Chapter 24

Tree Marking & Retention Guidelines

Last Full Revision: 11-12-12
Note- this chapter has not been fully revised since the restructuring of the Wisconsin Silviculture Guide, therefore some subject areas may be missing in the current version of this chapter.

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1 INTRODUCTION

Silvicultural practices are prescribed to address sustainable landowner goals and achieve stand management objectives. When stand management prescriptions and marking guides are developed, the desired characteristics of the remaining and/or regenerating trees and stand are of primary importance. The desired residual and future stand composition and structure guide the selection of trees for retention and trees for removal. The purpose of this chapter is to:

- Clarify concepts and considerations related to why and how trees are selected and marked, including appropriate silvicultural methods.
- Clarify silvicultural terminology. Provide silvicultural recommendations 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 guides for prescription implementation.
- Provide example of suitable marking guide templates

Selecting and marking trees to retain and/or remove is a fundamental practice and key element of many silvicultural systems. The selection of trees to retain and remove is commonly applied as part of intermediate treatments (ex. timber stand improvement, thinning), even-aged regeneration methods, and uneven-aged regeneration methods. Specific tree characteristics can also be defined to achieve specific management objectives; for example, high quality sawtimber tree or wildlife tree characteristics can be specified. Often, multiple objectives are identified for individual stands, and a variety of tree characteristics may be desired. Sometimes, individual trees can satisfy multiple objectives; for example, a large oak tree can provide wildlife mast and habitat, aesthetics, soil and water protection, and quality sawtimber when harvested.

During intermediate treatments, the focus is on which trees will be retained and managed until the next entry and beyond. In this case, tree selection commonly focuses on removing as many undesirable growing stock trees as possible and retaining as many desirable growing stock trees as possible to achieve prescribed goals, objectives, and targets. Foresters, however, should recognize that variability within stands will sometimes result in situations where acceptable growing stock will be marked, or undesirable growing stock will be retained to achieve marking objectives. Conditions in previously unmanaged stands, for example, are commonly variable and will require flexibility in the application of intermediate treatments.

When applying even-aged regeneration methods, the focus is on controlling stand composition and structure to facilitate the recruitment and development of desirable regeneration. However, some trees can be selected for retention beyond the regeneration period to achieve objectives other than regeneration. Uneven-aged stand management systems integrate regeneration, thinning, and harvesting practices; tree retention focuses on which trees will be retained and managed until the next entry and beyond, including wildlife trees and snags, and other non-timber objectives. The selection of trees to retain guides marking operations and

strongly influences the selection of trees to cut. The number of 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.

2 TIMBER MANAGEMENT CONSIDERATIONS

2.1 Growing Stock Classification Systems

Selecting the best trees to cut or leave depends on both stand level considerations (e.g., target stand composition and structure, density, rotation age, tree retention, other silvicultural system criteria) and tree level considerations related to the ability of individual trees to increase in volume, form, quality, and value after being released. Growing stock classification systems are field tools designed to help foresters assess and rate individual trees based on their quality, risk and vigor characteristics. Information on the growing stock class, in combination with other silvicultural prescription criteria, can be used to guide both the selection of cut/leave trees, as well as inform stand level assessments of growing stock quality.

Growing Stock Classification Systems for Timber Management located in Appendix C of this chapter has been developed to help foresters evaluate and rate growing stock for timber management purposes. The interrelated systems allow the forester to choose from two, three, or five tree classes depending upon stand assessment needs. The simplest 2-class system rates trees as either acceptable growing stock (AGS) or unacceptable growing stock (UGS) based on the criteria listed in Figure 24.10 and Table 24.4. The poorest criteria generally determine the class. The 3-class and 5-class systems provide increasing levels of detail. The systems are nested so that the quality, risk, and vigor criteria for the 5-class system can be combined to define criteria for the 2 and 3-class systems. The 3-class system has been recommended for most tree marking and stand assessment operations where the forester wants a balance between detail and ease of application. The 5-class system has been suggested for pre-sale cruising of stands that require a detailed analysis of stand quality, such as for supporting prescription development in a regulated northern hardwoods stand managed with single-tree selection.

2.2 Selecting Trees to Remove or Retain

The cover type chapters in this handbook provide silvicultural recommendations which strive to balance tree and stand vigor with forest product production. Most silvicultural practices implemented over the life of a stand focus on quality development, density management (e.g., residual basal area), and the selection of trees to retain or remove. Selecting and marking trees to retain and/or remove is a critical part of most silvicultural practices implemented to achieve a landowner's land management goals.

Before selecting trees to remove or retain, it is vital to identify a desired future condition (DFC). A DFC is based largely on a landowner's goals and management objectives. Informed by site conditions and characteristics, marking criteria are prescribed to achieve a desired residual stand composition and structure consistent with the DFC. If all trees except seed trees or reserve trees will be cut, then marking criteria will need to specify seed or reserve tree

objectives and characteristics. Marking criteria may also specify the removal of all other trees to a minimum diameter. For partial cuts, the characteristics of trees to cut are also delineated.

For intermediate treatments, particularly thinning, and uneven-aged selection treatments, trees with the potential for high timber quality or at least the ability to improve in grade may be favored, unless specified in a prescription, to become a component of a future commercial harvest. These trees are selected for retention and their crowns are released from competition to improve vigor and focus growth on the most desirable trees, dependent upon a stand's management prescription. Acceptable growing stock (AGS) trees are trees that contain or are potentially capable of producing high quality logs and are expected to maintain or improve their present quality through the next cutting cycle or until the next stand entry. The number of AGS trees to retain and the desired residual stand density depend on landowner objectives as reflected in the management prescription, silvicultural methods, forest type and species, stand and tree condition, and site. **Since management objectives may vary, growing stock status should not be viewed as direction for marking but rather as a tool used by foresters to aid in designing prescriptions to achieve objectives.** The selection of trees for retention strongly influences which trees will be removed.

If 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 remove and retain could apply the following sequence for removal and retention to achieve the desired residual stand composition and structure.

2.2.1 Common Priorities for Removal and Retention (see definitions below)

1. Remove trees with high risk of mortality, failure, or loss of quality and/or value
2. Release acceptable growing stock (AGS) trees
3. Remove trees with low crown vigor
4. Remove trees with poor stem form and quality
5. Remove less desirable tree species
6. Remove trees to improve spacing

The Common Priorities for Removal & Retention are most often applied during intermediate treatments, particularly thinning, and uneven-aged selection treatments. Foresters will need to review the application of The Common Priorities for Removal & Retention with each practice to ensure proper application. The Common Priorities for Removal & Retention will often vary 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 recommended sequence for removal & retention is not a silvicultural prescription but rather a marking guide element designed to aid in implementing a prescription**.

Definitions

Following are definitions and specifications for the terms quality, risk, vigor, desirable species, and spacing as used in the Common Priorities for Removal & Retention. These are not the

only factors that need to be assessed but may be the least clear in application. Some forest cover type chapters detail additional cover type specific criteria and guidelines.

Quality (timber): the capability of a tree to produce high quality timber products. Quality can be based on a tree's current or potential condition (ex. the ability to jump product class especially in the lower ½ of the tree and/or improve in grade). Quality is evaluated based on current or potential merchantable volume (diameter and log height), tree grade (value-limiting defects), and form (i.e., sweep or crook). Timber quality can vary significantly, depending on the type and severity of a defect, tree species, and other site factors. Quality is not necessarily related to the size of a tree. Due to this complexity, information specific to defect types and tree species is not described in this chapter. Some cover type chapters detail species specific indicators of timber quality.

Risk: the probability or potential that a tree will die, suffer structural failure (*physical risk*), decrease in quality and/or economic value (*quality risk*) due to internal degradation within a specified period or cutting cycle, or have a lower rate of economic return than that targeted by a landowner (*economic risk*). Table 24.4 can be used to evaluate potential physical and value risk to individual trees based on common indicators of defect or poor health. Factors that determine a landowner's desired economic return and economic risk may include net present value (NPV), internal rate of return (IRR), rate of value growth (RVG), etc. If utilized, these factors should be defined in the prescription to clarify economic risk marking criteria. Levels of risk tolerance may vary between landowners based on landownership goals and risk perception. Identification of excessive risk within a substantial portion of a stand is a well-founded reason to assess and prescribe new stand management practices.

Vigor: active, healthy well-balanced growth of individual trees. It describes the tree's potential to grow at a rapid rate and increase in volume. Vigor is evaluated based on tree characteristics which reflect recent and potential growth. Table 24.4 can be used to evaluate an individual tree's vigor based on crown class, crown silhouette, foliage condition, and bark character.

Desirable Species: Tree species which are compatible with sustainable landowner property goals, stand management objectives, site quality, and stand conditions. Desirable species are also well-adapted or potentially adapted to the site, and of commercial value.

