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SETs: Stand Evaluation Tools

I. An Individual-tree Approach to Making Stand Evaluations

by Paul S. DeBald and Joseph J. Mendel

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SETs

THIS IS ONE of a series of papers designed to help the forester estimate the value of timber stands. We call these papers SETs – Stand Evaluation Tools. The first three papers are being published concurrently. They are:

SETs I. AN INDIVIDUAL-TREE APPROACH TO MAKING STAND EVALUATIONS (USDA Forest Service Research Paper NE-336), which describes a method for using individual-tree values to make stand evaluations.

SETs II. TREE VALUE CONVERSION STANDARDS FOR HARDWOOD SAWTIMBER (USDA Forest Service Research Paper NE-337), which provides values for individual sawtimber trees.

SETs III. COMPOSITE VOLUME AND VALUE TABLES FOR HARDWOOD PULPWOOD (USDA Forest Service Research Paper NE-338), which provides values for individual growing-stock trees.

ABSTRACT

The authors outline a stand-evaluation method that stresses individuality by (1) making on-the-ground projections of individual tree development; (2) summarizing stand values in terms of the individual trees in the stand and their potential development; and (3) tailoring several management possibilities to an individual stand so the owner can choose among them.

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INTRODUCTION

THE SMALL WOODLAND owner can play an important role in meeting our Nation's projected timber needs (*USDA Forest Service 1973*). But he will accept that role only if he decides that he really wants to.

South, Hansbrough, and Bertrand (*1965*) pointed out that a woodland owner is likely to decide to become a timber producer when he becomes aware of the value of his timber and the income potentials from managing his woodland — especially if the income potentials are related to his own individual situation and needs. These potentials might be best expressed in terms of stand values and the changes in value that the stand's owner could expect if he exercised various management options.

OBJECTIVES

Our purpose is to outline a method for making stand evaluations that can be tailored to an individual stand and the individual owner's set of circumstances. The method generates stand values by totaling the values of the individual trees in a stand. It is based on timber quality and changes in timber quality, because quality is the key to timber value. It uses on-the-ground estimates of changes in merchantable height and butt-log grade. Yet, it is a method that can fit in with commonly used timber-cruising procedures.

It is also a method that can be adapted readily to many of the computer programs that have been developed to handle forest-inventory data and to make stand projections. Although we recommend the use of computers for applying the method, our aim in this paper is simply to share the idea of using an individual-tree approach in making stand evaluations. So we chose to avoid locking into any one particular computer program at this time. Instead, we used a desk calculator to make our stand evaluations.

Further, we do not intend at this time to evaluate all the different kinds of stands and all the different kinds of circumstances that surround them and confound them. There are too many. Rather, we will illustrate our procedure with a typical stand in a typical set of circumstances, with the aim of getting the method into the hands of potential users so that they can begin applying it.

GENERAL FRAMEWORK

We suggest making stand evaluations within an accounting type of framework. This general framework includes three accounts:

1. A current stand valuation.
2. A projected stand valuation, assuming that no trees will be cut.
3. One or more projected stand valuations, each representing an assumed cutting alternative.

We also suggest using individual tree values and summing them for stand totals. We do so to stress uniqueness. First, because a tree's value depends on its quality, which in turn depends on the individual tree's unique characteristics. Second, because each stand is a unique grouping of individual trees. We feel that, by relating to trees as individuals, we would be more apt to attract and hold the stand owner's attention. He, too, is unique.

Under the first account we will assign appropriate volumes and values to each tree in a stand and sum them to obtain a current stand valuation. This account will provide estimates of the stand's volume and value right now. It will also provide a base for evaluating the stand's development as described under the other two accounts of the general framework.

Under the second account, we will assume that no cutting will take place; and we will make a 10-year projection of the stand by projecting the diameter, merchantable height, and log quality of each tree in the stand. After assigning appropriate volumes and values to the projected trees, we will sum them to obtain estimates for the projected stand. The 10-year time period will help focus the stand's development within a relatively short and meaningful planning period.

This future stand valuation would reflect the results of exercising the most common management option for the stand — simply letting it grow. Contrasted against the stand's current valuation, this would provide estimates of the changes that we might expect to take place as the stand develops; that is, the changes in its volume and value, and the rates of those changes. We can then compare those changes with the owner's short-run expectations.

Under the third account we will make 10-year projections of the stand, using procedures similar to those above. Here, however, we will investigate the results of cutting the stand under various silvicultural and economic options pertinent to the stand. Taking each option in turn, we will mark the stand, then estimate its future business worth by combining: (1) the volume and value yields of the trees that are marked to be cut, and (2) projected volumes and values of the trees that are to be left.

We will then evaluate each of the cutting options in terms of: (1) the owner's objectives; (2) how it compares with the let-it-grow option; and (3) how it compares with the other cutting options.

FIELD PROCEDURES

For illustration, we used a 1-acre plot and tallied all trees 5.0 inches dbh and larger — 89 of them. Our procedures could also be used with 100-percent inventories of larger tracts, as long as the number of trees does not become burdensome. Or they could be used with representative samples of larger tracts, and the resulting data could be expanded appropriately. We recommend the latter for practical applications.

