INCIDENCE OF CULL IN MANAGED OAK STANDS IN NORTHERN ILLINOIS

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ABSTRACT.—This study describes the technique used at Sinnissippi Forest, in northern Illinois, to obtain cull factors for well-managed upland oak timber. The forest stands are described giving past history and present management policies. Soil types and their relationship to growth and volume are also discussed. A random selection of sample trees was taken, and measurements were made both before and after felling to determine form factors for a local volume table and to determine gross and net volumes. It was found in this study that cull factors based upon the percentage of total cull to calculated gross volume were 6.0, 7.5, and 12.9 percent for white oak on "good," "medium," and "poor" sites, respectively. For black oak the cull percent was 10.8 and 11.5 on "medium" and "poor" sites. There is little or no black oak on "good" and "medium" sites was found to have a cull of 7.3 and 11.3 percent, respectively. There is little or no red oak to be found on "poor" sites.

Little information is available on the amount of cull to deduct from standing timber tallies in managed forest stands. Consequently, many service foresters continue to use cull factors developed for unmanaged stands or, assuming that cull is negligible in well-managed stands, use no cull factor at all. Cull can be defined as the volume of material unmerchantable under prevailing utilization practices and is caused by sweep (crook), rot, shake (parting of the annual rings), or other defect.

There is no doubt that proper silvicultural management reduces the amount of cull in residual trees. Gruschow and Trousdell (1959), in a study on rot in unmanaged hardwood sawtimber, developed a grading system based upon standing tree qualities of 1 to 4 and found that 70 percent of the total cull volume was in Grade 4 trees and an additional 20 percent was in Grade 3 trees. Such trees would have been removed first under management. Cooley (1964), working on the effect of selection cutting in northern hardwoods, found that the proportion of unmerchantable material in the poorest residual sawtimber trees had been sharply reduced by one, two, or three selection cuts during the preceding 35 years.

This research was done to determine cull factors that could be used managing the 2,800-acre Sinnissippi Forest, located in Ogle County, Illinois. This privately owned forest has been managed for the past 20 years under the direction of the University of Illinois Department of Forestry.

Stand History and Condition

Sinnissippi Forest, with the exception of its plantations, is predominately 90- to 100-year-old even-aged upland oak timber. White oak (*Quercus alba* L.), black oak (*Q. velutina* Lam.), and red oak (*Q. rubra* L.) account for about 95 percent of the standing timber, while hickory (*Carya ovata* (Mill.) K. Kock and *C. cordiformis* (Wangenh.) K. Kock), elm (*Ulmus americana* L. and *U. rubra* (Mühl.), and cherry (*Prunus seriotina* Ehrh.) make up the remaining 5 percent (Table 1). The site quality of good, medium, and poor represents Mesavage and Girard's (1946) Form Class 79, 78 and 77, respectively, which is the ratio in percent between diameter inside bark at the top of the

first 16-foot log and the diameter outside bark at breast height (4½ feet above ground).

The soils are predominately sandy and were developed under forest or prairie cover. "Good" timber types are usually found in coves or on soils with clay accumulations in the B horizon. "Medium" types may be found on sandy soils with clay lenses in the lower part of the solum.

Indications are that there were no major fires during the development of these stands. Light grazing was carried on in most of the forest until about 1940. Browsing by deer was quite heavy, and in 1957 the forest was opened to hunting on a restricted basis to keep such browsing at a minimum.

Cutting history prior to 1900 is not known, but it appears that most of the older stands were cut for railroad ties and local construction lumber between 1850 and 1860. Between 1900 and 1947, little timber was cut.

The present management system was initiated in 1948 and involves a 10-year cutting cycle on 40-acre compartments. Records for each compartment are kept by timber type, site, and age classification. Growth and mortality records are maintained on 12 permanent sample plots in each compartment. During the first cutting cycle, the forest was systematically covered by improvement cuts in which misshapen, overmature, decadent, or otherwise undesirable trees were harvested or eliminated by girdling. The purpose of this initial cut was to leave the best possible growing stock upon which to concentrate future growth. After the first cutting cycle was completed, improvement cuts were continued using a group selection system and girdling cull trees. One-tenth of the forest was again cut each year, removing the equivalent of 10 years of annual growth, or less if growing stock was low, from each compartment.

The oak wilt disease (*Cerotocystis fagacearum* Bretz) has affected Sinnissippi Forest stands in many scattered areas. Himelick and Fox (1961) reported an average annual loss of 13,866 board feet of merchantable timber from 1945 through 1961 from oak wilt and its control. Control measures have not been completely effective, as some losses are still being suffered.

Present stand composition and volume by species on the upland hardwood sites are shown in Table 1. Annual growth per acre for the 91-110 year age class is 337, 202, and 104 board feet, respectively, for "good," "medium," and "poor" sites; and 162 and 139 board feet for "medium" and 'poor" sites in the 71-90 age class.

FIELD PROCEDURE

The permanent inventory plots were used as reference points to obtain a randomized sample of trees from the upland oak sites. Cull study plots were located 100 feet north of the center stake of the forest inventory plots, provided this point did not fall within 50 feet of a type line change involving species composition, age classification, or site quality change. If a type line was within 50 feet of the proposed location, the location was moved 90 degrees in a clockwise direction until a location was found where no type change was closer than 50 feet. If type line changes interfered with the location in all four cardinal directions, the plot was not used.

