THE EXTENT AND CHARACTERISTICS OF LOW PRODUCTIVITY ASPEN AREAS IN WISCONSIN

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The aspen type in Wisconsin occupies about 3.7 million acres, 25 percent of the commercial forest land in the State. Aspen is a major pulpwood species in the State and during recent years has provided 40 to 45 percent of the total pulpwood. Because of the wide extent of the aspen type and importance of the timber industry, there is considerable interest in knowing the inherent capabilities of the aspen forest land.

Extensive areas of aspen in Wisconsin currently produce little commercial timber, either because of inherently low timber-growing potential for aspen or because they are understocked and are not capturing the full site potential. However, details about the extent and distribution of these low productivity areas have not been available. This report summarizes the extent and characteristics of "low productivity" aspen areas in Wisconsin and shows their location and general distribution. It considers both the inherent capacity of a site to grow timber (its potential productivity) and the percent of potential captured by the existing stand.

DATA BASE

The data for this study were taken from 1,592 plots classified as aspen type that were measured during the 1968 forest survey of Wisconsin on non-National Forest land (Spencer and Thorne 1972), and from 27 plots on the Chequamegon National Forest measured in 1974 and 37 plots on the Nicolet National Forest measured in 1975. Each plot consisted of 10 variable radius (37.5 Basal Area Factor prism) points equally spread over approximately 1 acre. Plot locations were determined by placing a systematic grid of 1-acre dots over an aerial photo mosaic of each township. To simplify the computing and to present the data for smaller geographically similar sections, the State was divided into five survey units (fig. 1).

The definition of the aspen type used by forest survey is "A stand in which a mixture of quaking or bigtooth aspen and balsam poplar, singly or in combination, comprises a plurality of the stocking".[1] To determine which of the plots measured in the three surveys were in the aspen type, the stocking of all live trees tallied on a plot was summarized by species and the plurality rule applied. However, a plot with a diversity of species was typed as aspen if stocking in aspen and paper birch in combination with other hardwood species exceeded the stocking of conifers, if aspen and paper birch combined exceeded other hardwood species, and if the aspen exceeded the paper birch.

Throughout this paper trees are described as all live or as growing stock. Live trees are those 1.0-inch d.b.h. or larger that are alive at the time tallied. They are further classified as desirable, acceptable, rough, rotten, or short log. Desirable trees have no serious defects that limit present or prospective use, have relatively high vigor, and

[1]*Stocking is the degree of utilization of land by trees as measured in terms of basal area and/or the number of trees in a stand compared to the basal area and/or number of trees required to utilize fully the growth potential of the land. For a thorough discussion of stocking, see Spencer and Thorne 1972, page 27.*