Our 1-acre plot is located on the Vinton Furnace Experimental Forest in southeastern Ohio. It is a typical oak–hickory stand — second-growth sawtimber on a good site — and it needs thinning. The acre contains a volume of nearly 12,000 board feet (International ¼-inch rule). It has a basal area of 97 square feet.

On our field tally sheet (table 1) we recorded the following data for each tree:

1. Species.
2. Dbh.
3. Merchantable heights for sawlogs and pulpwood.
4. Butt-log grade.
5. Vigor class (See appendix A for definitions).

In addition, we estimated each tree's prospective dbh, merchantable height, and butt-log grade. That is, we made a 10-year projection of each tree, right there on the ground.

We chose to avoid boring a lot of trees — we don't like the job of making increment borings. Instead, we based our estimates of future dbh on regional growth rates (*Holcomb and Bickford 1952; Trimble and Mendel 1969; Grisez and Mendel 1972*). These rates are summarized in appendix B.

We based our estimates of prospective merchantable heights on the likelihood of each tree's adding upper-stem logs or bolts during the next 10 years. And we made our estimates of prospective merchantable height at the same time we estimated each tree's current merchantable height.

In hardwoods, merchantable heights are fixed more often by limbs and forks than they are by minimum diameters. And no matter how much additional diameter growth a tree puts on, it usually cannot increase in sawlog height above the point where its stem breaks into limbs. Thus, we found that most of the trees on our plot — two out of three — would not increase in merchantable height, because of existing limb patterns (table 1). There are a couple of exceptions to this general rule. One is the case of small sawtimber trees without large limbs and excessive taper. The other is the case of poletimber trees, whose minimum top diameters usually limit

Table 1.—Field tally sheet

Plot or Stand: Vinton Furnace #1

Type: Oak-hickory
Size: Sawtimber
Density: Well stocked

Site Index: 80
Stand Age: 70

Tree No.	Species	Present					Projected			
		Dbh	16-foot logs Saw-logs	16-foot logs Pulp-wood	Butt-log grade	Vigor	Dbh	16-foot logs Saw-logs	16-foot logs Pulp-wood	Butt-log grade
		In.	*No.*	*No.*	*Grade*	*Class*	*In.*	*No.*	*No.*	*Grade*
1	SO	14.7	1½	2½	T&T	2	16.8	1½	2½	3
2	SO	19.3	3	3½	Cull	1	21.7	3	3½	Cull
3	CO	7.6	—	½	—	4	8.2	—	1	—
4	CO	12.1	1½	1½	Cull	3	13.3	1½	1½	Cull
5	WO	7.1	—	1	—	4	7.7	—	1	—
6	SO	17.9	2½	3	T&T	1	20.4	2½	3	2
7	WO	11.7	1	2	3	4	12.2	2	2	3
8	WO	12.6	2½	3½	3	2	14.2	3½	3½	2
9	WO	9.2	—	2	—	4	9.8	—	2	—
10	CO	12.3	1½	2	3	2	14.4	2	2	3
11	BO	14.7	2	2½	2	3	15.8	2	2½	2
12	BO	17.3	2½	2½	2	1	19.8	2½	2½	1
13	BO	13.2	2	2½	3	2	15.3	2½	2½	2
14	WO	11.1	1½	2	3	4	11.7	2	3	3
15	WO	13.4	2	2½	3	2	14.9	2½	2½	2
16	HIC	6.6	—	1	—	4	7.2	—	1½	—
17	WO	15.3	2	2½	2	2	16.7	2½	2½	1
18	WO	13.0	2	3½	3	1	15.0	3½	3½	2
19	WO	9.6	—	2	—	3	10.7	—	2½	—
20	WO	9.4	—	2	—	4	10.0	—	2	—
21	WO	14.7	2	3	3	2	16.2	2	3	2
22	WO	15.0	2½	3	2	1	16.9	3	3	1
23	RO	18.2	2½	2½	2	1	20.7	2½	2½	1
24	WO	14.4	2½	3	2	1	16.4	3	3	2
25	WO	13.4	1½	2½	3	2	14.9	2½	2½	3
26	CO	12.6	1½	2	3	3	13.8	1½	2	3
27	CO	14.6	1½	2½	3	1	17.1	1½	2½	2
28	BO	18.0	3	3	1	1	20.5	3	3	1
29	CO	12.0	1½	2½	T&T	3	13.2	1½	2½	3
30	CO	9.4	—	2½	—	3	10.7	—	2½	—
31	CO	16.1	2½	2½	2	1	18.5	2½	2½	1
32	CO	13.9	2	3	2	1	16.4	2½	3	2
33	BO	16.7	2½	2½	1	1	19.4	2½	2½	1
34	CO	15.0	1½	1½	2	3	16.0	1½	1½	1
35	WO	8.7	—	2	—	4	9.3	—	2	—
36	CO	12.4	1	2	3	4	13.0	1½	2	3
37	CO	16.0	2	3	2	2	17.8	2	3	1
38	RM	6.6	—	1	—	3	8.5	—	1½	—
39	WO	10.4	—	2½	—	2	12.1	1½	3	3
40	RM	5.4	—	½	—	4	7.3	—	1½	—
41	CO	9.1	—	1½	Cull	4	9.7	—	1½	—
42	CO	12.1	1	1½	3	3	13.3	1½	1½	3
43	CO	12.8	1	2½	3	2	14.9	1	2½	3
44	RO	25.1	2½	2½	1	1	27.1	2½	2½	1
45	CO	13.1	1½	2	3	3	14.2	1½	2	3