Spacing: the distance between stems and crowns of desirable trees, and the equal distribution of growing space.

2.3 Marking Guides

A silvicultural prescription is a planned series of treatments designed to change the current stand condition to one that meets landowner goals and objectives and is an integral part of the overall forest management plan. Marking guides are tools to help foresters with on-the-ground implementation of a silvicultural prescription. Marking guides often take the form of written instructions that aid in the selection or marking of trees to retain or remove from the stand. Based on stand management prescriptions, marking guides may include information to help foresters implement a practice.

Marking guides should be recorded and discussed with the marking crew before field marking operations are initiated. Written stand management objectives, prescriptions, marking guides, and evaluations of results provide valuable information which should be documented and filed for future reference. Example of marking guide templates can be found in Appendix D.

3 TREE MARKING EVALUATION METHODS

3.1 Evaluation of Prescription Implementation, Marked Timber Evaluation

In many situations, foresters need to assess whether a silvicultural prescription has been implemented successfully. To determine if timber sale establishment field work or a post-harvest stand is consistent with prescribed management, evaluation criteria and tools may be used. These criteria and tools are applicable to marked, unmarked, and designated harvests where a harvest prescription establishes a post-harvest desired condition. Other considerations needing evaluation may include: BMPs for water quality, invasive species, Natural Heritage Inventory (NHI), archeological, historical, cultural, tree retention, and paint marks. These should be assessed separately. Marking for intermediate non-commercial practices (i.e., timber stand improvement) and other silvicultural treatments will need to be evaluated using different stand assessment criteria as well.

The use of evaluation criteria and tools should be tailored to assessment needs. Foresters may want to proactively assess marking for many reasons including self-assessment, providing clients with assurance of project completion, etc. Assessment of prescription implementation is not, however, mandatory.

Many methods may be used to determine if a project meets prescription goals and objectives. The Marked Timber Evaluation Procedure and Evaluation Sheet, found in Appendix A, and the general criteria for assessing prescription success (see below) were developed to assist with evaluating a marked harvest. It is up to professional judgment of the evaluator to determine whether to utilize either of these evaluation processes. Measuring whether a marked harvest has successfully implemented a silvicultural prescription is measurable but involves professional judgment as well. Professional judgment should also be used to determine if marking evaluation is warranted over an entire sale area or only on a subsample of the sale area.

If appropriate stand-level inventory data is available or can be collected, success in achieving sound forestry and prescription goals can be determined by comparing prescription targets with cut vs. leave / post-harvest information. For intermediate thinning and generally accepted natural regeneration methods, general criteria for measuring success specific to each practice have been established. Successful implementation is measured by comparing these criteria against post-treatment data. Where a deciding factor is whether the result is “within acceptable limits of variation above or below the identified target,” the acceptable degree a variation may be somewhat different based on cover type, stand condition, or landowner objectives. Foresters should refer to the appropriate cover type chapter to help formulate both the appropriate target and expected range of variation in results. For intermediate thinning and

generally accepted natural regeneration methods, general criteria for assessing prescription success are:

1. Intermediate Thinning

a. Thinning from below (low thinning)

i. The percent of AGS basal area increases

ii. The average merchantable stand diameter increases. Note, this can also be documented with a d/D score <1.

- d/D = QMD of trees removed / QMD of pre-harvested stand

iii. Residual BA within acceptable limits of variation above or below the prescribed target

iv. Other potential criteria

- Range of within stand basal area variance is smaller unless specified in harvest prescription
- The proportion of suppressed and intermediate trees decreases

b. Thinning from above (crown thinning)

i. The percent of AGS basal area remains approximately the same or increases.

ii. The average merchantable stand diameter remains the approximately the same.

- d/D ≈1

iii. Residual BA within acceptable limits of variation above or below the prescribed target

iv. Other potential criteria

- The proportion of dominant and codominant trees remains approximately the same

c. Row thinning

This may be modified to reflect other marking criteria if coupled with removal of trees in retention rows

i. The percent of AGS basal area does not change significantly

ii. The average merchantable stand diameter does not change significantly

iii. Residual BA within acceptable limits of variation above or below the prescribed target

iv. Rows designated for removal are consistent with prescription objectives and operational needs

d. Free thinning

This will be modified to reflect other marking criteria and will depend greatly on the harvest prescription. Note, free thinning prescriptions will need to be more detailed to fully assess success.

i. The percent of AGS basal area remains the same or increases.

ii. Residual BA within acceptable limits of variation above or below the prescribed target

iii. Other potential criteria
- The proportion of suppressed and intermediate trees decreases

2. Even-Aged Management

a. Coppice: simple, compound, and/or with standards
i. Residual trees per acre or basal area within acceptable limits of variation above or below the prescribed target

b. Clearcut: uniform, alternate, or progressive
i. Residual trees per acre or basal area within acceptable limits of variation from prescribed target

c. Seed Tree: single and group (aggregated)
i. Residual trees or numbers of seed tree clusters per acre within acceptable limits of variation above or below the prescribed target
ii. Residual trees are predominantly the target species
iii. Residual trees have near term ability or potential to produce sufficient and desirable seed (i.e., large crowns, high vigor, dominant or codominant, sufficient seed tree spacing, desirable phenotypes)

d. Overstory Removal: uniform and patch
i. Residual trees per acre or basal area within acceptable limits of variation above or below the prescribed target
ii. Adequate regeneration (see Table 21.2) is present (number of seedlings / saplings per acre) and within acceptable limits of variation from identified threshold for overstory removal

e. Shelterwood: uniform, strip, and patch
i. Preparation cut
- The percent of AGS basal area remains the same or increases.
- Residual basal area within acceptable limits of variation above or below the prescribed target
- Other potential criteria
  (a) The proportion of suppressed and intermediate trees decreases
  (b) Potential seed producing trees crown released

ii. Seeding cut
- Residual stand crown cover or basal area is within acceptable limits of variation above or below the prescribed target
- Residual trees are the target species identified in the harvest prescription
- Residual trees have the potential to produce sufficient and desirable seed (i.e., large crowns, high vigor, dominant or codominant sufficient seed tree spacing, desirable phenotypes)

iii. Overstory removal
- Residual trees per acre or BA within acceptable limits of variation from identified target
- Advance regeneration (number of seedlings / saplings per acre and height class) is within acceptable limits of variation from identified target, based on species silvics or cover type guidance

3. Uneven-Aged Management

a. WDNR Northern Hardwood Conversion Process (even-aged / two aged → single tree selection)
   i. The percent of AGS basal area increases
   ii. Residual basal area within acceptable limits of variation above or below the prescribed target
   iii. The number and size of installed gaps is within acceptable limits of variation
   iv. Other potential criteria
      - The proportion of suppressed and intermediate trees decreases

b. Single-tree selection
   i. The percent of AGS basal area remains approximately the same or increases
   ii. Residual stand diameter distribution or BA distribution is closer to identified target distribution
   iii. Residual BA within acceptable limits of variation above or below the prescribed target
   iv. Other potential criteria
      - The proportion of suppressed and intermediate trees decreases

c. Group/patch selection

   This may be modified to reflect other criteria if group/patch selection is coupled with removal of trees in the intervening matrix
   i. Numbers of regeneration openings per acre or amount of area occupied by openings is within acceptable limits of variation from prescribed target
   ii. Average size of established regeneration openings is within acceptable limits of variation from prescribed target
   iii. Adequate regeneration (see Table 21.2) present within regeneration openings created to release established regeneration

4 WILDLIFE MANAGEMENT CONSIDERATIONS

Prior to cutting a stand, identify specific trees that have high value for wildlife. Retain sufficient numbers of these wildlife trees to meet landowner goals and to provide for sustainable management of forest-dependent wildlife. Both stand and landscape level considerations may play a role in the decision process. Wildlife trees provide important structure (standing or as down woody debris) and function when managing an ecosystem. Wildlife trees can be periodically re-evaluated. Removal of wildlife trees can occur, but some should be allowed to senesce and die.

In southern Wisconsin, black cherry is a good example of a wildlife tree; large, vigorous specimens are uncommon and their fruit is eaten by many birds and mammals. In the north, large, tall white pines or hemlock groves are often reserved. Any current or future cavity or mast-producing tree is a good candidate to retain. If a few very large trees remain from previous harvests, continuing to reserve these trees can contribute to cavity, snag and species diversity objectives.

A variety of mast-producing trees suited to the habitat type should receive management consideration. Vigorous trees of a variety of species will best provide the benefits of mast production. Mast trees may provide other wildlife benefits. As an example, the "wolf tree" is often chosen as a wildlife tree. Though reserving wolf trees may mean sacrificing some timber production, they are among the best mast and cavity producers.