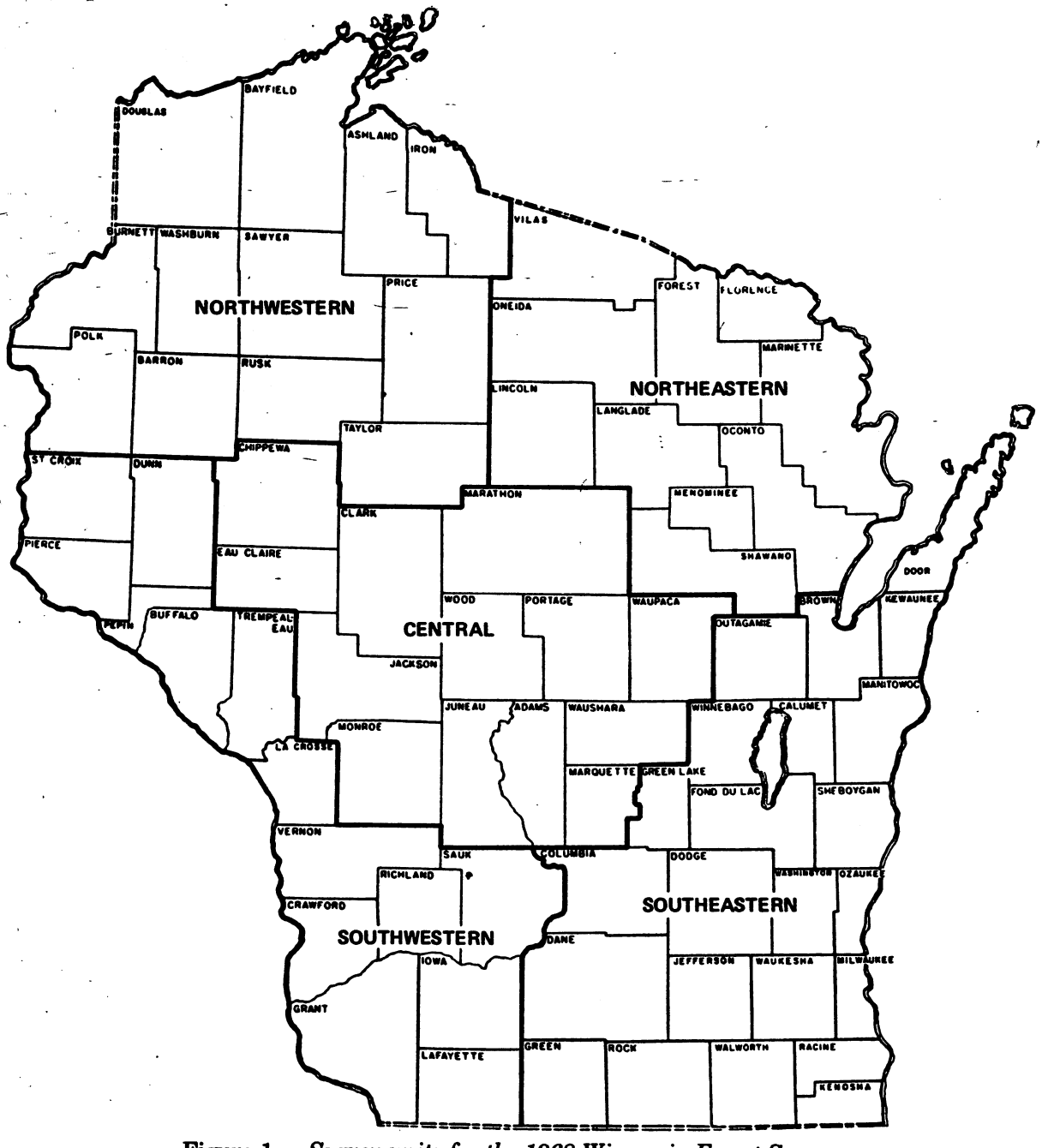

Figure 1.—*Survey units for the 1968 Wisconsin Forest Survey.*

contain no pathogens that may kill or seriously deteriorate them before rotation age. These are trees that would be favored by forest managers in silvicultural operations. Acceptable trees have no serious defects that limit present or prospective use but have pathogens or damage that may affect quality. The class of trees referred to as growing stock include only desirable and acceptable trees.

PRODUCTIVITY

The first step in the analysis was to establish the potential and actual productivity of each inventory plot in Wisconsin in comparable units so each plot could be characterized by the percent of its potential actually achieved. Site productivity is

expressed in cubic feet per acre per year. The current productivity of a stand varies with its age, but for a given rotation length productivity of a stand can be expressed in terms of the mean annual increment over the rotation. Site productivity typically is expressed by the maximum mean annual increment over the range of rotation ages.

Yield tables from Kittredge and Gevorkiantz (1929), reporting total peeled cubic foot volume per acre per year in trees 1-inch d.b.h. and larger in well-stocked aspen stands, have been used for more than a decade as the standard for determining aspen site productivity in the Lake States, and are used in this analysis.[2] An equation relating maximum mean annual increment (MAI) in cubic feet per acre per year to site index (S) was derived from the table data in Kittredge and Gevorkiantz (1929). A second-degree polynomial was fit to the data for the five sites reported in the table to minimize the squared differences between the derived and predicted values and resulted in the following equation:

$$MAI = -97.53 + 3.5463S - .014286\ S^2$$

We used this equation to estimate the MAI for each plot from its recorded site index, and then we used this MAI estimate to classify the plot's potential site productivity.

The actual productivity of each plot is more difficult to estimate. Present inventory procedures require that only merchantable volumes of growing stock trees be recorded, whereas the MAI developed from the Kittredge and Gevorkiantz data included total peeled volumes of all live trees 1.0-inch d.b.h. and larger. Thus, the actual and potential volumes could not be compared directly. Therefore, we decided to use basal area rather than volume for our comparisons. All tree species, not just aspen, are included in estimating percent achievement.

Schlaegel (1971) derived an equation for estimating the total stand cubic-foot yield per acre, inside bark, for aspen (V) from total basal area in square feet per acre (B) and average total height in feet of dominants and codominants (H):

$$V = 0.41898\ HB$$

If we assume that stand height is the same for a given age and site regardless of stand density, then for a given age and site the total cubic volume of a stand is directly proportional to the basal area of the stand. That is,

$$V = kB$$

where $k = 0.41898\ H$

The actual volume in a stand (V_a) is estimated directly from its actual basal area (B_a), and the potential volume in a stand (V_p) is estimated from its potential basal area (B_p):

$$V_a = kB_a$$
$$V_p = kB_p$$

From these volume equations it is evident that the proportion of potential volume actually achieved, V_a/V_p, is identical to the proportion of basal area actually achieved, B_a/B_p, for a given age and site:

$$\frac{V_a}{V_p} = \frac{kB_a}{kB_p} = \frac{B_a}{B_p}$$

Using basal area, which is directly available from the plot records, to estimate the percent of potential productivity achieved eliminated extensive volume computations and adjustments.