CONTINUED

Table I—Continued

Tree No.	Species	Present Dbh	Present Saw-logs (16-foot logs)	Present Pulp-wood (16-foot logs)	Present Butt-log grade	Vigor	Projected Dbh	Projected Saw-logs (16-foot logs)	Projected Pulp-wood (16-foot logs)	Projected Butt-log grade
46	HIC	5.7	—	1	—	3	7.2	—	2½	—
47	ASH	10.9	—	1½	—	3	12.0	1½	1½	3
48	CO	8.0	—	1½	—	3	9.2	—	1½	—
49	WO	12.0	1½	3	3	2	13.6	2	3	3
50	WO	18.3	2½	3	2	1	20.1	2½	3	2
51	WO	15.6	2½	3½	2	1	17.0	2½	3½	1
52	WO	9.8	—	1½	—	4	10.4	—	1½	—
53	WO	9.2	—	2	—	4	9.8	—	2	—
54	WO	17.6	3½	3½	1	1	19.4	3½	3½	1
55	WO	11.2	1	2½	3	3	12.3	1½	2½	3
56	YP	7.6	—	2	—	3	9.0	—	2	—
57	BO	20.2	3	3½	1	1	22.6	3	3½	1
58	SO	19.6	3	3	1	1	22.0	3	3	1
59	WO	17.4	3	3	1	1	19.2	3	3	1
60	BO	11.9	1½	2½	3	3	13.2	2	2½	3
61	CO	12.7	1½	1½	3	4	13.3	1½	1½	3
62	WO	18.8	2½	3	1	1	20.6	2½	3	1
63	WO	13.9	2½	3	2	2	15.4	2½	3	2
64	BO	17.9	1½	1½	2	1	20.4	1½	1½	1
65	WO	10.9	—	2	—	3	12.1	1½	2	3
66	WO	16.5	1½	2	Cull	4	17.0	1½	2	Cull
67	WO	11.0	1½	2½	3	3	12.1	1½	2½	3
68	WO	7.4	—	1	—	4	8.0	—	1½	—
69	WO	14.0	2	2½	2	3	15.1	2½	2½	2
70	BO	22.7	2½	2½	1	1	24.9	2½	2½	1
71	WO	21.2	3½	3½	1	2	22.4	3½	3½	1
72	WO	13.2	1½	2½	3	3	14.3	2	2½	2
73	WO	10.7	—	2	—	3	11.9	1½	2	3
74	WO	13.6	2	2½	3	3	14.7	2	2½	2
75	WO	12.8	2	2½	3	2	14.4	2	2½	3
76	BO	17.1	2½	3	1	2	19.0	2½	3	1
77	WO	7.6	—	1½	—	4	8.2	—	2	—
78	WO	13.7	2	2	3	2	15.2	2	2	2
79	CO	17.9	1½	1½	1	1	20.1	1½	1½	1
80	RO	25.0	2	2	1	2	26.5	2	2	1
81	BO	19.7	3	3	1	2	21.5	3	3	1
82	BO	13.7	1½	2½	3	3	14.8	2	2½	3
83	WO	17.0	3	3½	2	2	18.4	3	3½	2
84	CO	10.9	—	1½	—	2	13.1	1	1½	3
85	WO	8.9	—	2	—	4	9.5	—	2	—
86	WO	8.3	—	2	—	4	8.9	—	2	—
87	BO	19.7	2	2	1	1	22.1	2	2	1
88	YP	7.6	—	1½	—	3	9.2	—	2	—
89	WO	16.6	2	3	2	1	18.5	2½	3	2

merchantability. In these instances we estimated prospective merchantable heights by considering each tree's taper and visually projecting its upper stem diameters.

Regardless of whether limbs or minimum diameters are the limiting factors, the only place to estimate a tree's current merchantable height is right there on the ground. It is also the best place to estimate its prospective merchantable height.

This do-it-yourself-while-you-are-out-there approach also applies to estimating timber quality. We used it to estimate the prospective butt-log grade of each tree. And, as with prospective merchantable heights, we estimated the prospective butt-log grade of each tree at the same time we assigned it a current butt-log grade.

In judging potential changes in butt-log grade we did, of course, consider such external grading features as branches and knots. We also considered minimum top diameters — more so than we did with merchantable heights. That's because of the diameter thresholds that are built into the standard grades (*Rast and others 1973*).