Wisconsin's wildlife Species of Greatest Conservation Need (SGCN) were identified by WDNR (2005). SGCNs that utilize snags and/or cavity trees include northern flying squirrel, Osprey, Red-headed Woodpecker, Black-backed Woodpecker, northern long-eared bat, silver-haired bat, and hoary bat. Bat species prefer large, spreading, snags with the bark still on. SGCNs associated with large trees are Bald Eagle, Northern Goshawk, Red-Shouldered Hawk, Acadian Flycatcher, Cerulean Warbler, and Prothonotary Warbler. Coarse woody debris associates among the SGCN include Louisiana Waterthrush, four-toed salamander, and American marten. In addition to these, many of the more common forest wildlife species benefit from the presence of large trees, cavity trees, snags, and coarse woody debris.

To minimize the impact of timber harvest on cavity-dwelling wildlife, it is important that a reasonable number of appropriate snag and cavity trees be left after harvest. For most forest ecosystems the current understanding of the biology of cavity-using wildlife is too limited to employ species by species estimates of snag requirements. A guideline of three or more cavity trees and as many snag trees as possible per acre should meet the requirements of most cavity-dwelling wildlife. A range of sizes and decay stage of snags will best achieve the objective of providing this habitat requirement. Large snags (18" DBH or larger) are particularly valuable. Large snags can accommodate a variety of wildlife. Larger wildlife species require larger trees, while smaller species can still use the large snags. Additionally, large cavity trees tend to remain available for a longer time. Some long-lived wildlife species will use this resource seasonally over a period of years and some species will use the same resource across generations. Cavity-dwelling wildlife range in size from bats and chickadees to pileated woodpeckers and black bears.

The long-term nature of snag and large diameter cavity tree availability must also be considered. To maintain an appropriate number of snags, the recruitment rate for snags must balance the rate of loss through decay. One solution is to leave some trees with poor form and low economic value to serve as future snag trees. Cavity requirements might sometimes be more easily attained with living trees since the number of residual snags is so unpredictable. Because one can assume that a portion of those trees set aside to become the second generation of snag trees will fall down before they die, it is advisable to leave more than will ultimately be needed as snags.

Some individual trees are favored by wildlife for a variety of reasons. They may be better producers of a food resource or they may be well suited to be used as a territorial marker. As an example, the Yellow-bellied Sapsucker is a common primary cavity excavator. Individuals tend to return regularly to the same trees for foraging. If preferred trees are removed, then excavations will be transferred to another tree. Maintaining trees with signs of sapsucker activity will concentrate this activity to relatively few trees and reduce impacts on timber yields. Retain trees with signs of sapsucker activity or other regular wildlife use.

In addition to selecting trees with poor form as future snag trees, it is sensible to choose trees that are infected with heart rot. These trees will be of low value and may already have cavities. Diseased trees can be identified by the presence of conks of heart rot fungi, wounds such as broken branch stubs and fire scars, dead portions of the crown, and woodpecker holes. These trees may provide habitat niches to species requiring loose bark which may not be available on older snags.

Within forests, inclusions may be found where seasonal ponding of water occurs. These ponds are called “vernal pools” (Rogers and Premo 1997). Vernal pools are characterized as small, seasonal, ephemeral, pools or ponds that lack predatory fish (Colburn 2004). Due to the lack of predators, these pools are important areas for amphibians and invertebrates to reproduce. The actual size used as definitional criteria of these “small” pools is debatable. Rogers and Premo (1997) described size range of vernal pools as “from a puddle to an acre or more.” Vernal pools contain species of aquatic flora and fauna not found throughout the terrestrial matrix. The frequency and distribution of vernal pools are of importance to their function in maintaining or enhancing biodiversity. Prior to timber harvesting, vernal pools should be identified and assessed, and for those pools deemed important to achieving biodiversity conservation goals (e.g., pools infrequent on the landscape and pools with known concentrations of uncommon species), protection measures should be specified. Some vernal pools should be buffered to protect amphibian foraging and breeding habitat. Retention of down woody debris nearby will improve habitat for some amphibians. Harvesting should avoid felling trees into or skidding through vernal pools and avoid rutting in the nearby vicinity. Vernal pools may not be apparent at certain times of the year due to their ephemeral lack of standing water or during periods of snow cover. Signs of vernal pools include water marks on tree trunks, changes in ground layer vegetation, and discoloration of litter on the forest floor.

Many of the forest cover type chapters in this guide provide wildlife management considerations, and specific species are sometimes addressed. Guidance for more specific snag and den tree management prescriptions can be found in *"A Landowner's Guide to*

Woodland and Wildlife Management" (University of Wisconsin-Extension, Publication Number 193578). This publication was developed to help the private landowner better manage woodlands for wildlife. It is a good source of information for specific snag requirements of some of our most common cavity-using birds and provides other information useful when managing mature forests for wildlife.

4.1 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 (decadent) 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 >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. Retain as many mast trees as possible.

Cavity (den) trees are living trees that are partially hollow and used by wildlife for shelter. Large diameter cavity trees, especially those >18 inches DBH, can provide the greatest array of benefits. Increasing the number and size of cavity trees facilitate increased populations of some species. Retain as many large diameter cavity trees as possible.

Figure 24.1. Large yellow birch tree (photo by Colleen Matula).

Figure 24.2. Cavity tree (photo by Joseph O'Brien, USDA Forest Service, Bugwood.org).

Figure 24.3. Snag (photo by Jeff Martin, J-Mar Photography).

Figure 24.4. Mast (photo by Paul Wray, Iowa State University, Bugood.org).

Snags are standing dead trees. Snags benefit many species of wildlife; large diameter snags 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.

For general wildlife management objectives, retain as many large trees, mast trees, cavity trees, and snags as possible in concordance with stand management objectives and landowner property goals. Wildlife trees retained can be scattered uniformly or irregularly distributed, as single trees, groups, and patches. Large trees and mast trees may benefit from crown release. Cavity trees do not necessarily require release, but in some cases crown release can prolong tree life and cavity benefits. Clearly designate, in writing and/or by marking, which trees should be retained (not cut) prior to any cutting operations.

5 AESTHETIC MANAGEMENT CONSIDERATIONS

Forest Aesthetics management guidelines should be referenced when designing aesthetic considerations for forest management application. Aesthetics involves not only individual marking decisions but long term planning and design. General aesthetic tree retention criteria have been developed, but specific characteristics and retention design will be highly variable depending on landowner preferences and stand specific considerations.

5.1 Aesthetic Tree Retention Criteria

- Low risk
- Good crown vigor
- Desirable species depend on landowner goals and site conditions, and may consider:
  - Lifespan
  - Foliage color
  - Flowers and fruits
  - Bark characteristics
  - Crown architecture, such as large spreading crowns and unusually shaped trees

6 WATER QUALITY MANAGEMENT CONSIDERATIONS

Wisconsin Best Management Practices (BMP) for Water Quality guide forest management practices to maintain water quality. Forest management in stands where the maintenance of water quality is a primary objective and concern, involves not only individual marking decisions but long-term planning and design. General water quality tree retention criteria have been developed, but specific characteristics and retention design will be highly variable depending on landowner goals and specific stand and site conditions and considerations.

6.1 Water Quality Tree Retention Criteria

- Low risk
- Good crown vigor
- Desirable species depend on landowner goals and site conditions, and may consider
  - Lifespan
  - Tolerance of saturated soils and flooding

7 BIODIVERSITY AND ENDANGERED RESOURCE MANAGEMENT CONSIDERATIONS

Figure 24.5. Biological legacies following windstorm (photo by Joe Kovach).

Many biodiversity and endangered resources issues are addressed at the landscape level, and then through the protection of special habitats. Within managed stands, identify and protect element occurrences and special habitats. Follow general wildlife management guidelines; select and retain wildlife trees, including reserve trees as dispersed and aggregated individuals, groups, and patches. By integrating the identification of special habitats and microsites with the retention of reserve tree patches, multiple benefits can be achieved. Areas to consider when selecting patches for retention include groups of trees that are older or have high species diversity, sites where understory composition exhibits high diversity or uncommon

species, vernal pools, seeps, wet depressions, cliffs, rock outcrops, ravines, and caves. Some of the forest cover type chapters in this guide provide biodiversity management considerations, and specific species are sometimes addressed.

Figure 24.6. Biological legacies following fire (photo by Joe Kovach).

Biological legacies are organisms, reproductive portions of organisms, and biologically derived structures and patterns inherited from a previous ecosystem. Compositional legacies influence ecosystem function, and can include trees, understory plants, fungi, invertebrates, and other animals. For example, mycorrhizal fungi and microbial decomposers are potential compositional legacies whose nutrient cycling functions are essential in maintaining site productivity. Structural legacies, such as trees, snags, and surface organic matter (including down woody debris) also influence ecosystem function and provide habitat for organisms.