We also had to determine at what point in the stand's development to compare the basal areas. The actual current annual increment recorded for each inventory plot cannot be compared directly with the potential MAI. Current increment is an average for only one recent growth period, whereas the MAI is an average for all growth periods throughout an entire rotation. Ideally, actual total production of a stand from its present age to the end of the rotation should be compared with its potential total production throughout the same period. With a one-final-harvest-cut system of management, as is used almost universally with aspen, the projected actual basal area at the time of harvest could be compared with its expected potential at the time of harvest to estimate the percent of potential the stand will achieve. But if understocked stands tend to approach full stocking with increasing age, using the current state of the stand would underestimate the stand's ultimate percent achievement of full productivity. To correct this deficiency current basal area must be projected to rotation.

Unfortunately, Schlaegel's (1971) equation for projecting aspen basal area growth covers only

[2]*Mean annual increments derived from Ek and Brodie (1975) are from 10 to 15 percent lower than those reported by Kittredge and Gevorkiantz on site indexes 50 to 70, but they agree closely on site index 80.*

sites greater than site index 65 and assumes that growth is the same on all sites. Although the growth rates given by Schlaegel's equation correspond reasonably well with those implied by the Kittredge and Gevorkiantz tables for older stands on better sites, they consistently give much higher basal area growths than shown by Kittredge and Gevorkiantz for poorer sites and younger ages. We decided to express the percent of full production achieved in terms of the current state of the stand rather than attempt projecting stand density to the end of the rotation.

The potential basal area per acre (B) at any given site index (S) and stand age (A) was estimated by the following equation:

$$B = 2.385\ S\ (1\text{-}e^{-0.031268A})$$

The parameters of this equation were determined by fitting a nonlinear function to the basal areas given by Kittredge and Gevorkiantz (1929) for all trees ≥1-inch d.b.h. in well-stocked aspen stands for a range of ages and sites. To estimate the proportion of potential achieved, the current basal area recorded for the inventory plot was divided by its potential estimated from the above equation. Using this equation, the estimated potential basal area of a 30-year-old stand on site index 70 would be 102 square feet/acre. If the actual basal area was 51 square feet/acre, the stand would have achieved only 50 percent of its potential, and would be so recorded.

The present basal area of a stand can be obtained directly from each plot record. But should the basal area include all live trees or should only growing-stock trees be included? The first provides a measure of apparent stocking of all trees in a stand and may be most appropriate for such harvest systems as full-tree chipping of all live trees. The second measures stocking of only those trees considered desirable and acceptable by traditional markets and harvesting systems. We used both measures and made separate sets of tables for each. When using the tables, keep in mind the distinction between the two measures of potential achievement.

EXTENT OF LOW PRODUCTIVITY AREAS

The stand age, site productivity, and percent of potential achieved were determined for each inventory plot classed as aspen type. The percent of achievement was based on the basal area of (1) all live trees >1.0-inch d.b.h. (tables 1-6, p. 13-18) and (2) growing stock trees only (tables 7-12, p. 19-24). The total acres within each age and potential productivity class are the same for both methods of computation, but the distribution of acres among achievement classes differs.

We did not attempt to define what constitutes a "low productivity area". But a broad definition of low productivity can be specified and the number of acres that fall in that class in the State or one of the survey units can be determined (tables 1-12). For example, if a low productivity area is defined as one with a potential for growing less than 40 cubic feet/acre/year, then in the State of Wisconsin there are 236,000 acres of such "low productivity" stands (table 7) of all ages out of a total of 3,715,000 acres. Or, low productivity could be defined as all stands with a potential of less than 60 cubic feet/acre/year *and* all stands presently achieving less than 50 percent of potential based on growing stock. In this case you would determine the total acres of "low productivity" areas in the State by adding up all acres with 60 cubic feet/acre/year or less potential (236,000 + 774,000 = 1,010,000 acres) and those areas with more than 60 cubic feet/acre/year that are producing at 50 percent or less of potential (1,178,000 acres) to get a total "low productivity" area in Wisconsin of 2,188,000 acres. When adding up both low site and low achievement areas, do not double count those acres that are both low site *and* low achievement.

LOCATION OF LOW PRODUCTIVITY AREAS

Maps showing the location of aspen plots by township and range in Wisconsin were prepared by computer printout for selected categories of plots. These maps provide a visual impression of plot locations and help identify areas with a concentration of special categories of aspen plots. A map showing the location of all inventory plots in Wisconsin typed as aspen in the 1968 survey provides a visual standard for comparing all the other maps (fig. 2). This map and all other maps measure percent of productivity achieved in terms of growing stock basal area, not the basal area of all live trees.

