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Evaluating the Management Potential of Upland Hardwood Stands

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Almost 40 percent of the Arkansas forestland area consists of upland hardwood stands. The management potential of these stands ranges from very low to very high.

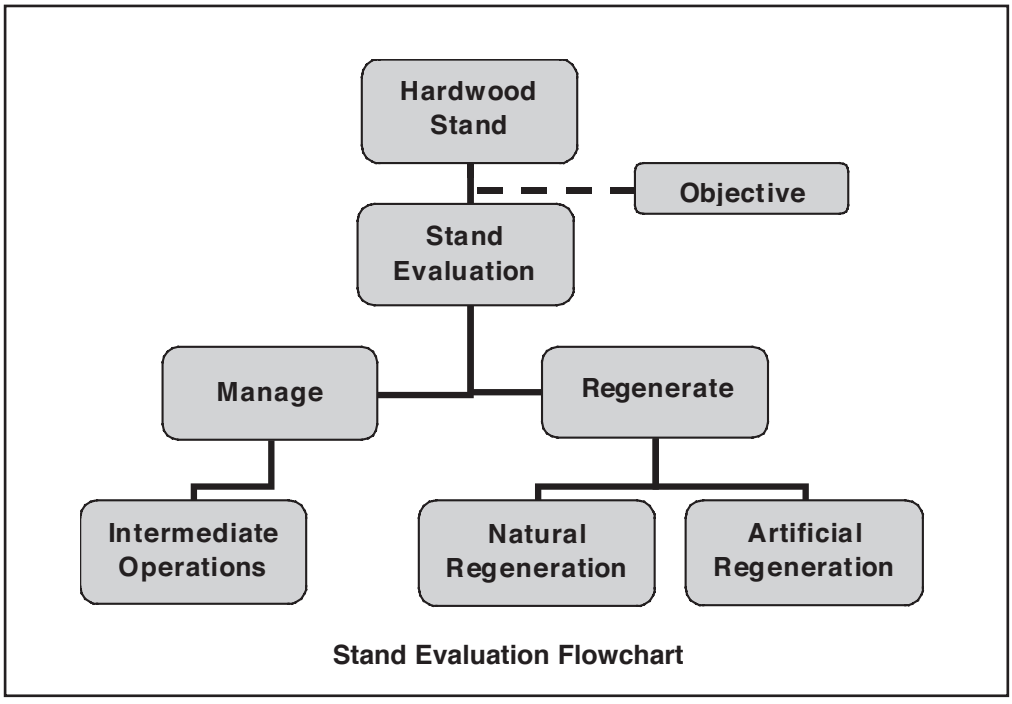
Upland hardwood stands with an extremely low management potential are generally easy to identify because there are few desirable trees in the stand. Upland hardwood stands with a high management potential are also easy to identify because they generally contain higher levels of quality trees.

The stands with a management potential in between these extremes create uncertainty for many forest landowners. The initial decision that needs to be made when evaluating any upland hardwood stand is whether it should be managed or regenerated.

What Does It Mean to "Manage" or "Regenerate" a Stand?

Evaluating the management potential of upland hardwood stands begins with a decision to either continue to manage the current stand or to regenerate it immediately. This decision should be based solely on whether there are enough desirable trees present in the current stand to continue to manage it.

Hardwood stands are generally evaluated on ten-year intervals (also known as "cutting cycles"). Therefore, a decision to manage a stand means that the stand will be managed another ten years and re-evaluated. During this cycle, management operations could include improvement thinnings, timber



Stand Evaluation Flowchart

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stand improvement (removing undesirable stems) and other intermediate management operations.

If a hardwood stand is in need of regeneration, the stand should be regenerated immediately by either a natural regeneration method or artificial regeneration method. In most cases, artificial regeneration in upland hardwood stands should only be employed when a stand is not capable of producing sufficient natural regeneration.

Establishing a Management Objective

Before an effective stand evaluation can be conducted, the goals or objectives for management must be determined. The primary management objective may include timber production, wildlife, recreation, aesthetics, water protection and/or others. Forest landowners may have only one of these objectives as their primary objective, or they may have more than one objective for a forest site.