In forests managed for timber production, variable retention harvesting retains biological legacies from the harvested stand for integration into the new stand to achieve ecological objectives. Structural legacies selected for retention often include large trees, large snags, and large down logs to provide refugia and to structurally enrich the new stand. Large structures

take a long time to develop and are not easily replaced. Important characteristics of trees selected as biological legacies are: species diversity; size class representation, especially very large trees; tree health, including both healthy and decadent trees; and heterogeneous distribution as dispersed individuals and aggregated patches. Reserve trees intended for future harvest provide biological legacies as living (usually large) trees. Reserve trees can be allowed to persist, developing into large trees, snags, and eventually large coarse woody debris. Management of biological legacies requires adaptive silvicultural methods to promote stand level heterogeneity, compositional and structural complexity, and ecosystem diversity.

8 RESERVE TREES

Reserve trees are living trees, ≥5 inches DBH, retained after the regeneration period under even-aged or two-aged silvicultural systems. They are retained well beyond stand rotation, and for purposes other than regeneration. They may be harvested eventually or retained to complete their natural lifespan (becoming a snag and then coarse woody debris). Reserve trees can be dispersed uniformly or irregularly, as single trees or aggregated groups or patches, or any mixture thereof. Synonyms include standards and green tree retention.

A legacy tree is a specific type of reserve tree that is usually older (past typical rotation age) and sometimes a remnant of a previous stand. Legacy trees may not be present in some stands, depending on management and disturbance history. These trees are individual old trees that function as refuges or provide other important structural habitat values. Legacy trees are meant to provide long term ecological benefits and are generally kept in perpetuity.

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 (either scattered or within patches) 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 decadent trees.
  - Vigorous trees of long-lived species can enable long-term retention and potentially yield a variety of benefits.
  - Decadent 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.

Exceptions to these typically desirable and generally poor reserve tree characteristics will occur.

Note: Application of the tree retention guidelines for County Forests is slightly different than stated within the guide. Refer to a County's 15 Year plan for details on tree retention for a particular County Forest. That version should be used to evaluate and approve sales for that respective County forest. Foresters should be aware that other third party certified lands may have their own tree retention guidelines.

8.1 Benefits of Reserve Tree Retention

Silvicultural practices are designed to manipulate vegetation to achieve management objectives. At its foundation, silviculture is based on understanding and working with ecological processes. Silvicultural practices that more closely emulate natural disturbance and stand development processes are more likely to sustain a wide array of forest benefits. Most natural disturbance regimes and events retain compositional and structural legacies in heterogeneous patterns and create ecological complexity. Silvicultural practices that develop and maintain reserve trees in managed stands can enable the promotion of ecological complexity – composition, structure, and pattern.

The retention of reserve trees can provide a "lifeboat" function that contributes to the conservation of biological diversity (see preceding section). These structures facilitate the perpetuation of some biota (plant and animal species and genotypes) on site. They also perpetuate habitat for re-colonization and occupation. They can improve landscape connectivity, facilitating the movement of some organisms. Reserve trees influence reorganization and recovery processes in post disturbance ecosystems; they can sustain functional roles and modify the post-disturbance environment.

The actual benefits achieved through the retention of reserve trees can be variable, depending on such factors as landscape composition and structure, stand composition and structure, site, retention design, and management objectives.

Some specific potential benefits include:

- Timber Production
  - Reserve high quality trees for future harvest
  - Perpetuation of tree species diversity

- Wildlife and Plant Habitat (Biodiversity)
  - Cover
  - Cavity (den) and nest trees

  - Display locations
  - Food (foraging, hunting)
  - Future snags and down woody debris (coarse and fine)
  - Habitat diversity
  - Protect special habitat
  - Travel corridors

- Aesthetics
  - Limit line of vision
  - Break up “clearcut” look
  - Retain visually unique trees
  - Provide diversity in future stand

- Water and Soil Quality
  - Reduce run-off
  - Reduce erosion
  - Maintain water and nutrient cycles

- Miscellaneous
  - Buffer adjacent stands
  - Protect cultural resources
  - Landmarks, such as marker trees and witness trees

8.2 Potential Costs of Reserve Tree Retention

The retention of reserve trees in actively managed stands can provide ecological benefits desired by landowners and society. However, there are also costs or trade-offs. The primary potential cost is reduced timber yield at the stand-level. Also, retention can result in less available habitat for some wildlife species, particularly those that prefer open, treeless habitat. However, impacts on long-term forest ecosystem sustainability and productivity are uncertain; current understanding suggests that the maintenance of ecological complexity will more likely sustain long-term productivity.

Some specific potential costs include:

- Potential additional operational costs to manage reserve tree retention
- Potential for reduced timber growth rates maintained by larger, older trees
- Potential for reduced short-term stand-level timber yields by foregoing harvest of some trees
- Potential for epicormic branching
- Potential for stem and crown damage during stand harvest
- Potential for crown dieback and mortality following harvest
- Potential for windthrow, particularly on wet or shallow soils, or for shallow rooted species
- Potential damage to younger stand if reserve trees are harvested during mid-rotation
- Reduced growth rates of regeneration occurring beneath reserve trees
- Potential sites for pathogen breeding and maintenance
- Potential for reduced habitat for or increased predation of certain wildlife species

8.3 Considerations for Reserve Tree Retention

Reserve overstory trees will shade portions of a newly developing stand. Increased numbers of dispersed reserve trees and trees with larger and denser crowns will cause more shading. Furthermore, reserve tree crowns can expand over time, increasing shading effects. Shading by reserve trees potentially can reduce growth within portions of newly developing established even-aged stands. The point at which growth reductions become significant depends on a variety of factors, including: stand management objectives (for reserve trees and young trees), growth rates and potential development of reserve trees, growth rates and shade tolerance of species comprising the new stand, site quality, understory competition, and potential damaging agents. In general, to promote optimum growth of established even-aged stands of reproduction, (nearly) full sunlight is preferred. Under even-aged management systems, when objectives include the retention of reserve trees beyond the regeneration establishment phase, crown cover of <20% generally (for most species and conditions) will not significantly reduce vigor, growth, and development of most of the developing stand. If reserve trees are dispersed and expected to survive and grow, crown cover will increase over time; 15% crown cover is a generally recommended maximum for dispersed retention at final rotation. If reserve trees are aggregated, then shading impacts will be reduced; total crown cover retained could be greater and will depend on stand management objectives.

Excessive shading may also be a concern when regenerating shade intolerant species in small stands or in narrowly linear stands, surrounded by relatively mature forest. In such cases, it may be necessary to retain fewer reserve trees. Alternatively, there may be opportunities to redesign stand boundaries creating a larger stand with increased opportunities for internal tree retention.

Reserve tree retention is a generally recommended silvicultural practice for stands ≥10 acres. It is encouraged in smaller stands, but operational, shading, and other biological issues may limit application.

Insect and disease issues and potential impacts on tree health should be another consideration in reserve tree selection and design. Regeneration methods are designed to foster the vigor of the regenerating stand. Although the imminent mortality of some reserve trees may be desirable or acceptable, typically some vigorous trees will be retained with the expectation of continued growth and survival (perhaps for a long time). When regenerating a stand and retaining reserve trees, potential risks to tree health should be evaluated, and methods implemented to reduce risks while achieving stand management objectives. In most cases, well designed regeneration and retention strategies can minimize risks; however, stand and site conditions may limit options in some cases. Refer to the cover type chapters in this guide and forest pest management guidelines to appropriately consider and address insect and disease risks when selecting and designing regeneration methods and reserve tree retention for a specific stand and site.

Two examples of how insect and disease considerations can influence reserve tree selection and design:

- Red pine: Retaining red pine reserve trees when regenerating a new red pine stand may significantly increase the risk of Sirococcus and Diplodia incidence within the

young stand. This risk is highly variable geographically; where experience has shown the risk to be significant, then retaining red pine reserve trees over red pine regeneration would be poor silviculture. In such cases, retain other species (e.g., oak) as reserve trees if available; if not available, then it may not be possible to retain reserve trees as generally recommended, but consider including representation of other species as part of stand regeneration to provide increased options for future managers. Red pine can be an excellent reserve tree when regenerating other species (e.g., aspen or oak).

- Jack Pine: In general, retaining jack pine reserve trees when regenerating a new jack pine stand is not recommended, because of the risk of budworm outbreaks. When regenerating jack pine, other species (e.g., oak) should be retained as reserve trees if available. Jack pine can be retained as a reserve tree when regenerating other species.