We found that a number of trees were limited in butt-log grade solely by their top diameters, and that we could expect some of them to improve in grade as they grew in diameter during the next 10 years. All in all, we estimated that one-third of sawtimber trees would improve in grade. Included in the other two-thirds were 15 trees that already have grade-1 butt logs and thus could not improve within the grading system that we limited ourselves to.

We are aware that our on-the-ground projections of merchantable heights and butt-log grades are not foolproof. Indeed, they were subjective. But at least they were not mechanical. Because we made them one tree at a time and based them on each tree's own characteristics, we did so with reasonable confidence.

OFFICE PROCEDURES

Evaluating Stand Development

We made valuations of our present and projected stands by assigning appropriate values to the individual trees in the stand. Here we define values as numerical quantities, not just dollar quantities. They include board-foot and cord volumes, basal areas, and dollar values.

For volumes we used the Lake States Composite Volume Tables (International ¼-inch rule), because their composite nature makes them applicable to a variety of species. For dollar values we used tree-value conversion standards. Those for sawtimber are from TREE VALUE CONVERSION STANDARDS FOR HARDWOOD SAWTIMBER (*Mendel, DeBald, and Dale 1976*). Those for pulpwood (at $1.50 per cord) are from COMPOSITE VOLUME AND VALUE TABLES FOR HARDWOOD PULPWOOD (*DeBald and Mendel 1976*). Briefly, these standards reflect a tree's net worth as 4/4-inch lumber and/or pulpwood; we assumed that the tree would be converted into one or both of those products in an integrated logging operation and allowed for the cost of conversion.

It is obviously appropriate to apply the same volume and basal-area standards to both our present stand and our projected stand. But there may be some question about applying current dollar-value standards to our future stand. We can answer by pointing out that our goal is to evaluate the stand's development and not to fix the stand's absolute future value. By using the same dollar value base at both ends of the projection period, we can focus directly on the biological development of the stand without letting valuation items irrelevant to biological change get in the way.

We used an extension of our field tally sheet to make our stand valuations (table 2). We listed each tree's basal area, board-foot, cord, and dollar value and summed them for stand totals.

At this point we have valuations for both our present stand and the stand that would result if we simply let it grow.

	Basal area per acre (square feet)	*Volume (board feet)*	*Value (dollars)*
Present	97	11,627	$465.44
Projected	119	15,590	$770.75

These valuations give us yardsticks for gaging the stand's development and its potential value. But before we use those yardsticks, let's check the effectiveness of the on-the-ground projections we used to develop them.

Testing Our Projections (Or, How Wrong Can We Be?)

We certainly don't want to wait for 10 years to judge our estimates of prospective heights and grades. But we can weigh now the implications of having made errors in our estimates. The following does so; but keep in mind that it applies to only this plot.

Obviously, the worst we could have done was to have estimated wrong every time. We

Table 2.—Tree values

Tree No.	Present Basal area	Present Volume		Present Tree value	Projected Basal area	Projected Volume		Projected Tree value
	Sq. ft.	Bd. ft.	Cords	Dollars	Sq. ft.	Bd. ft.	Cords	Dollars
1	1.18	123	0.357	$0.54	1.54	162	0.472	$3.81
2	2.03	—	.768	1.15	2.57	—	.983	1.47
3	.32	—	.027	.04	.37	—	.053	.08
4	.80	—	.164	.25	.96	—	.199	.30
5	.27	—	.040	.06	.32	—	.047	.07
6	1.75	275	.604	.91	2.27	366	.794	19.78
7	.75	54	.191	.29	.81	104	.208	.31
8	.87	126	.317	.48	1.10	202	.406	.61
9	.46	—	.116	.17	.52	—	.132	.20
10	.83	85	.211	.32	1.13	148	.292	.60
11	1.18	157	.305	3.84	1.36	176	.415	5.10
12	1.63	255	.501	8.20	2.14	343	.665	24.12
13	.95	122	.286	1.17	1.28	196	.388	4.83
14	.67	69	.171	.26	.75	95	.250	.38
15	.98	127	.295	.44	1.21	186	.368	1.54
16	.24	—	.034	.05	.28	—	.057	.08
17	1.28	166	.388	2.13	1.52	235	.466	10.39
18	.92	118	.277	.51	1.23	232	.455	1.13
19	.50	—	.127	.19	.62	—	.186	.28
20	.48	—	.122	.18	.55	—	.138	.21
21	1.18	154	.401	.60	1.43	186	.491	3.33
22	1.23	188	.418	1.81	1.56	278	.536	11.16
23	1.81	285	.557	12.83	2.34	378	.729	31.00
24	1.13	173	.384	1.07	1.47	261	.503	3.65
25	.98	102	.295	.44	1.21	186	.368	.55
26	.87	90	.222	.33	1.04	107	.268	.40
27	1.16	121	.352	.82	1.59	168	.489	4.38
28	1.77	320	.611	17.90	2.29	425	.802	28.34
29	.79	80	.235	.35	.95	99	.286	.43
30	.48	—	.142	.21	.62	—	.186	.28
31	1.41	216	.432	3.72	1.87	296	.577	15.19
32	1.05	138	.357	1.83	1.47	226	.503	4.21
33	1.52	235	.466	13.40	2.05	328	.637	22.50
34	1.23	128	.255	2.25	1.40	147	.292	7.70
35	.41	—	.104	.16	.47	—	.119	.18
36	.84	61	.215	.32	.92	96	.237	.36
37	1.40	180	.478	3.58	1.73	230	.597	12.55
38	.24	—	.034	.05	.39	—	.079	.12
39	.59	—	.175	.26	.80	82	.268	.40
40	.16	—	.014	.02	.29	—	.058	.09
41	.45	—	.091	.14	.51	—	.104	.16
42	.80	58	.164	.25	.96	100	.199	.30
43	.89	66	.268	.40	1.21	91	.368	.64
44	3.44	560	1.109	57.10	4.01	655	1.299	70.96
45	.94	97	.240	.36	1.10	114	.284	.47
46	.18	—	.025	.04	.28	—	.083	.12
47	.65	—	.132	.20	.79	80	.161	1.92
48	.35	—	.070	.11	.46	—	.093	.14
49	.79	80	.264	.40	1.01	131	.341	.51
50	1.83	289	.632	7.51	2.20	354	.770	12.44
51	1.33	203	.493	2.44	1.58	245	.590	11.40
52	.52	—	.106	.16	.59	—	.120	.18
53	.46	—	.116	.17	.52	—	.132	.20
54	1.69	342	.634	13.33	2.05	423	.777	20.85
55	.68	50	.204	.31	.83	85	.247	.37