Establishing the management objective will have an impact on how a stand is evaluated. For instance, there may be tree species that would not be suitable for timber production but would be desirable for other objectives. Due to its lower wood quality, post oak is not usually considered desirable for timber production; however, it would be desirable for many other objectives, such as wildlife or aesthetics. This fact sheet examines the stand evaluation primarily from a timber production perspective, but it is important to realize that a stand evaluation for other objectives may differ.

Site quality is the underlying factor for establishing management objectives for upland hardwood stands. It tells us which tree species and forest products we should focus on in a management objective. For example, if a landowner's primary objective is to grow high-value hardwood sawtimber, then an assumption would be that the forest site maintains a level of productivity that is capable of producing hardwood sawtimber. Typically, these high-quality sites occur on north-facing, mid-to-lower slopes of upland areas. If the forest site is located on southern-facing, upper slopes or ridges, the management objective would need to be adapted for the lower site productivity. On such a site, management options for timber production could include either hardwood pulpwood production or pine management. In the case of a wildlife objective, mast-producing tree species (such as oaks) would be an excellent choice for these lower quality sites because it is generally easy to establish them on lower quality sites.

Site quality could also be called soil productivity because the soil properties influence the ability of a forest site to produce certain products or to grow certain tree species well. In forestry, site quality is measured by site index. (For a detailed description of site index, see fact sheet FSA5004, *Site Index: A Measure of Site Quality* at www.uaex.uada.edu.)

Factors Involved in a Hardwood Stand Evaluation

A decision to manage or regenerate an upland hardwood stand involves many factors including species composition, stem quality, tree vigor and stand age.

Species Composition

Determining which tree species should be considered desirable for management is a complicated task. The productivity of a site limits which species will be desirable for management. Also, determining which species will maintain value over an extended period of time can be difficult. The value of wood products varies depending on current trends and demand. A species that is considered high value today may be considered low value in the future. Typically, red oaks and white oaks maintain higher values because of their use in furniture, hardwood flooring and other products. The differences in value of individual hardwood species over time can complicate hardwood management.

The growth rates of different species also affect their desirability rating. Many red and white oaks maintain good growth rates, which add to their value as desirable species. Species such as hickory have value in the current market; however, due to a relatively slow growth rate and poor wood properties, they are often not viewed as desirable species for timber production (Table 2).

Table 1. Common timber management on typical upland hardwood sites in Arkansas.

Slope Aspect	Topographic Position	Typical SI Range*	Desired Species	Timber Products
North or northeast	Mid to lower slope	Hardwoods: 60 - 80 Pine: 60 - 90	Red oaks, white oaks, white ash, pine	Hardwood and/or pine sawtimber
North or northeast	Upper slope and ridges	Hardwoods: 40 - 65 Pine: 55 - 75	Red and white oaks, mixed hardwoods, pine	Hardwood pulpwood or pine sawtimber
South or southwest	All slopes	Hardwoods: 30 - 60 Pine: 55 - 75	Red and white oaks, mixed hardwoods, pine	Hardwood pulpwood or pine sawtimber

* Site index range @ base age 50.

Table 2. Desirability rating of common species for upland hardwood timber production.

Desirable Species	Undesirable Species
Red oaks – Northern red oak – Southern red oak – Black oak – Shumard oak	Blackjack oak
White oaks – White oak – Chinkapin oak	Post oak
White ash	Elms
Yellow poplar*	Hickory
	Maple
	Blackgum
	Sweetgum

*Yellow poplar only occurs naturally in the Crowley's Ridge region of Arkansas.

Stem Quality

One of the most important factors in a hardwood stand evaluation is the quality of the stems present. The quality of upland hardwood trees is evaluated by the butt log grade. The butt log on a hardwood tree is the portion of the trunk located within the first 17.5 feet from the ground. The butt log of hardwood stems generally contains the majority of the value of the tree.

Properly grading the butt log of hardwood trees requires appreciable hardwood management knowledge. The butt logs of upland hardwoods are typically given one of three (F1, F2 or F3) field grades, with F1 representing the highest grade. Factors that determine log grade include size (diameter), amount of clear wood and straightness. The size of a tree is essential in log grading, because larger diameter trees require shorter lengths of clear wood than smaller diameters to maintain a high grade. For more detailed information on hardwood log grading, see additional resources: *A Guide to Hardwood Log Grading* (Rast and others, 1973).