Representation of reserve trees can range from none to many. If silviculture is to simulate, to some extent, natural disturbance processes, then most actively managed stands should include some level of structural retention. To accomplish general sustainable forestry goals that include multiple stand management objectives, recommended representation could typically range from 5-15% of stand area or crown cover. In some stands, particularly intensively managed single objective stands (e.g., maximize short-term economic returns, maximize pulp production, or maximize populations of wildlife species that prefer completely open, treeless habitat), landowners may choose to not retain reserve trees. In some stands, with appropriate species and site characteristics, where the optimization of tree vigor and timber quantity and quality is a minor concern, adaptive silvicultural practices that retain 20-60% cover could be considered by the landowner. It is recommended that sound reasons and expected impacts be documented when the decision is to retain reserve trees at less than or greater than the recommended level of 5-15% of stand area or crown cover.

Distribution of reserve trees can be evenly or irregularly dispersed individuals, groups, and patches.

Retention in aggregated patches generally provides the most benefits, including:

- patches of habitat that maintain forest floor, understory plants, and vertical structure within the patch, and increase compositional and structural diversity,
- more heterogeneity across the stand,
- less damage to retained trees during harvesting operations, and
- less impact on regeneration in stand matrix.

Patch retention should consider retention of large trees, cavity trees, and snags within the patches. Reserve patches can be thinned during the even-aged rotational harvest of the matrix; however, retention of unthinned patches potentially provides the greatest benefit. Patches can be located to complement other management objectives or respond to stand conditions; for example, patches can be located in riparian management zones, to provide connectivity between stands, and to protect sensitive sites (e.g., cliff faces and vernal pools) or endangered resources. Patches should be >0.1 acres and generally <2.0 acres, but can be larger; patches, particularly large ones, should be documented as retention patches.

Figure 24.7. Reserve trees retained in patches (photo by Jeff Martin, J-Mar Photography).

Retention of evenly dispersed individual trees also provides unique benefits, including:

- retention of comparatively more large trees, and
- wide distribution of structural benefits (large trees, snags, and coarse woody debris) and seed sources.

Table 24.1 Patch sizes for retention and approximate dimensions (circular and square).

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

Retention of irregularly dispersed individual trees and small groups provides another strategy; this can be particularly useful to develop feathered edges to stands and reduce abrupt transitions and edge effects.

The general recommended strategy is to retain irregularly distributed patches along with scattered groups and individuals.

Stand representation and spatial distribution patterns of reserve trees can be highly variable. The goal of heterogeneity of conditions indicates a wide array of retention strategies. Retention design, including amount to retain, species, and distribution, can enable the production of increased benefits and minimize potential costs. Criteria to consider when determining desired representation and distribution include landowner goals and stand management objectives, current and desired stand and community condition, characteristics of current and desired plant and animal species, potential damaging agents, site, and landscape characteristics. Detailed landscape analysis and planning that clearly addresses the sustainable allocation of resources, including the production of timber and the conservation of biodiversity, can improve upon stand-based management guidelines (such as those offered herein).

Figure 24.8. Reserve trees retained as a group (photo by Joe Kovach).

Figure 24.9. Reserve trees retained irregularly as individuals (photo by Joe Kovach).

8.4 Recommendations for Retention in Managed Stands: Reserve Trees, Mast Trees, Cavity Trees, and Snags

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 ≥3 (if available), preferably large, snags per acre.
  - Retain reserve trees and/or patches at 5-15% crown cover or stand area, including large vigorous trees, mast trees, and cavity trees. Reserve tree retention is a generally recommended silvicultural practice for stands ≥10 acres. It is encouraged in smaller stands, but operational, shading, and other biological issues may limit application.

- Even-aged intermediate treatments
  - Retain ≥3 (if available), preferably large, snags per acre.
  - Retain ≥3 (if available), preferably large, cavity trees per acre.
  - Retain ≥3 (if available), preferably large, mast trees per acre.
  - If previously established, manage reserve trees and patches. Management may include timber harvesting or passive retention. Consider retaining ≥3 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 ≥3 (if available), preferably large, snags per acre.
  - Retain ≥3 (if available), preferably large, cavity trees per acre.
  - Retain ≥3 (if available), preferably large, mast trees per acre.
  - Consider retaining ≥3 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 decadent trees will provide an array of benefits.
- In general, species diversity is encouraged when selecting trees to retain.
- Large trees and snags are >12 inches DBH, and preferably >18 inches DBH.
- Trees retained can be scattered uniformly throughout a stand or irregularly dispersed, as single trees, groups, and patches. The general recommended strategy is to retain irregularly distributed patches along with scattered groups and individuals.
- Retention in aggregated patches generally provides the most benefits for wildlife and biodiversity. Also, patches retained can satisfy multiple benefits; for example, at stand rotation, an internal or adjacent unharvested buffer along a stream (RMZ) could provide a portion of reserve tree retention as well as satisfy BMP (water quality) recommendations. Patches should be >0.1 acres and generally <2.0 acres, but can be

larger; reserve tree patches, particularly large ones, should be documented as retention patches.

- Estimating the amount of retention can be measured using the following techniques: crown area of retention trees, GPS area around a retention patch, densitometer of crown closure, and basal area of residual trees.
- Harvesting of reserve trees may occur in the future or may be foregone to achieve other benefits. Retain reserve trees for at least one-half the minimum rotation age of the new stand (e.g., retain reserve trees at least 20-25 years if regenerating aspen). Consider retaining some trees to develop into large, old trees and to complete their natural lifespan; these trees will often become large cavity trees, snags, and coarse woody debris.
- Retaining down coarse woody debris already present. Minimize disturbance, including crushing, fragmenting, and displacing existing down coarse 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.

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10 APPENDIX A. MARKED TIMBER EVALUATIONS PROCEDURE & EVALUATION SHEET

This evaluation sheet can be used to evaluate marked uneven-aged harvests and even-aged, intermediate thinnings. Stand management objectives, prescriptions, and residual target basal area should be clearly stated prior to marking. The attached field data collection sheet and procedure is designed as a tool to help evaluate how effectively the prescribed silviculture system has been applied. Once the timber harvest has been marked, it may be evaluated for meeting criteria set forth in the WI DNR Wisconsin Silviculture Guide, forest management plan, and/or cutting prescription (i.e., MFL Cutting Notice or public land Timber Sale Notice and Cutting Report Form 2460-001).

10.1 Number of Plots

Recommendation for the minimum number of variable radius plots (10 BAF) to measure: 1 plot for every 4 acres of the sale area with a minimum of 5 well-spaced plots per stand within the sale area (e.g., 32-acre sale / 4 = 8 plots). Plots shall be systematically spaced to sample the entire sale area; except on large timber sales, professional judgment can be used to determine if marking evaluation is warranted over the entire sale area or only on a subsample of the sale area if initial results are good. If the initial sample does not pass for any reason, additional sampling may be necessary. Note: It is not the intent of the evaluation to take a statistically sound number of plots. Plot intensity will increase if problems are noted in the initial sample(s). The follow-up sample(s) may be up to one plot per acre.

10.2 Plot Sampling

Basal Area and Individual Tree Quality: At each plot, data will be collected on the Marked Timber Evaluation Sheet. The data includes marked (**C**ut Tree) and residual (**L**eave Tree) basal area (BA) by species and size classes (5-11” pole, 11-14” sm. saw, 15-19” med. saw, and 20+” lg. saw). BA will be determined using a 10 BAF tool. At each plot, tally individual trees under species code (if needed) and also under basal area size class columns. It may be easiest to first tally marked trees (C - Cut) and then residual trees (L - Leave). Trees may be tallied with “dot tally” or utilizing the growing stock classifications listed below. Classifying the trees may help paint a picture of the quality of the marking job.

Each tree may be classified based on tree risk, vigor and quality as follows:

- “**1**” means crop tree: See definition in Wisconsin Silviculture Guide Ch. 24
- “**2**” means average tree: Better than class 3 but not a crop tree; acceptable growing stock.
- “**3**” means obvious cut tree: High risk (See definition in Wisconsin Silviculture Guide Ch. 24); obvious low vigor/quality tree to release higher classified tree; unacceptable growing stock.

10.3 Plot Evaluation

The marking of each individual plot will be evaluated (graded) on the following basis:

- Residual basal area
- Stand quality - order of removal is followed to achieve target residual basal area
- Other considerations: canopy gaps, paint marks, insect & disease concerns, BMPs, wildlife considerations, endangered resource considerations, etc.

If any of these criteria receive an unacceptable rating, then the plot receives an unacceptable rating. Each of these criteria are described in greater detail below.

Basal Area Rating: For an individual plot to be rated acceptable, the residual basal area must fall within the following range around the stated Target BA:

- For Target BA ending in zero: the acceptable range will be from Target BA minus 10 to plus 20 ft^2 (e.g., Target BA 90 ft^2 then acceptable for plot is ≥ 80 and ≤ 110 ft^2).
- For Target BA ending in five: the acceptable range will be from Target BA minus 15 to plus 15 ft^2 (e.g., Target BA 85 ft^2 then acceptable for plot is ≥ 70 and ≤ 100 ft^2).