Figure 3 shows the location of plots with the lowest site productivity potential; they are capable

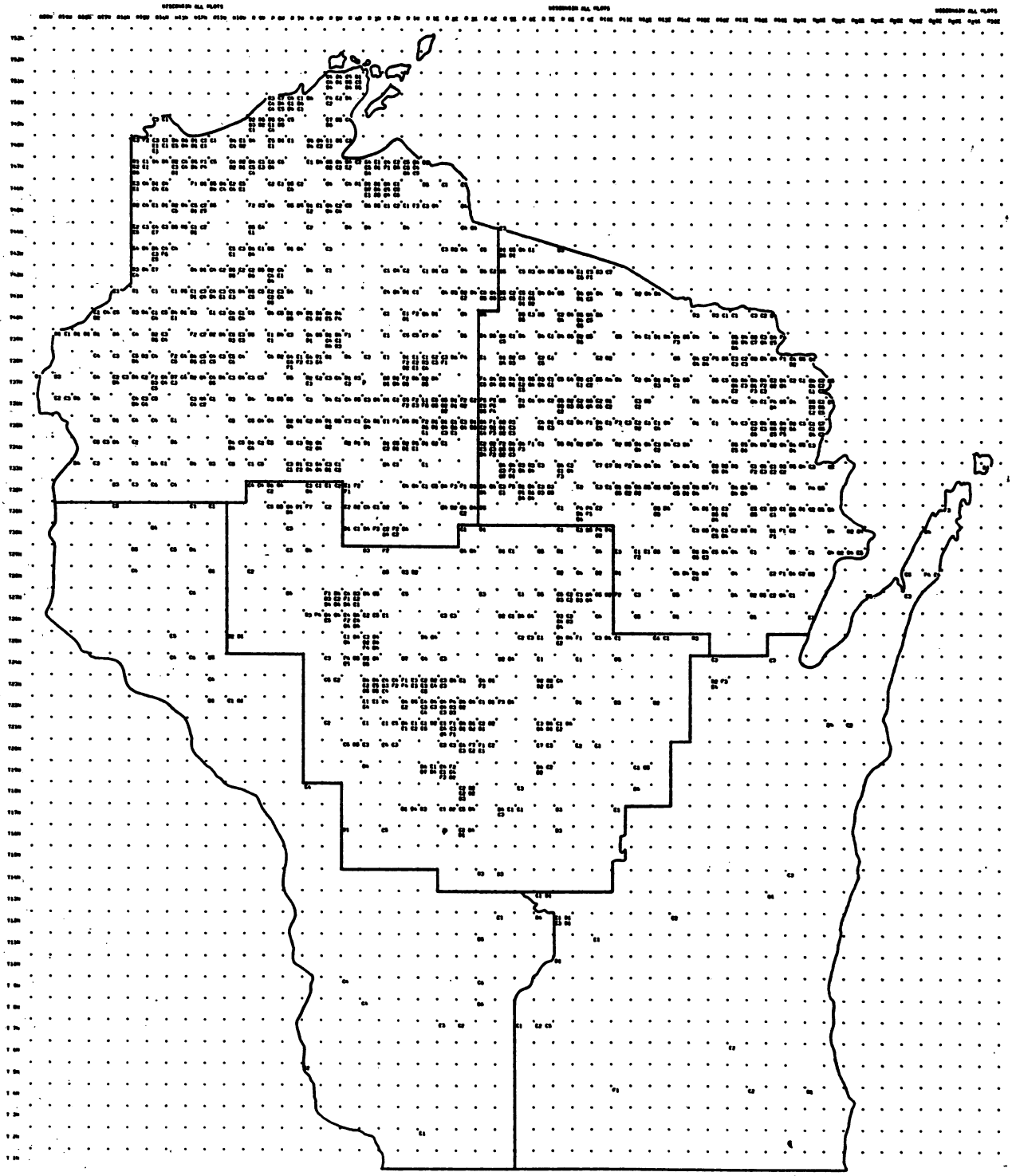

Figure 2.—*Location of all inventory plots in the 1968 Wisconsin Forest Survey typed as aspen.*

of growing <40 cubic feet/acre/year. For the plots shown on this map, timber production from aspen stands would be low even if full potential could be achieved. The bulk of these plots were concentrated in two areas—one in north-central Wisconsin (extending roughly from Tomahawk to Park Falls), and one in central Wisconsin (roughly from Wisconsin Rapids to Eau Claire).

Figure 4 shows the location of plots in the lowest achievement-percent class; these plots are achieving <25 percent of their potential. This map indicates where timber production could be increased substantially if full potential could be achieved. Again areas of concentration are evident, particularly an area in the north central part of the State (extending roughly from Tomahawk to Hayward).