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Table 2.—Continued

Tree No.	Present				Projected			
	Basal area	Volume		Tree value	Basal area	Volume		Tree value
	Sq. ft.	*Bd. ft.*	*Cords*	*Dollars*	*Sq. ft.*	*Bd. ft.*	*Cords*	*Dollars*
56	.32	—	.079	.12	.44	—	.111	.17
57	2.23	410	.845	26.91	2.79	522	1.070	39.66
58	2.10	384	.730	27.37	2.64	495	.930	41.29
59	1.65	297	.569	12.78	2.01	368	.699	19.63
60	.77	79	.231	.68	.95	122	.286	1.17
61	.88	91	.181	.27	.96	100	.199	.30
62	1.93	307	.669	17.38	2.31	374	.810	25.04
63	1.05	160	.357	.97	1.29	198	.442	2.32
64	1.75	186	.369	7.09	2.27	246	.484	21.19
65	.65	—	.165	.25	.80	82	.204	.31
66	1.48	—	.388	.58	1.58	—	.413	.62
67	.66	68	.197	.29	.80	82	.239	.36
68	.30	—	.043	.06	.35	—	.070	.11
69	1.07	140	.323	1.00	1.24	190	.378	1.92
70	2.81	458	.886	37.92	3.38	550	1.090	49.60
71	2.45	515	.936	30.70	2.74	577	1.051	38.37
72	.95	99	.286	.43	1.12	146	.338	1.22
73	.62	—	.159	.24	.77	79	.197	.30
74	1.01	131	.304	.46	1.18	154	.357	1.56
75	.89	114	.268	.40	1.13	148	.342	.51
76	1.59	248	.549	14.65	1.97	314	.684	21.12
77	.32	—	.063	.09	.37	—	.092	.14
78	1.02	133	.264	.40	1.26	164	.327	1.84
79	1.75	186	.369	10.88	2.20	239	.470	15.66
80	3.41	470	.960	50.21	3.83	530	1.085	59.19
81	2.12	388	.738	24.54	2.52	472	.886	33.50
82	1.02	106	.309	1.46	1.19	156	.362	2.18
83	1.58	281	.590	4.86	1.85	336	.695	8.20
84	.65	—	.132	.20	.94	69	.193	.29
85	.43	—	.109	.16	.49	—	.124	.19
86	.38	—	.094	.14	.43	—	.109	.16
87	2.12	286	.562	21.89	2.66	365	.715	31.69
88	.32	—	.063	.09	.46	—	.116	.17
89	1.50	197	.516	3.92	1.87	296	.647	8.00
Total	97.12	11,627	29.299	465.44	119.31	15,590	36.782	770.75

tested this supposition by remaking our projections of each tree's merchantable height and butt-log grade, purposely introducing errors, except for trees that have grade-1 butt logs right now and trees that would be limited in grade by minimum diameters (we assumed no change in them).

For example, in our original projection we may have estimated that a particular tree would remain at 2 logs. We *re-projected* it to 2½ logs. Or, if we had estimated that a tree's butt log would improve from grade 3 to grade 2, we remade our projection to show that it would remain in grade 3.

Such errors would, of course, make big differences for many individual trees, on a tree-by-tree basis. But by summing individual tree values to obtain stand totals, we found that the differences tended to net out.