However, no matter which method is utilized, the lower acceptable BA will be no less than the B-line for even-aged stocking guides and 70 ft^2 for NH uneven-aged stands.

The plot will be rated based on the residual BA as follows:

- **"+"** The residual basal area falls within the following range around the stated Target BA:
  - ✓ Target BA ending in zero: residual BA within -10 to +20 ft^2
  - ✓ Target BA ending in five: residual BA within -15 to +15 ft^2

- **"–"** The residual basal area falls outside the specified range around the stated Target BA

- **"NA"** Used for plots that have an acceptable reason for not falling within the target BA range, for example:
  - ✓ Initial BA was below the target BA range
  - ✓ Residual BA was below target BA range after only high risk trees were removed
  - ✓ Plot is within an uneven-aged gap
  - ✓ Aspen patch to be removed (stand inclusions)
  - ✓ Residual BA is > the target BA range and silviculture guidelines were followed leaving the BA appropriately higher than target range. Examples might include the following:
    - ∗ No more than 1/3 of the initial BA should be removed
    - ∗ Hemlock or white cedar are present as stand inclusions (at least 50% of BA)

- High percentage of basswood

Stand Quality Common Priorities for Retention and Removal Rating: Designation of trees for harvest at each plot will be evaluated and rated in regard to improving and maintaining overall stand quality by correctly applying the order of removal as agreed upon in the cutting prescription, or, if not listed in cutting prescription, as defined in Ch. 24 of the Wisconsin Silviculture Guide.

Application of the standard common priorities for retention and removal (See Wisconsin Silviculture Guide Ch. 24):

1. High risk of mortality or failure (unless retained as a wildlife tree)
    - Were high risk trees removed?

2. Release crop trees
    - Did crop trees needing release have at least partial release by marking neighboring tree of lesser quality?
      Note: Some crop trees may already have full or partial release, therefore requiring no further release.

3. Low crown vigor
    - Were trees of the low crown vigor marked for removal?

4. Poor stem form and quality
    - Were trees with poor stem form and quality relative to adjacent individual trees marked for removal?

5. Less desirable species
    - Is species diversity maintained and desired species composition achieved?

In order to better quantify what is and is not acceptable variation in order of removal marking, the growing stock classification system listed above (i.e., crop tree, average tree, obvious cut tree) may help in the evaluation process. The order of removal criteria can then be individually evaluated and rated. Finally, each plot is given a total order of removal rating as follows:

- **"+"** **Good**: tree designation correctly applied within the plot.
    - Example: If the marking follows the order of removal, then the rating is "+" (Good).

- **"0"** **Acceptable**: Tree designation is not perfect <u>but</u> is acceptable (still meets stand objectives).
    - Example: If you are questioning a tree that is marked vs. lesser quality tree left, and they both are in the same classification (both are average), then, although not desirable, this would be an example of acceptable variation and the rating is "0" (Acceptable).

- **"–"** **Unacceptable**: Tree designation is not consistently and correctly applied within the plot (cutting marked tree(s) will result in degradation of stand quality and/or vigor).
    - Example: If the marked tree is in a higher classification than the lesser quality tree retained (average class tree marked and obvious cut tree left, or crop tree marked and average class tree left), then this would be unacceptable and the rating is "-" (Unacceptable).

- **"NA"** Used for plots that have an acceptable reason for not following criteria.
    - Example: No high risk trees, no crop trees on plot, or desired residual stocking achieved before a criterion applied.

***Other Plot Evaluation Considerations*:** Other considerations, as stated in the cutting prescription, that may need to be evaluated on plot include: canopy gaps, paint marks, insect & disease concerns, BMPs, wildlife, and endangered resources. These considerations can be rated, such as the canopy gap example below, or described in plot remarks.

Canopy Gap Rating - For uneven-aged management, evaluate canopy gaps (appropriate size & cleaned of poor quality saplings & poles). Criteria are found in the Wisconsin Silviculture Guide, Chs. 21 and 40.

- **"+"** means appropriate size gap (see table 40.8), and it is designated to be cleaned.
- **"–"** means the gap was not appropriate size or not correctly designated to be cleaned.
- **"NA"** means a gap did not fall within the plot.

Paint Marks - Marked trees must have an adequate volume of paint and have adequate stump mark at ground level. Preferably stump marks will be located in crevasses of the stump. In order to facilitate marking, checking, and harvesting, there should be at least two marks on opposite sides of the tree.

***Plot Evaluation Remarks*:** Use space below stand quality rating for plot remarks, including other considerations.

***Plot Grade*:** Grade each plot as good, acceptable, or unacceptable based on basal area, order of removal, and other considerations. If any of these criteria receive an unacceptable rating, then the plot is graded unacceptable.

- **"G" or "+"** **Good**: Marking correctly achieved basal area target range, and quality factors correctly applied.
- **"A" or "0"** **Acceptable**: Marking achieved basal area target range, and quality factors acceptable.
- **"U" or "-"** **Unacceptable**: Marking did not achieve basal area target range and/or quality factors incorrectly applied.

10.4 Sale Evaluation

The data collected may be used to assess compliance of stand wide timber marking with acceptable silviculture guidelines and/or stated cutting prescriptions. Summarize the data, and compute average cut and residual basal area, as well as plot grades. Whereas it is acceptable for wider individual plot BA variation, stand averages should be closer to the target BA (+/-10%).

Minimum requirements for sale approval are:

- Average residual BA within +/-10% of target BA
- At least 70% total plot grades tally “G” or “A”
  - ✓ If excessive number of plots are rated A (>40%), then a follow-up discussion should occur with the marker with possible corrections and/or opportunities for improvement.

If evaluation determines that the proposed treatment meets these minimum timber marking standards and conforms to stated silviculture guidelines as found in the WI DNR Wisconsin Silviculture Guide and/or cutting prescription (i.e., MFL Cutting Notice or public land Timber Sale Notice and Cutting Report Form 2460-001), then the sale will be deemed to meet silvicultural standards.

If evaluation determines that the proposed treatment does not meet these minimum timber marking standards and/or does not conform to stated silviculture guidelines as found in the WI DNR Wisconsin Silviculture Guide and/or cutting prescription (i.e., MFL Cutting Notice or public land Timber Sale Notice and Cutting Report Form 2460-001), then the sale does not meet silvicultural standards and corrective action should be implemented. Once corrected, the sale may be re-evaluated using the above process.

MARKED TIMBER EVALUATION SHEET Rev. 6/10	Property:	Sec.	T	R	Desc.
Estimator:	Date:	Covertype:			Page ___ of ___

Pt. #	Species Code						Basal Area (Target BA_____)						Stand Quality - Order of Removal					Total OOR Rating	Other Rating e.g.Gap	Total Plot Grade
							Pole 5-9/11	Saw-Sm 9/11-14	Saw-Md 15-19	Saw-Lg 20+	TOTAL	BA Rating	Risk Trees Removed	Crop Trees Released	Vigor	Quality	Species Selection			
1C																				
1L													Comments:							
2C																				
2L													Comments:							
3C																				
3L													Comments:							
4C																				
4L													Comments:							
5C																				
5L													Comments:							
6C																				
6L													Comments:							
7C																				
7L													Comments:							
8C																				
8L													Comments:							
9C																				
9L													Comments:							
10C																				
10L													Comments:							
C-Tots												C-Total	Comments regarding the stand:							
C-Avg												C-Avg								
L-Tots												L-Total	Stand Quality Rating: Each aspect of stand quality is rated separately.							
L-Avg												L-Avg								

TREE CLASSIFICATION: (Trees recorded by class for species and basal area size class.)

1 = Obvious crop tree: See definition in Silviculture Handbook Chapter 24

2 = Average tree: Better than class 3, but not a crop tree.

3 = Obvious cut tree: High risk, suppressed, low vigor to release higher classed tree.

\+ = Good: Plot met expectations for Order of Removal.

0 = Acceptable: Plot did not fully achieve Order of Removal, but still meets management objective.

\- = Unacceptable: Plot did not implement the Order of Removal correctly.

Other: Paint volume, Stump marks, Canopy gaps, I & D, Marks on two sides, etc.

TOTAL PLOT GRADE: G = Good; A = Acceptable; U = Unacceptable.