Tree Vigor

The vigor of individual trees within a stand influences its ability to sustain growth and value throughout a cutting cycle (10 years). High-vigor trees are better able to defend against insects and disease, are less likely to experience degrade and decay and will generally experience less mortality.

Tree vigor could be considered a subjective observation. In stand evaluations, three vigor classes of high, medium and low are typically used. There are two key elements to consider in making a vigor rating: (1) the tree crown and (2) the tree bole. High-vigor tree crowns should be full (not one-sided) and show no signs of limb dieback or decay. High-vigor tree boles (trunks) should maintain tight bark and show no evidence of damage or decay. It is important to remember that tree species will differ in crown size, crown depth and bark characteristics. Therefore, some knowledge about the characteristics of different tree species can be useful when determining tree vigor.

Stand Age

The age of a hardwood stand is another key component in a stand evaluation. Typically, hardwood stands managed for timber production are based on 80-year rotations or less. After a hardwood stand surpasses 80 years of age, the trees within the stand are more likely to lose vigor and degrade. This loss in vigor and grade can become costly in older hardwood stands.

Stand age can be determined by counting the rings of felled trees or by using an increment borer to take a core from a standing tree. It is important to age several trees to determine the range of tree ages within a stand. Although most upland hardwood stands are even-aged, there still may be a significant range of tree ages within a stand.

Tree Management Categories

The tree characteristics discussed to evaluate hardwood stands – (1) species desirability, (2) vigor, (3) grade and (4) stand age – can be used to categorize trees within a stand. These categories include **(1) manageable trees, (2) cull trees and (3) undesirable trees**. The focus of a stand evaluation should be to determine the number of trees per acre within each category. Categorizing trees into one of the three categories can be helpful in determining whether a stand is manageable or in need of regeneration.

Manageable Trees

Simply stated, manageable trees are trees that consist of the proper condition to meet the management objectives for a stand. For timber production, these trees should be of a desirable species, medium to high vigor, proper grade and manageable age to achieve the desired timber products in the desired amount of time. For goals other than timber production (or different levels of management intensity), these ratings may differ.

Cull Trees

Cull trees are trees that are of desirable species but do not contain the proper grade to meet the desired objectives.

While cull trees may contain little commercial value, it is important to acknowledge that cull trees do contain value. Cull trees may serve as excellent wildlife trees. Also, since cull trees are of a desirable species, they can serve as a source of reproduction.

Undesirable Trees

Undesirable trees are simply trees that are of an undesirable species. These trees are not capable of assisting in achieving the desired management objectives. Management operations should focus on the removal of undesirable trees.

Collecting Data for a Stand Evaluation

There are two methods for collecting hardwood stand evaluation data. Either utilize a consulting forester or (with some background forestry knowledge) conduct the evaluation yourself. For accuracy and in-depth results, a consulting forester with a hardwood management background is usually a reliable option. However, a simplified stand evaluation can be conducted by a landowner with some forestry knowledge.

