAL SYSTEM
A planned program of vegetative treatment during the entire life of a stand including tending, harvesting and regeneration, which are named after the stand age class structure and regeneration method employed.

SITE
1. The total of environmental conditions surrounding and available to a plant. The physical (climate, topography, soil) and biotic (plants, animals) factors interact to yield the light, heat, water, and chemicals that are directly available and used by the plant, as well as other chemical and mechanical disturbance factors.
2. The area in which a plant or stand grows, considered in terms of its environment, particularly as this determines the type and quality of the vegetation the area can carry.
3. A spatially-explicit, relatively homogeneous portion of land characterized by specific physical and chemical properties that affect ecosystem functions, and where a more or less homogenous forest type may be expected to develop.

SITE INDEX
A species-specific measure of actual or potential forest productivity (usually for even-aged stands) expressed in terms of the average height of trees included in a specified stand component (dominants, codominants, or the largest and tallest trees) at a specified index or base age.

SKID (Skidding)
Short-distance moving of logs or felled trees from the stump to a point of loading.

SKID TRAIL
A temporary, nonstructural travel way for logging equipment, called skidders, to drag felled trees or logs to the landing for further processing, loading and transport to a mill.

SLASH
Any tree tops, limbs, bark, abandoned forest products, windfalls, or other debris left on the land after timber or other forest products have been cut.

SLOPE
Degree of deviation of a surface from the horizontal, measured as a numerical ratio, 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 percent slope. Expressed in degrees, the slope is the angle from the horizontal plane, with a 90° slope being vertical (maximum) and a 45° slope being a 1:1 slope.

SNAG
A standing dead tree.

STAND
1. A contiguous group of trees sufficiently uniform in species composition, structure and age class distribution, and growing on a site of sufficient uniform quality, to be a relatively homogeneous and distinguishable unit.
2. A contiguous group of similar plants.

STAND STRUCTURE
1. The physical and temporal distribution of plants in a stand.
2. The horizontal and vertical distribution of components of a forest stand including the age, height, diameter, crown layers, and stems of trees, shrubs, herbaceous understory, snags, and down woody debris.

STREAM
A watercourse that (1) has an ordinary high water mark; (2) has bed and banks; (3) flows at least periodically; and (4) does not lose its character as a watercourse even though it may become braided in a wetland complex.

SUCCESSION
Gradual supplanting of one community of plants by another.

SUPPRESSED (Overtopped) CROWN CLASS
A tree whose crown is completely overtopped by the crowns of one or more neighboring trees.

T

TAKE
To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, root up, cut, sever, or to attempt to engage in any such conduct upon an animal or plant. This term is used with discussions on endangered and threatened animal or plant species.

THREATENED SPECIES
A species likely to become endangered in the foreseeable future throughout all or a significant portion of its range.

TIMBER HARVESTING
See "HARVESTING (Logging)."

TRANSPIRATION
Evaporation which enters the atmosphere from the soil through plants.

TURNOUT (BMPs for Water Quality)
A drainage ditch that drains water away from roads and road ditches.

U

UNDERSTORY
All forest vegetation growing under an overstory.

V

VISUAL QUALITY
A subjective measure of the impact that viewing an object, landscape or activity has on a person's perception of attractiveness.

W

WATER QUALITY
The chemical, physical and biological characteristics of water, usually in respect to its suitability for a particular purpose.

WATERBAR
A shallow trench or diversion dam which diverts roadside ditch and surface water runoff from roads (inactive or closed), firebreaks, or skid trails (active or inactive) into a dispersions area. Waterbars are used to minimize erosion and provide conditions for natural or artificial revegetation.

WATERSHED
The surrounding land area that drains into a lake, river or river system.

WET LINE
A line of water or water and chemical fire retardant sprayed along the ground, and which serves as a temporary fireline from which to ignite or stop a low-intensity fire.

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.

WILDFIRE
Uncontrolled fire occurring in forestland, brushland and/or grassland.

WILDLIFE
All forms of life that are wild, including plants, animals and microorganisms.

WINDROW
Logging debris and unmerchantible woody vegetation that has been piled in rows to decompose or be burned, or the act of constructing these piles.

WINDTHROW
A tree or trees uprooted by the wind (also known as "blowdown timber").

Y

YARDING
Method of transport from harvest area to storage landing.

YIELD
The amount of wood that may be harvested from a particular type of forest stand by species, site, stocking, and management regime at various ages.