11 APPENDIX B. SUMMARY TABLES

Table 24.2. Wildlife tree and snag selection 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 (decadent) 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

Table 24.3. Recommendations for tree and snag retention in managed stands

Recommendations:

- Even-aged rotations
  - Retain ≥3 (if available), preferably large, snags per acre.
  - Retain reserve trees and/or patches at 5-15% crown cover or stand area, including large vigorous trees, mast trees, and cavity trees. Reserve tree retention is a generally recommended silvicultural practice for stands ≥10 acres. It is encouraged in smaller stands, but operational, shading, and other biological issues may limit application.
- Even-aged intermediate treatments
  - Retain ≥3 (if available), preferably large, snags per acre.
  - Retain ≥3 (if available), preferably large, cavity trees per acre.
  - Retain ≥3 (if available), preferably large, mast trees per acre.
  - If previously established, manage reserve trees and patches. Management may include timber harvesting or passive retention. Consider retaining ≥3 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 ≥3 (if available), preferably large, snags per acre.
  - Retain ≥3 (if available), preferably large, cavity trees per acre.

- Retain ≥3 (if available), preferably large, mast trees per acre.
- Consider retaining ≥3 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.

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 decadent trees will provide an array of benefits.
- In general, species diversity is encouraged when selecting trees to retain.
- Large trees and snags are >12 inches dbh, and preferably >18 inches dbh.
- Trees retained can be scattered uniformly throughout a stand or irregularly dispersed, as single trees, groups, and patches. The general recommended strategy is to retain irregularly distributed patches along with scattered groups and individuals.
- Retention in aggregated patches generally provides the most benefits for wildlife and biodiversity. Also, patches retained can satisfy multiple benefits; for example, at stand rotation, an internal or adjacent unharvested buffer along a stream (RMZ) could provide a portion of reserve tree retention as well satisfy BMP (water quality) recommendations. Patches should be >0.1 acres and generally <2.0 acres, but can be larger; reserve tree patches, particularly large ones, should be documented as retention patches.
- Harvesting of reserve trees may occur in the future or may be foregone to achieve other benefits. Retain reserve trees for at least one-half the minimum rotation age of the new stand (e.g. retain reserve trees at least 20-25 years if regenerating aspen). Consider retaining some trees to develop into large, old trees and to complete their natural lifespan; these trees will often become large cavity trees, snags, and coarse woody debris.
- 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.

12 APPENDIX C. GROWING STOCK CLASSIFICATION SYSTEMS FOR TIMBER MANAGEMENT

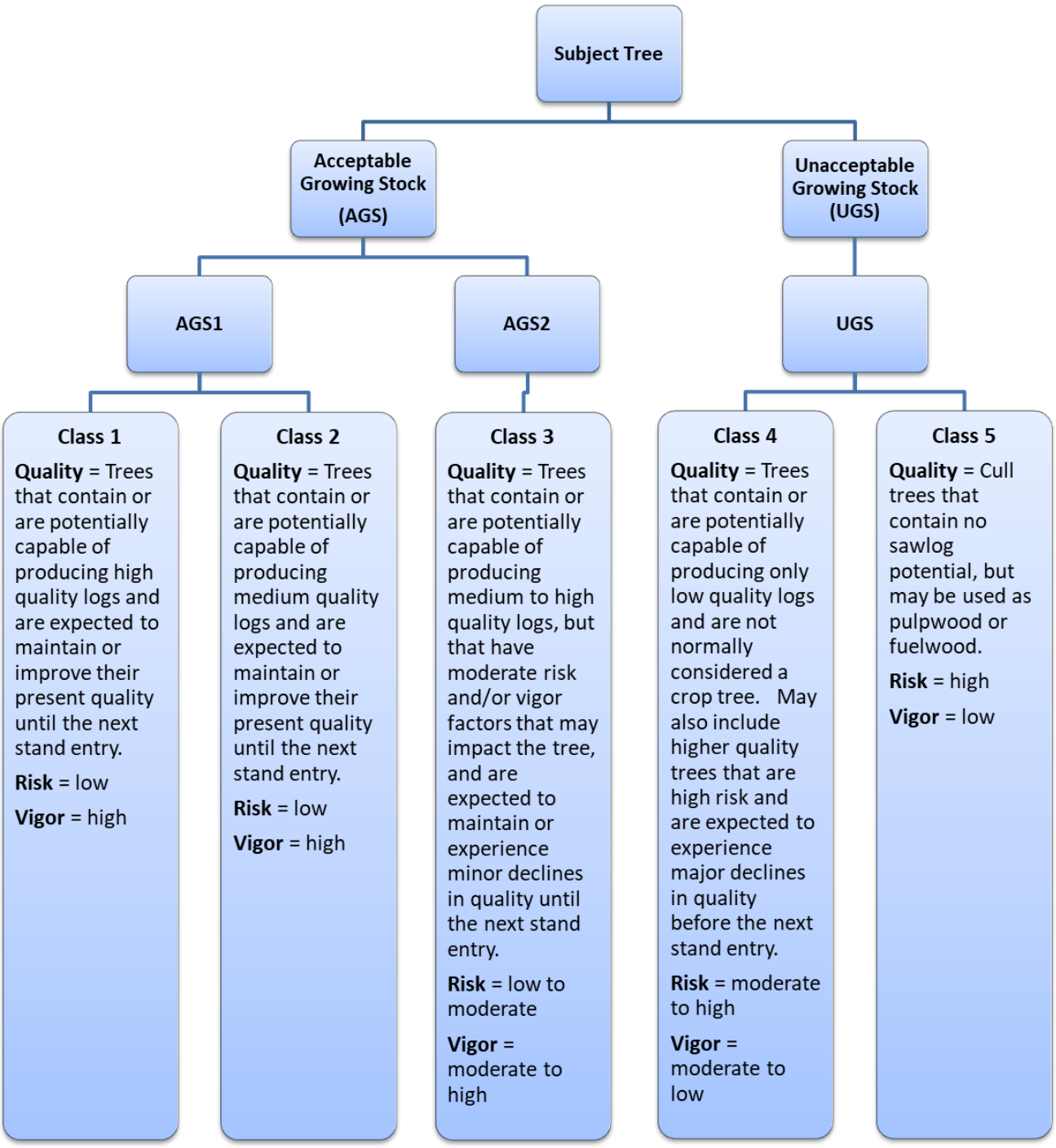

Figure 24.10. Relationship among 2, 3, and 5-class growing stock classification systems.

Table 24.4. General 5-class system decision criteria to help better define subject tree classification.

	CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 5
QUALITY[1]		**high**	⟷	**low**	
min. log height (potential)	16' (butt log)	16' (butt log)	8'	8'	none
tree grade (potential)	1	2	2 or better	3	cull
bole form (sweep or crook)	none or minor (cuts out)	none or minor (cuts out)	moderate	heavy	heavy
RISK[2]		**low**	⟷	**high**	
lean	<10%				>30%; recent root lifting; associated horizontal or long vertical cracks and buckling wood
forking	no acute (V-shaped) forking; no cracks allowed at forks		Acute (V-shaped) forking confined to upper bole and crown		Acute (V-shaped) forking on lower bole
crown damage/dieback	<10%		10-49%		≥50%
stem rot/decay	none		minor		major; indication of major heart rot such as conk fungus; decay affects ≥40% stem cross-section
seams/cracks	none		minor; relatively straight, shallow, little evidence of internal decay		major; open, deep, spiral, evidence of internal decay
cankers	<10% stem circumference; main stem structurally sound		10-49% stem circumference; main stem structurally sound		≥50% stem circumference
bole wounds	minor; dry, hard, no evidence of decay, well above root collar		minor; dry, hard, no evidence of decay		major
cavities	<10% stem cross-section; confined to upper stem, main stem structurally sound		10-39% stem cross-section; main stem structurally sound		≥40% stem cross-section
root damage	<10% compromised		10-33% compromised		>33% compromised
insect/disease	no concerns within next cutting cycle				major impacts likely within next cutting cycle

VIGOR[3]	high ⟷ low				
crown class	dominant	codominant		intermediate	suppressed
crown silhouette	hardwoods - full concentric; conifers - >30% live crown ratio		hardwoods – ½ to ¾ full concentric, indications of minor crown competition; conifers - 20-30% live crown ratio		hardwoods - <1/2 full concentric, indications of major crown competition, flattened crown; conifers - <20% live crown ratio
foliage condition	healthy		fair		poor
bark character	rough-barked species – furrows vertical, narrow, light color; smooth-barked species – smooth and thin				rough-barked species – furrows with cross checks in vertical pattern, broad furrows, ridges soft and corky; smooth-barked species – rough with large flaky plates

[1]**Quality:** Refers to stem form, soundness, and potential timber value of individual trees. Timber quality is evaluated based on log length, diameter, and defect.
[2]**Risk:** 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.
[3]**Vigor:** Active, healthy, well-balanced growth of individual trees. It describes the tree's potential to grow at a rapid rate and increase in volume.