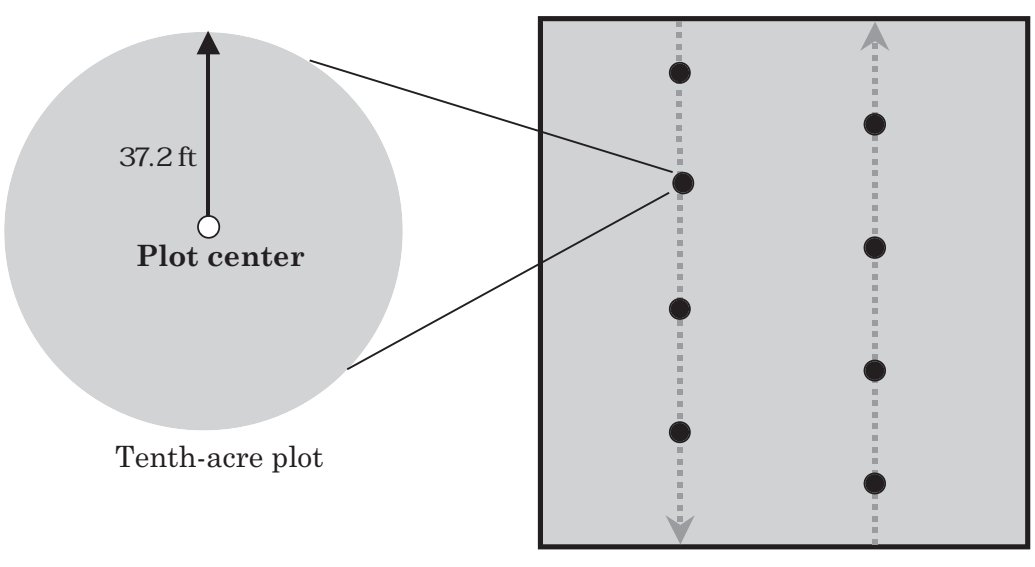
Remembering that the goal of a stand evaluation is to determine the number of manageable, cull and undesirable trees per acre (TPA) and that – depending on the landowner and their objectives – there are different levels of management intensity, data collection for a stand evaluation can be simple to complex. For example, a landowner less interested in intensive stand management or with a limited forestry background may desire to categorize trees using only species desirability. However, a landowner with specific goals and background forestry knowledge may use all aspects (species, size, grade, vigor and age) to categorize the trees within a stand.

Data collection for hardwood stand evaluations can be gathered using a sample of circular, fixed-area plots (either 0.1 acre plots or 0.2 acre plots) aimed at inventory of midstory and overstory trees (Figure 1). Tenth-acre plots (radius = 37.2 feet from plot center) are generally used in stands that contain smaller diameter trees. The larger fifth-acre plot (radius = 52.7 feet from plot center) is usually employed in stands with larger trees. The stand characteristics previously discussed, including species desirability, grade, vigor and stand age, are used to categorize trees within the sample plots into one of the three categories: manageable, cull or undesirable trees. The plot numbers can then be adjusted to per-acre values by calculating the average number of trees per plot within each category and multiplying by 10 for tenth-acre and 5 for fifth-acre plots. This information can be used to determine if enough manageable trees are present to continue to manage a stand or whether regeneration should be considered.

Table 3 presents a sample data sheet for stand evaluation data collection. The sheet contains information to be collected for a stand evaluation including stand age, species class, diameter, grade and vigor. The stand age is simply the age range of the majority of trees within a stand. Species class is entered as desirable or undesirable. Diameter is entered in inches and will be useful in determining the number of TPA required for a particular stand to be manageable. Grade is determined for all trees larger than 12 inches. Vigor is entered as high, medium or low. Then, these variables are used to classify each tree on the sample plot.

The sample plot in Table 3 contains four manageable trees, one cull tree and two undesirable trees. To convert to per-acre values, multiply the plot numbers by 10 (tenth-acre plot). This would give the stand 40 manageable TPA, 10 cull TPA and 20 undesirable TPA.

Figure 1. Example of sample plot layout and size for stand evaluation data collection.



It should be noted that several plots should be taken and plot averages should be established before converting to per-acre values.

A Note on

Table 3. Sample inventory sheet for stand evaluation.

Stand name: Sample stand			Plot size: tenth acre			Stand age: 45 to 60 years		
						Tree Category		
Plot #	Tree #	Species	Diameter	Grade	Vigor	Manageable	Cull	Undesirable
1	1	des	12	3	M	X		
1	2	undes	10					X
1	3	des	18	1	H	X		
1	5	des	8	N/A*	M	X		
1	6	des	14	2	H	X		
1	7	des	16	X**	M		X	
1	8	undes	6					X

* Cannot grade an 8" diameter tree.
** This particular tree did not contain enough clear wood to make grade.

Regeneration

A good idea when conducting a hardwood stand evaluation is to include regeneration plots within the larger midstory and overstory sample plots. Regeneration plots can be established using a 100th- (0.01) acre plot (radius = 11.8 feet from plot center). Tally the number of seedlings in the sample area by size class (for example, less than 1 foot, 1 to 3 feet and greater than 3 feet) and convert to per-acre values. These regeneration numbers can be useful in determining if enough material is present to naturally regenerate a hardwood stand (for more information, see fact sheet FSA5010, *Using Natural Regeneration to Promote Oaks in Upland Hardwood Stands*).