If we had estimated every future merchantable height wrong, we would have projected our stand's future volume to 17,609 board feet, a net difference that is 8 percent higher. That is because, in our re-projection, we would have underestimated the heights of trees with small diameters and small volumes, and would have overestimated the heights of trees with large diameters and large volumes.

The difference in projected dollar values would be a lot smaller. Even if we had estimated all our future heights wrong, we would show a projected dollar value for the entire stand that was only 6 percent higher than our original projection. If we had been wrong on future grades every time possible, we would show a difference that was 6 percent lower. This would have offset our errors in height. Thus, had we erred every time in our estimates of change in height and grade, the overall difference in stand value between the right and wrong projections would be less than 1 percent.

STAND EVALUATIONS

Current Stand Valuation

As noted earlier, we estimated our stand's current value at $465. This is not a stumpage value, because it makes no allowance for a prospective buyer's profit and risk or bargaining skill. Nor does it reflect current local demands for timber. Rather, it is a conversion value, based on average regional prices and conversion costs at a particular time (1972). It is a standard measure and a starting point for making stand evaluations.

The matter of placing a dollar value on the stand is, in itself, important. For, in many cases, forest land owners are apathetic to the idea of practicing timber management, simply because they are not aware of their timber's value. But when they do learn of its value, they often become interested in further developing the income potential of their forest land. We suggest this as a first step in encouraging woodland owners to adopt management practices.

Let-Grow Projections

When we make our stand evaluations, we need to consider, first, the results that we can expect if we just let the stand grow. This let-grow option is the option that is most commonly adopted by forest land owners. And it's the one that gives us a yardstick for measuring the stand's development.

We should, however, emphasize two things about our estimate of future stand value. First, it is not an estimate of future stumpage value. Like our current stand value, it is based on conversion value standards. Second, the conversion value standards have 1972 lumber prices built into them. Thus our estimate of future stand value is not an estimate of actual future worth. Instead, and more important, it is a dollar estimate of our stand's development that is tied directly to the biological development of the individual trees in the stand and is measured with the same units that we used for our estimate of the stand's current value. For these reasons we can make some direct comparisons between our current and future stand and some meaningful evaluations of the stand's development, even though we are not attempting to fix, absolutely, the stand's future value.

Our forecast for our sample acre indicates that, if we simply let it continue to grow for 10 more years, it will then have a volume of more than 15,000 board feet. This would be an increase of nearly 4,000 board feet, or an average annual increase of 3.4 percent. During the same period our stand's value would increase by more than $300 and amount to $771. We would thus expect our stand to increase in value at a rate of 5.2 percent, compounded annually.

The stand owner must judge for himself the acceptability of the size and rate of this projected value increase. He would ordinarily base his judgment on a number of outside factors and on how he views them within his own circumstances. If he is satisfied with the size and rate of the value increase, he might well be content to sit back and let his stand grow. But, if he is not satisfied with them, he might want to do something about it. In any case, he should be aware of the options open to him.

One obvious thing the owner could do is liquidate his timber and invest the proceeds at some higher alternative rate. But he has other choices, too. He could lower his financial expectations and rationalize them in view of whatever other reasons he may have for maintaining ownership of the timber. Or he could look for ways to improve the stand's income potential. If so, he would be willing to at least listen to some arguments that point out the benefits of adopting silvicultural treatments.

Here is where timing is important. We have, so far, limited our evaluation to a 10-year period. It would be logical to frame evaluations of stand treatments within the same time period. This would not only facilitate comparisons; it would also help clear a lot of the murk that we often expect forest landowners to see through when we are promoting good forestry. If we can convince the owner that he can expect some acceptable results within a 10-year period, he would be more inclined to accept our assurances of longer-range benefits.

Of course, we can't show that good forestry pays every time and in every case. In some cases we will be able to point out great benefits from stand treatment; in others, only slight benefits, which may or may not be enough to encourage the owner. In still others we will have to admit to the cost of practicing recommended forestry. And many times we won't know which case is which until we evaluate a particular treatment. But even then the choice of adopting it lies with the owner.

Cutting Projections

Our current stand, with 97 square feet of basal area, is well stocked. According to regional standards, recommended stocking would be about 70 square feet (*Gingrich 1971*). Thus our stand could be partially cut to increase the growth of crop trees and, if even-aged management is envisioned, to condition the stand for a harvest cut.

The stand could be cut in several ways. We will consider four of them, using:

1. An even-aged approach in which we would carry the main stand through a series of periodic thinnings until it was mature and ready for harvest. Our first thinning in this particular stand would include large culls, biologically mature trees, and small culls, in that order (*Roach and Gingrich 1962*).
2. An all-aged approach in which we would periodically remove selected individual trees throughout the whole range of diameters. Our first cutting in this stand would include culls, trees that are silviculturally undesirable, and trees that are financially mature (*Trimble and others 1974*).
3. A high-grade cutting in which we would remove trees with the highest value and leave those with the lowest value. In this stand such a cutting, a form of high-grading, would approximate a diameter-limit cutting.
4. A low-grade cutting in which we would remove trees with the lowest value and leave those with the highest value.