13 APPENDIX D. MARKING GUIDE ELEMENTS AND TEMPLATES

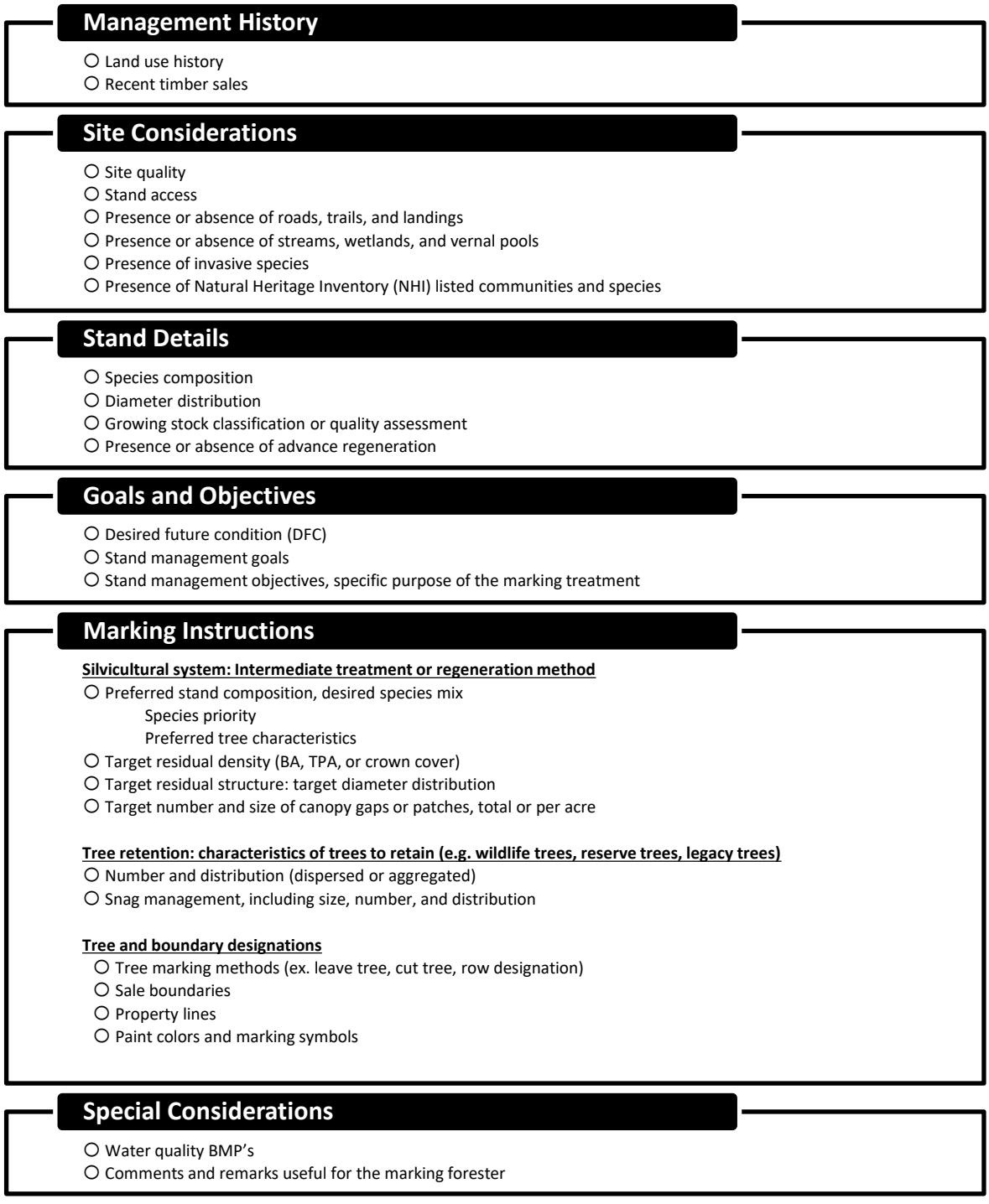

Figure 24.11. Suggested Marking Guide Elements

Table 24.5. Ontario Prescription and Marking Guide Template.

TREE MARKING PRESCRIPTION

OWNER _____ COMPARTMENT _____

LOCATION _____ STAND # _____

_____ Working Group(FRI) _____

TOWNSHIP _____ FOREST UNIT _____

AERIAL PHOTO NUMBER _____ SITE CLASS _____

STAND ACCESS _____

_____

OBJECTIVES

LONG TERM: _____

SHORT TERM: _____

STAND INFORMATION: (Based on Stand Analysis Cruise)

SPECIES COMPOSITION: _____ STAND AREA (ha:) _____

AGE CLASS: _____ HEIGHT (m): _____ STOCKING (%): _____

REGENERATION NOTES: _____

_____

STAND QUALITY NOTES: _____

_____

SITE & TOPOGRAPHY NOTES: _____

BASAL AREA DISTRIBUTION (m²/ha);

Tree Size Classes (cm)>>>:	10-24	26-36	38-48	50+	TOTAL
Actual Basal Area (m²/ha):					

STAND PRESCRIPTION

Treatment Instructions:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Integrated Resource Management INSTRUCTIONS:

_____

_____

_____

_____

_____

_____

_____

FOLLOW-UP RECOMMENDATIONS

_____

_____

YEAR OF NEXT CUT _____

RECOMMENDED BASAL AREA DISTRIBUTION OF CUT

Tree Size (cm)	ACTUAL BA (m²/ha)			BA TO CUT (m²/ha)			RESIDUAL BA (m²/ha)		
	AGS	UGS	TOTAL	AGS	UGS	TOTAL	AGS	UGS	TOTAL
10-24									
26-36									
38-48									
50+									
TOTAL									

PRESCRIPTION PREPARED BY:

DATE:

PRESCRIPTION APPROVED BY:

DATE:

(OMNR 2005)

Table 24.6. Lincoln County Prescription and Marking Guide Template.

Marking Guidelines Template							
Property:		Comp #		Stand #		Acres	
Prescription :							
Fill in the blank, with suggestions from below							
Treatment:							
	(Thinnning (comm, pre-comm), single tree selection (with gaps, groups, patch), shelterwood, seed tree)						
Goal density:							
	(Basal Area/Crown cover/Trees per acre, etc)						
Retain:							
AGS/Crop trees/seed trees:							
	(crown release, number per acre, characteristics of trees)						
Wildlife trees:							
	(number per acre of cavity/den, mast producer)						
Desirable species:							
	(oak, BY)						
Understocked size classes:							
	(less strict on quality?)						
Remove:							
Risk trees:							
	(mortality risk, financially mature)						
UGS:							
	(remove low quality to release AGS, improve spacing)						
Undesirable species:							
	(discriminate against ash)						
Overstocked size classes:							
	(more strict on quality)						
Designated species to cut:							
	(Cut all A, fir, BW etc.)						
Special considerations:							
	(Historic sites, snags, nest trees, RMZ, ephemerals, legacy trees, etc)						
Gap, group, patch:							
	(Size and number per acre)						

Table 24.7. WDNR Prescription and Marking Guide Template.

TIMBER SALE MARKING GUIDE

WDNR Draft 05_01_2017

District	Property	Code				County

Sale Name	Sale Number	Tract Number

Site Considerations

Further describe the current stand conditions and other existing site factors important to the marking crew (Items to consider are listed below). Attach WisFIRS stand printouts for further information.

- *Composition details*
- *Diameter distribution*
- *Management history*
- *Site quality*
- *Advance regeneration*
- *Roads, trails, access, landings*
- *Topography*
- *Other resources (e.g., NHI, invasive species, riparian areas, nests and dens, archeological sites)*

Desired Future Condition

Describe long term goals for the site and the desired future stand conditions (e.g., structurally diverse northern hardwood stand with a hemlock component).

Short Term Silvicultural Objectives

Describe immediate silvicultural actions to be implemented.

Marking Instructions

Treatment Method:	Target Residual Density:	Estimated Treatment Acres:

Describe marking instructions in detail (items to consider are listed below)

GENERAL MARKING -

- *Species priority, order of removal*
- *Crop tree characteristics and release requirements*
- *Target residual density(BA, TPA, crown cover)*
- *Target residual structure (e.g., single tree selection target diameter distribution)*
- *Canopy gaps*
- *Special cutting requirements*

TREE RETENTION -

- *Reserve tree species, numbers, islands*
- *Snags and CWD*

TREE & BOUNDARY DESIGNATION –

- *Paint colors and marking symbols*
- *Tree marking methods (e.g., leave tree, cut tree, row designation)*
- *Reserve area boundaries*
- *Sale boundaries*
- *Property lines*

Timber Sale Design Features and Remarks
Describe other timber sale design features (items to consider are listed below) • *Operating Requirements – equipment, season, road access, sale layout, etc.* • *Water Quality BMPs* • *Wildlife* • *Aesthetics* • *TES* • *Invasive Species* • *Cultural Resources* • *Other comments and remarks useful for the marking crew*

Prepared by:	**Title:**	**Date:**

Timber Sale Map