Figure 5 shows the location of plots on the best sites; these plots are capable of growing >80 cubic feet/acre/year but are currently achieving less than half of their potential. The stands represented by these plots occupy some of the best sites, but currently fall short of fully utilizing the site potential for timber production. Most of these high-potential areas are in the north central part of the State.

DISCUSSION

In Wisconsin, 1.7 million acres of aspen (47 percent of the total 3.7 million acres in aspen) achieve less than half of their potential, if only growing stock trees are considered (table 13). Even if all live trees are included, 1.0 million acres (27 percent of the aspen type) achieve less than half of their potential. Thus, aspen stands in Wisconsin currently produce only slightly more than half their potential growing stock timber.

If it were desirable and possible to reach full production from all of the aspen type, inventories of aspen growing stock would be at least 80 percent higher than they are currently. But attaining full stocking on all acres of aspen type may be an unrealistic goal (Bruce 1977, Spurr and Vaux 1976). Insect and disease epidemics, windstorms, drought, and many other factors may all contribute to understocking and make full stocking on every acre an unattainable goal. Research is needed to determine why these large areas are understocked and to suggest measures that could be taken to improve stocking.

The site potentials outlined in this paper appear reasonable. A sizable portion of plots closely approach their "potential" for the entire range of sites and ages. For example, 45 percent of the 1,656 aspen plots in Wisconsin had more than three-quarters of their potential basal area in all live trees. Twenty-two percent of all the aspen plots had *more* than their indicated potential, if all live trees are included. Even if only growing stock basal area is considered, 12 percent of all the plots exceeded the potential indicated for their specific site and age. This strongly indicates that the potential productivities used in this report are realistic goals to use.

Thirty-eight percent of the aspen type is capable of growing >80 cubic feet/acre/year (total cubic foot volume of the entire peeled stem). Seventy-three percent of the type can produce more than 60 cubic feet/acre/year, and 94 percent can produce more than 40 cubic feet/acre/year. Only 6 percent of the type is capable of producing <40 cubic feet/acre/year. The sites capable of growing <60 cubic feet/acre/year occupy 27 percent of the aspen type and would, if fully stocked, produce only 17 percent of the potential volume from the type.

If full potential stocking could be attained, 45 percent of the best site aspen land fully stocked with growing stock trees would produce as much volume as the entire aspen type in the State currently produces.

Table 13.—*Aspen area by achievement classes, 1968 Wisconsin survey*

Survey Unit	Percent achievement class 0-25	26-50	51-75	76+	Aspen area
		(percent)			*(acres)*
TOTAL BASAL AREA					
Northeastern	7	19	28	47	1,207,000
Northwestern	9	21	27	43	1,627,000
Central	10	12	32	45	699,000
Southwestern	0	22	27	51	78,000
Southeastern	11	17	25	47	104,000
GROWING STOCK BASAL AREA					
Northeastern	14	26	29	31	1,207,000
Northwestern	20	30	22	28	1,627,000
Central	21	28	31	21	699,000
Southwestern	18	33	33	14	78,000
Southeastern	28	27	28	17	104,000