Taking each cutting option in turn, we made a cut-and-leave tally for our sample acre. In doing so, we assumed that our *leave* trees would grow at the same rate under a cutting option as they would under the let-grow option. We made no effort to allow for increased growth at lower residual densities. In actual practice, such increases are likely and should be expected. So our estimates for the future stands under the cutting options are conservative.

The results we would expect from the above cuttings are summarized in table 3. It also summarizes the results we would expect if we exercised either the let-grow or the harvest-now options.

Note that we would remove approximately the same basal area in each of the cuttings and, of course, leave about the same basal area in each so as to approximate full site utilization. Note, too, that our expected future basal areas would be nearly the same.

But look at the big differences in board-foot volumes and dollar values. If we removed only low-value trees, our cutting would be practically noncommercial in terms of both board-foot volume and dollar value. But it would result in a high-valued stand in 10 years. If we made a high-grade cutting, we would sacrifice future value for a big return right now. With an even-aged approach, our first thinning in this stand would be pretty well concentrated in mature trees in the upper diameters. But with an all-aged approach, we would cut trees throughout the range of diameters. Thus our even-aged cutting would remove more volume and value now, and our

Table 3.—Treatment comparisons

Option	Cut			Leave			Projected stand		
	Basal area	Volume	Value	Basal area	Volume	Value	Basal area	Volume	Value
	Sq. ft.	*Bd. ft.*	*Dollars*	*Sq. ft.*	*Bd. ft.*	*Dollars*	*Sq. ft.*	*Bd. ft.*	*Dollars*
Let-grow	—	—	—	97	11,627	$465.44	119	15,590	$770.75
Harvest now	97	11,627	$465.44	—	—	—	—	—	—
Partial cut:									
Even-aged	25	3,471	278.76	72	8,156	186.68	89	11,394	403.94
All-aged	26	2,416	167.85	71	9,211	297.59	90	12,705	558.96
High-grade	26	4,346	326.57	71	7,281	138.87	88	10,311	331.99
Low-grade	25	1,295	9.19	72	10,332	456.25	89	13,388	754.90

Table 4.—Treatment yields

Option	Overall		Net		Rate-of-value increase
	Volume	Value	Volume	Value	
	Bd. ft.	*Dollars*	*Bd. ft.*	*Dollars*	*Percent*
Let-grow	15,590	$770.75	3,963	$305.31	5.2
Harvest now	11,627	833.53	—	368.09	6.0
Partial cut:					
Even-aged	14,865	903.16	3,238	437.72	6.9
All-aged	15,121	859.55	3,494	394.11	6.3
High-grade	14,657	916.83	3,030	451.39	7.0
Low-grade	14,683	771.36	3,056	305.92	5.2

all-aged cutting would result in more volume and value 10 years from now.

The yields that we might expect from each of our options are summarized in table 4. Here the overall board-foot yield for each option is the present volume in trees that would be cut under that option, plus the projected volumes of the trees that would be left. The overall dollar yield of each option is its cut value, compounded at a moderate 6 percent for 10 years, plus the projected values of the trees in the future stand. The net yields were found by subtracting the stand's present volume and value from the overall yields of each option. And the rate-of-value increase for each option is the interest rate that corresponds to the ratio of the overall value yield in 10 years and the stand's present value.

Note that the board-foot yields would not vary greatly from one cutting option to another, but that each of them would be lower than the board-foot yield from let-grow option. Remember, we did not allow for residual densities in our growth estimates. But note, too, that the dollar value yields would be fairly similar in each of the three commercial cuttings and that each of them would exceed the dollar value yield from either the let-grow or the harvest-now options. Even the low-grade cutting would yield more value than the let-grow option.

In each of the cuttings we would remove many trees that are increasing in value at rates less than 6 percent, and re-invest their present value at a 6-percent rate. Thus, with each of the cuttings, our stand would display a rate-of-value increase that is higher than the rate we would expect from the let-grow option. And, here too, the three commercial cutting options would increase in value at similar rates.

The choice of which cutting option is best depends, of course, on the owner and his individual situation. The high-grade cutting does have a slightly higher dollar yield, but this can be expected in the short run. Repeated cutting of this type is, nonetheless, continued high-grading and will have an adverse silvicultural effect in the long run (*Trimble 1971*).

The important thing is that we can show the owner how cutting could improve his stand's value yield during the next decade, even if he chooses to make a noncommercial thinning. So he just might be willing to listen to additional arguments that emphasize the longer-range benefits of practicing silviculture.

As a clincher we could point out that our comparisons are conservative (pessimistic might be a better word). We must emphasize, again, that we used the same set of diameter growth rates in each of our projections. These rates were developed from data that had been collected in unmanaged stands, and we did not adjust the rates to changes in residual-stand density.

Actually, we would expect the diameter growth rates of many residual trees to increase under the cutting options. But we really don't know how much of a response to expect, especially in terms of individual trees.