After all acceptable plots were separated into site quality classes and randomly sampled, sample trees were selected at each plot location. These were the three nearest red oak, white oak, and black oak trees to the sample point and 11.6 inches

TABLE 1.—Stand composition of upland hardwood sites in board feet per acre

Type	Site	Age class	Board feet, International ¼" log rule						
			White oak	Black oak	Red oak	Elm	Hickory	Misc.	Total volume[1]
Red oak	Good	91-110	816	415	8,576			134	9,941
White oak	Med.	91-110	6,216	725	367		18	9	7,335
White oak	Poor	91-110	3,649	302	202				4,153
Black oak	Poor	91-110	697	2,976	77	10	15	67	3,842
Mixed oak	Good	91-110	3,737	700	5,734	68	34	222	10,495
Mixed oak	Med.	91-110	3,064	2,211	1,177	62	41	214	6,770
Mixed oak	Poor	91-110	1,884	1,926	126			7	3,943
Mixed oak	Med.	71- 90	1,907	1,652	297			42	3,898
Mixed oak	Poor	71- 90	1,046	1,767	107	6	94	12	3,032
Mixed oak	Poor	Uneven	1,759	440		293	60	176	2,728

[1]Gross volume in trees 9.6" or larger in diameter.

DBH or larger. An adequate sample was determined to be 25 trees of each species on each site quality. It appeared unlikely that 25 black oaks on "good" site or 25 red oaks on "poor" site could be found, and no attempt was made to derive cull factors for these categories. As soon as 25 trees of each species were sampled on a given site quality, no additional plots were taken. Only 11 red oaks were found on "medium" sites so the cull factor for this species is based on a smaller number of samples than the established optimum.

Data collected on sample trees, before and after felling, included:

1. DBH and double bark thickness (DBT).

2. Total height.

3. DOB (diameter outside bark) and DBT at stump height.

4. DOB and DBT at 1 foot above stump height.

5. The length, top DOB, and DBT of each log or cull section.

6. DOB and DBT at 16 feet above stump for the Girard form class.

All measurements were coded for future use on IBM cards. The amount of cull in each log was determined using the *National Forest Log Scaling Handbook* (1963).

Logs were sawn at the Sinnissippi Forest mill, and usable lumber was recorded for each log by the following two grades:

1. Shop grade = lumber usable for manufacture into pallets and other items using short unsaleable pieces.

2. Saleable grade = lumber of construction grade or better.

Because of insufficient data for some age classes, all age classes were combined and the following summaries were developed for each species on each of the three site qualities, for all species combined on each of the three site qualities, for all site qualities combined for each species, and for all site qualities and species combined:

1. Gross board-foot volume in the standing tree. Volume in BF = $.0254D^2H - 6.226$, when D = DBH and H = merchantable height (Column 4, Table 2).

TABLE 2.—Total volume in board feet by species and site for 157 sample trees with standard error for critical variables.

Species	Site	No. trees sampled	Volume, International ¼" rule				
			Standing tree	Gross log scale	Cull	Net log scale	Mill tally
White oak	Good	25	3,839	3,748±14.5	231± 3.4	3,517±14.4	3,772
White oak	Medium	23	3,154	3,081±12.4	238± 3.2	2,843±11.5	3,085
White oak	Poor	25	2,580	2,711±15.6	334± 6.9	2,377±10.9	2,552
Black oak	Medium	23	3,086	2,961±14.2	334± 3.1	2,627±14.8	2,934
Black oak	Poor	25	2,144	2,166± 8.8	246± 2.9	1,920± 8.3	2,111
Red oak	Good	25	7,371	7,508±42.3	542± 4.7	6,966±42.0	7,195
Red oak	Medium	11	3,118	3,151±59.7	352±16.4	2,799±44.8	3,001
Total		157	25,292	25,326	2,277	23,049	24,650

TABLE 3.—Recommended cull factors for managed upland oak timber in northern Illinois.

Species	Site			
	Good	Medium	Poor	Sites combined
	Percent			
White oak	6.0	7.5	12.9	8.4
Black oak	..	10.8	11.5	11.1
Red oak	7.3	11.3	...	8.5
Species combined	6.9	9.9	12.3	9.0

2. Gross board-foot volume in all sections within the merchantable height whether merchantable or cull (Column 5, Table 2).

3. Net log scale with cull deductions based on the *National Forest Log Scaling Handbook* (Column 7, Table 2).

4. Mill tally in actual board feet sawn (Column 8, Table 2).

RESULTS

Volume and cull data for the 157 sample trees are shown in Table 3. The difference between gross volume and mill tally does not necessarily indicate cull, since this figure constantly changes with utilization standards and milling specifications. The slight overrun on the net log scale indicates good sawing techniques with a minimum of waste in slabs and edgings.

Cull factors based upon the percentage of total cull to calculated gross volumes are shown in Table 3 and are recommended for use in managed upland oak timber in northern Illinois, Iowa, southern Wisconsin, and northern Indiana. These factors should be acceptable for conditions similar to those at Sinnissippi Forest. However, in determining net volumes of standing timber, local volume table, and accurate estimating of merchantable height are of great importance if one is to obtain accurate net volumes.

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