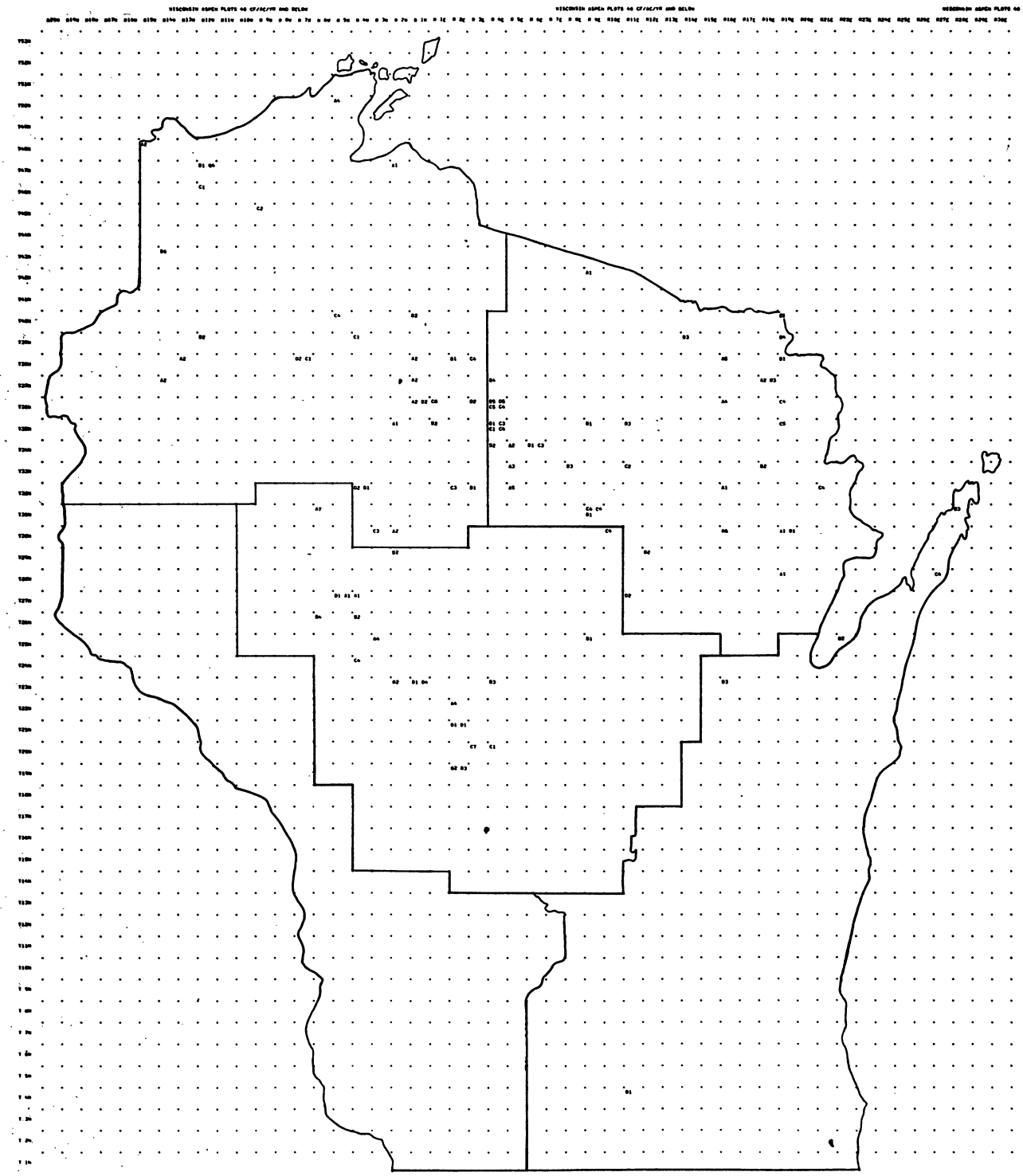

Figure 3.—*Location of all aspen plots in Wisconsin's 1968 Survey with the potential for growing ≤40 cubic feet per acre per year.*