We could be completely optimistic and assume that, as a result of a cutting, every residual tree will increase in vigor and will grow faster than it would have in the unthinned stand. But this is not likely. We could be moderately optimistic and assume that perhaps half of the residual trees will increase in vigor. Yet we can't say which ones.

Instead, we will emphasize the point that our estimates are conservative, that the owner can expect somewhat higher yields from his cutting options, and that the degree of optimism is up to him. After all, they are his trees. And optimism is what we thrive on.

IN SUMMARY SOME PHILOSOPHY

Each tree is unique. So is each stand. So is each woodland owner. Each deserves recognition as an individual.

We recommend stressing individuality, in promoting timber management. We suggest using an evaluation approach that refers to the individual trees in a particular stand and allows the stand owner to relate their development to his own particular circumstances.

In our approach we recognize tree individuality, even to the point of making on-the-ground projections of each tree's development, based on each tree's own unique characteristics. We recognize stand individuality by summarizing our sample stand's values in terms of the individual trees in the stand and their potential development. And we recognize woodland owner individuality by tailoring several treatment possibilities to the owner's individual stand, by focusing treatment results within a relatively short planning period, and by reserving for the owner the choice to do as he sees fit.

We sense that such an approach would provide timber owners with an improved basis for deciding to become timber producers.

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APPENDIX A
DEFINITION OF VIGOR CLASSES

Vigor I. — A tree in this vigor class has a large, healthy, full crown in a dominant or codominant position. Half the crown or more is exposed to direct sunlight. The crown is typically dense, with no evidence of disease or mechanical injury. The bark and twigs have good color.

Vigor II. — A tree in this vigor class has a fair-size crown in a codominant position. Less than half the crown is exposed to direct sunlight. The crown is less dense and less perfect than that of a vigor-I tree. This class may also include a large-crowned or dominant tree that otherwise fails to meet the requirements for vigor I.

Vigor III. — A tree in this vigor class has a medium to small crown of intermediate position. Only the top is exposed to direct sunlight. The crown may be open, with some dead or broken limbs. This class also includes trees that have fair to large crowns in a codominant position but cannot meet requirements for vigor I and vigor II. It may also include overtopped trees of a tolerant species that have dense crowns of good color.

Vigor IV. — A tree in this class usually has a small crown in an overtopped position. This class includes all living trees that fail to meet the requirements of the higher vigor classes.

APPENDIX B

Table 5.—10-year diameter growth rates, in inches

Dbh	Vigor 1	Vigor 2	Vigor 3	Dbh	Vigor 1	Vigor 2	Vigor 3
	RED OAK[1]				YELLOW-POPLAR[2]		
12	3.0	2.2	1.2	12	2.9	2.1	1.4
14	2.8	2.1	1.1	14	2.8	2.0	1.3
16	2.7	2.0	1.1	16	2.6	1.9	1.2
18	2.5	1.9	1.0	18	2.5	1.8	1.2
20	2.4	1.8	1.0	20	2.4	1.7	1.1
22	2.2	1.7	.9	22	2.3	1.7	1.1
24	2.1	1.6	.9	24	2.2	1.6	1.0
26	2.0	1.5	.8	26	2.1	1.5	1.0
28	1.8	1.4	.7	28	1.9	1.4	.9
30	1.6	1.2	.7	30	1.8	1.3	.8
32	1.5	1.1	.6	32	1.7	1.2	.8
	WHITE OAK[1]				RED MAPLE[3]		
12	2.1	1.6	1.1	12	2.5	2.0	1.7
14	2.0	1.5	1.1	14	2.5	2.0	1.6
16	1.9	1.4	1.0	16	2.4	2.0	1.5
18	1.8	1.4	1.0	18	2.4	2.0	1.3
20	1.7	1.3	.9	20	2.4	2.0	1.2
22	1.6	1.2	.8	22	2.3	2.0	1.1
24	1.5	1.1	.8	24	2.3	1.9	.9
26	1.4	1.1	.7	26	2.2	1.9	.8
28	1.3	1.0	.7	28	2.2	1.9	.7
30	1.2	.9	.6	30	2.2	1.9	.5
32	1.1	.8	.6	—	—	—	—
	CHESTNUT OAK[1]				WHITE ASH[3]		
12	2.7	2.1	1.2	12	2.0	1.7	1.1
14	2.5	1.9	1.1	14	2.1	1.7	1.1
16	2.4	1.8	1.0	16	2.2	1.7	1.1
18	2.2	1.7	.9	18	2.2	1.7	1.1
20	2.1	1.6	.9	20	2.3	1.7	1.1
22	2.0	1.5	.9	22	2.3	1.7	1.2
24	1.9	1.4	.8	24	2.4	1.7	1.2
26	1.8	1.3	.8	26	2.4	1.7	1.2
28	1.6	1.2	.7	28	2.5	1.7	1.2
30	1.5	1.1	.6	30	2.5	1.7	1.2
32	1.4	1.1	.6	—	—	—	—

[1] Trimble and Mendel 1969.

[2] Holcomb and Bickford 1952.

[3] Grisez and Mendel 1972.

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