Making a Stand Analysis

Unfortunately, there is no universal magic number of manageable TPA required to consider a stand manageable. The minimum number of manageable TPA really depends on the management objective and the size (in diameter) of the trees within a stand. A stand that contains tree diameters in the 8- to 12-inch diameter range will require a larger number of manageable TPA than would a stand with trees in the 16- to 20-inch diameter range.

There is a widely accepted rule-of-thumb measure that can provide an idea of what is required for a stand to be manageable. This rule of thumb suggests that a stand consisting primarily of small sawtimber sized trees – 12 to 14 inches in diameter – will need approximately 55 manageable TPA to be considered a manageable stand.

Stocking Tables

Stocking tables can be very useful in making stand management decisions. These tables provide forest managers with an idea of the TPA required for stands of different sizes (average diameter) to be at different stocking levels. While these tables are based primarily on the number and size of trees present, knowing the number of manageable TPA can make these tables more beneficial in the decision-making process.

Table 4 illustrates the number of TPA required for upland hardwood stands of different sizes to be understocked, fully stocked or overstocked. For example, if a stand contains an average diameter of 10 inches, 95 TPA would be required for a stand to reach the understocked level, 125 TPA to reach the fully stocked level and 215 TPA to reach the overstocked level. Knowing the number of manageable TPA makes this information even more useful in determining if a stand is manageable or in need of regeneration. The understocked numbers represent the minimum TPA required to consider a stand manageable (40% stocking).

Take Home Points

- Management goals should be determined before conducting a stand evaluation.
- The primary tree attributes that are used in a stand evaluation include species desirability, tree size, tree grade, tree vigor and stand age.
- These tree attributes are used to categorize trees into one of three categories: (1) manageable trees, (2) cull trees or (3) undesirable trees.
- Different levels of data collection can be used to categorize trees into one of the management categories, depending on the desired level of management intensity and/or the level of background forestry knowledge possessed by a forest landowner.
  - If less intensive stand management is desired, a forest landowner may wish to utilize primarily species desirability to categorize trees.
  - If intensive stand management and specific

For timber production, a stand needs at least an understocked number of "manageable" TPA to reach its potential.

Table 4. Minimum stocking levels for upland hardwood stands to be understocked, fully stocked or overstocked.

Stocking Level	Average Diameter	Trees Per Acre	Basal Area	Stocking Percent
Understocked	8	130	46	40%
	10	95	52	40%
	14	58	62	40%
Fully Stocked	8	177	62	60%
	10	125	68	60%
	14	70	75	60%
Overstocked	8	305	106	100%
	10	215	117	100%
	14	118	126	100%

Adapted from Gingrich, 1967.

Note: Understocked numbers illustrate the minimum level required for a stand to be considered manageable.

goals are desired, a forest manager may wish to use all tree attributes to categorize trees.

- Sample plots should be established to collect tree data at the plot level. Plot level data is then converted to per-acre numbers to provide an idea of the number of manageable, cull and undesirable trees per acre.
- Stocking tables can be useful tools in stand evaluations.
  - For a hardwood stand to be considered manageable, it must reach at least the minimum understocked level (40%). Stands within this level contain enough material to grow near or into the fully stocked level.
  - Ideally, a hardwood stand will be stocked at the fully stocked level for maximum production.
  - Hardwood stands near or at the overstocked level will require thinning operations to maintain quality within a stand and improve individual tree growth.

Evaluating the management potential of hardwood stands is an essential step in determining the proper management or regeneration activities that should be employed. A stand evaluation can provide a picture of existing stand conditions, which establishes a base for effective decision-making and planning activities that will assist forest landowners in achieving their management goals.

Additional References

Gingrich, S.F. 1967. Measuring and evaluating stocking and stand density in upland hardwood forests in the central states. *Forest Science*. 13:38-52.

Rast, E.D., D.S. Everette and G.L. Gammon. 1973. *A Guide to Hardwood Log Grading*. Gen. Tech. Rep. NE-1, USDA Forest Service, Northeastern Forest Experiment Station. 32 p. (Available online at www.treesearch.fs.fed.us/).

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