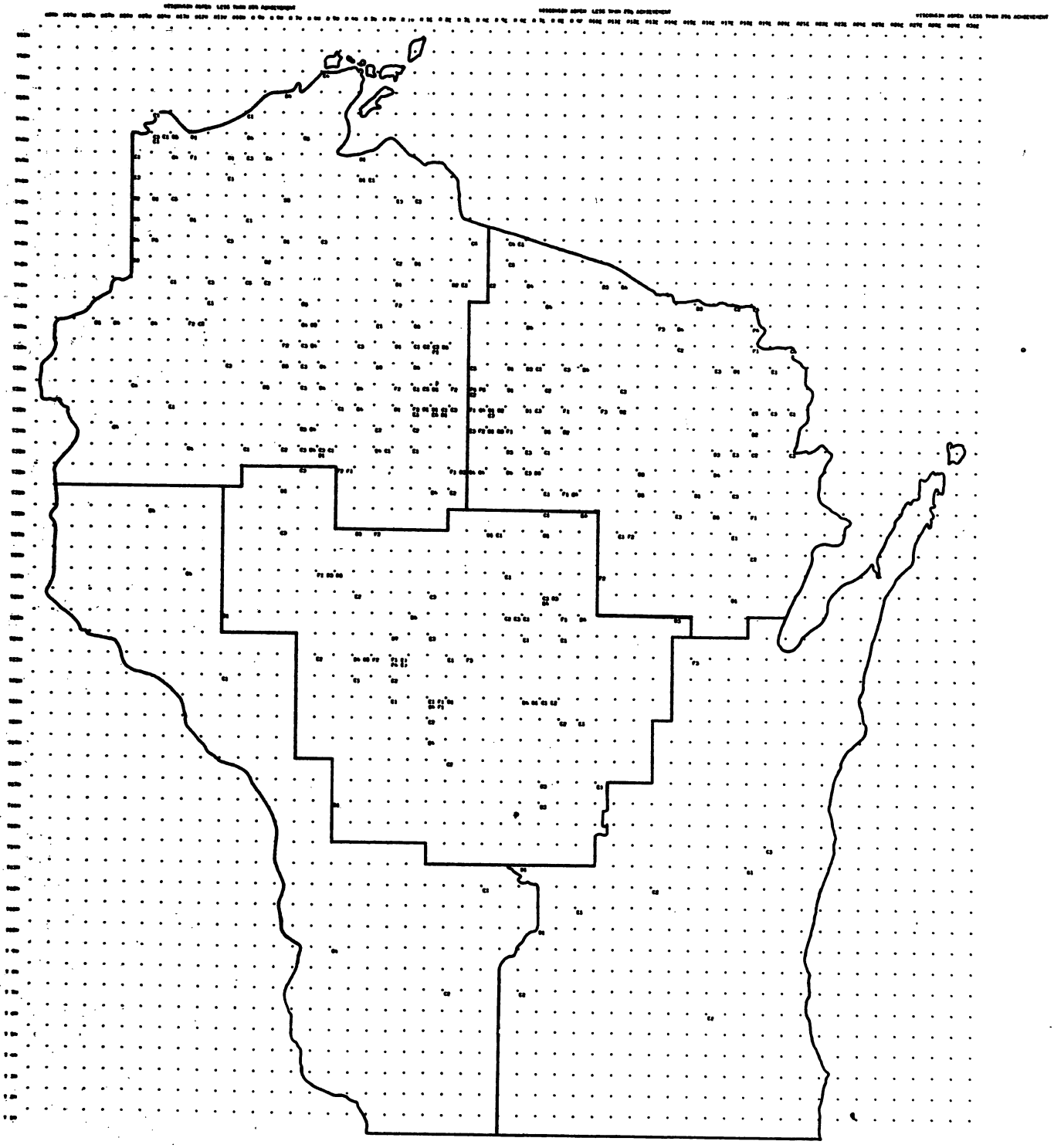

Figure 4.—*Location of all aspen plots in Wisconsin's 1968 Forest Survey achieving ≤25 percent of potential.*