FINAL NOTE: Additional forestry definitions can be found in the Wisconsin DNR *Silviculture Handbook, 2431.5,* by visiting ***dnr.wi.gov – keyword "silviculture."***

NOTES

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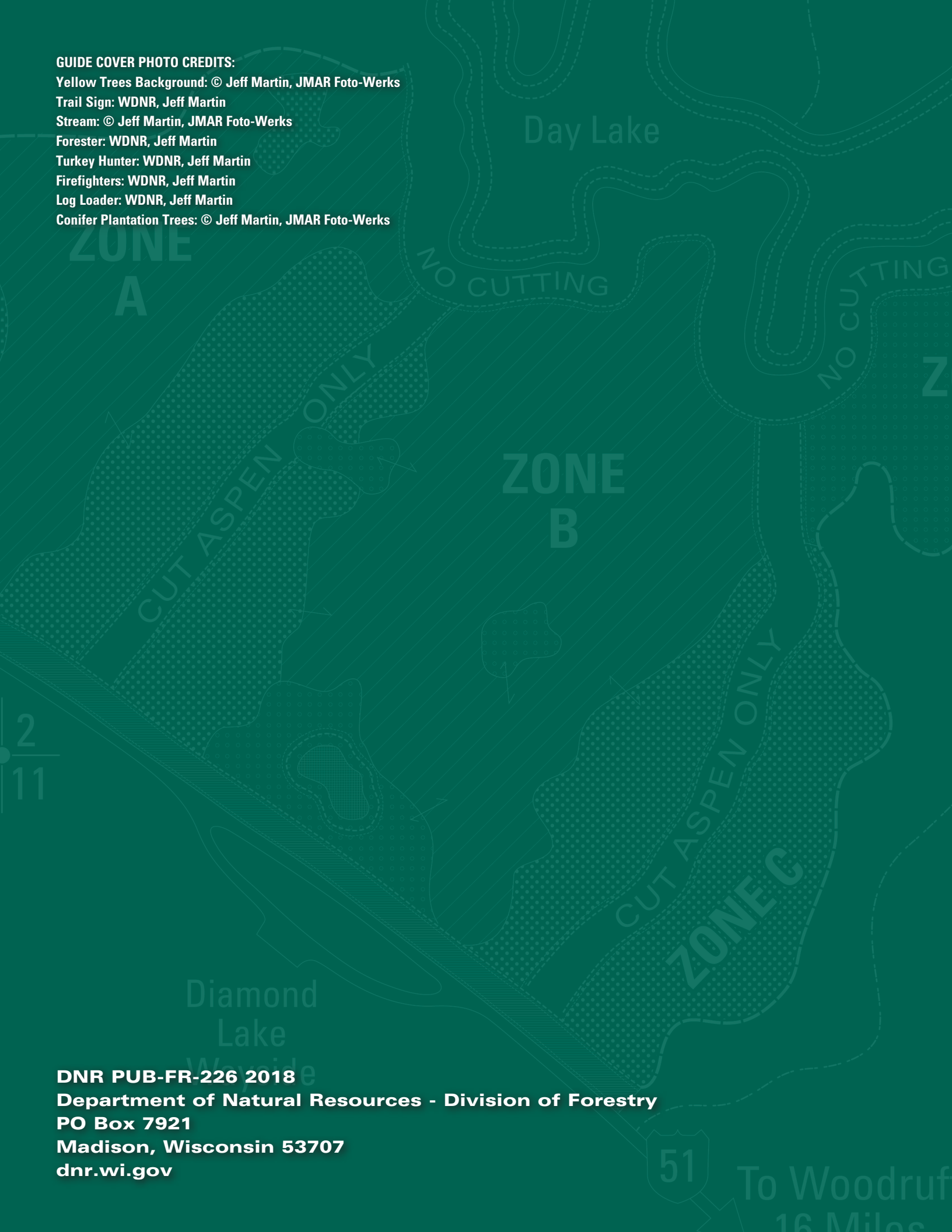

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Department of Natural Resources - Division of Forestry
PO Box 7921
Madison, Wisconsin 53707
dnr.wi.gov

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
NOTICE OF FINAL GUIDANCE & CERTIFICATION

Pursuant to ch. 227, Wis. Stats., the Wisconsin Department of Natural Resources has finalized and hereby certifies the following guidance document.

DOCUMENT ID

FA-20-0005

DOCUMENT TITLE

Wisconsin Forest Management Guidelines

PROGRAM/BUREAU

Forest Economics and Ecology, Applied Forestry Bureau

STATUTORY AUTHORITY OR LEGAL CITATION

S. 823.075, Wis. Stats. & NR 1.25, Wis. Admin. Code

DATE SENT TO LEGISLATIVE REFERENCE BUREAU (FOR PUBLIC COMMENTS)

2/10/2020

DATE FINALIZED

4/6/2020

DNR CERTIFICATION

I have reviewed this guidance document or proposed guidance document and I certify that it complies with sections 227.10 and 227.11 of the Wisconsin Statutes. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is not explicitly required or explicitly permitted by a statute or a rule that has been lawfully promulgated. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is more restrictive than a standard, requirement, or threshold contained in the Wisconsin Statutes.

Carmen Hardin — March 27, 2020

Signature — Date