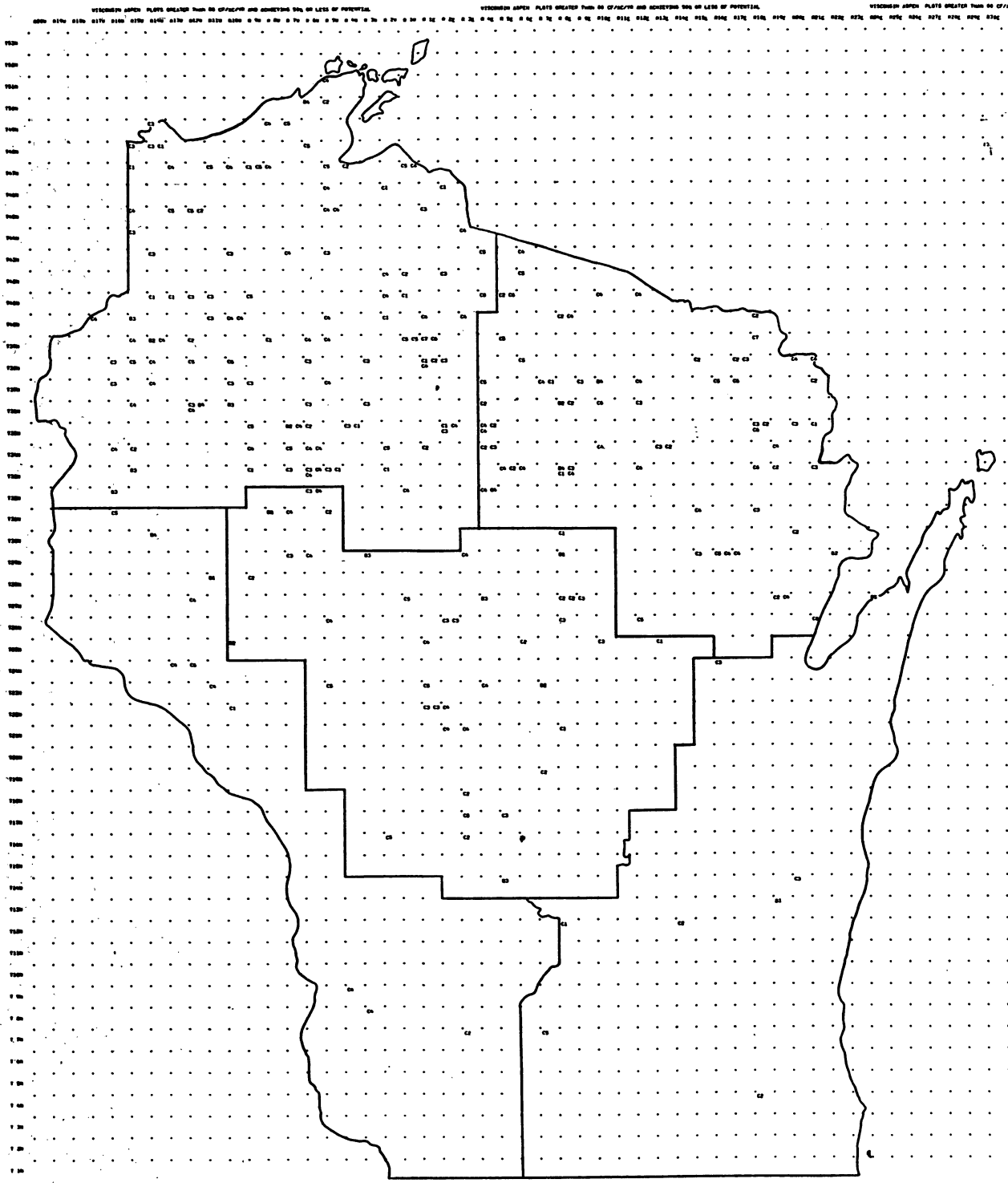

Figure 5.—*Location of all aspen plots in Wisconsin's 1968 Forest Survey capable of growing 80 cubic feet per acre per year but achieving ≤50 percent of their potential.*

To achieve full site potential in poorly-stocked aspen stands, the existing stand may have to be removed and regenerated by appropriate site preparation. But it may not be desirable to regenerate all sites to aspen — some may be better adapted to another species or the cost of site preparation to ensure full stocking may exceed the benefit.

A summary of acres by physiographic class and site index for all aspen plots may give some clues about the potential for site conversion (tables 14 and 15). Five physiographic classes were used in the Wisconsin inventory, ranging from xeric (very dry droughty sites) through mesic (deep, well-drained soils favorable to tree growth) to hydric (where growth and number of species are seriously limited by excess water).

Table 14.—*Area of aspen type in Wisconsin by physiograph class, potential productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Physiographic Class: Xeromesic	Mesic	Hydromesic	Hydric	Total
	Percent	Thousand acres				
101-120	0-25	0	9	2	0	11
	26-50	2	30	9	0	41
	51-75	0	42	9	0	51
	76+	0	25	0	0	25
	TOTAL	2	107	20	0	129
81-100	0-25	7	138	51	5	200
	26-50	9	268	81	6	364
	51-75	11	310	50	2	373
	76+	9	285	60	0	353
	TOTAL	36	1,000	241	13	1,290
61-80	0-25	8	128	50	9	196
	26-50	15	242	102	6	366
	51-75	12	275	74	0	360
	76+	7	303	55	0	365
	TOTAL	42	948	281	15	1,286
41-60	0-25	7	111	73	2	194
	26-50	11	113	77	5	206
	51-75	6	114	43	8	171
	76+	7	146	47	3	203
	TOTAL	31	485	241	17	774
21-40	0-25	7	16	53	9	85
	26-50	0	41	16	10	67
	51-75	3	15	5	3	26
	76+	2	36	20	0	58
	TOTAL	12	108	94	22	236
TOTAL	0-25	29	402	229	25	686
	26-50	38	695	285	27	1,044
	51-75	32	756	180	13	982
	76+	24	795	182	3	1,004
	TOTAL	124	2,648	876	67	3,715

[1]Columns may not add due to rounding.
[2]Based on all live trees.

Table 15.—*Area of aspen type in Wisconsin by physiograph class, potential productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Physiographic Class: Xeromesic	Mesic	Hydromesic	Hydric	Total
	Percent	Thousand acres				
101-120	0-25	0	5	0	0	5
	26-50	0	18	4	0	22
	51-75	2	31	7	0	40
	76+	0	52	9	0	61
	TOTAL	2	107	20	0	129
81-100	0-25	2	48	31	2	83
	26-50	9	185	71	9	274
	51-75	9	294	48	0	351
	76+	15	473	91	2	582
	TOTAL	36	1,000	241	13	1,290
61-80	0-25	6	45	27	7	86
	26-50	4	128	61	2	196
	51-75	15	311	84	4	414
	76+	16	463	108	2	590
	TOTAL	42	948	281	15	1,286
41-60	0-25	2	36	45	0	83
	26-50	7	80	42	5	133
	51-75	7	122	58	8	195
	76+	16	246	96	5	363
	TOTAL	31	485	241	17	774
21-40	0-25	7	7	28	9	51
	26-50	0	27	26	6	59
	51-75	0	29	17	4	51
	76+	6	45	22	3	75
	TOTAL	12	108	94	22	236
TOTAL	0-25	17	141	131	18	308
	26-50	20	438	205	21	684
	51-75	34	789	213	16	1,051
	76+	52	1,280	327	12	1,672
	TOTAL	124	2,648	876	67	3,715

[1]Columns may not add due to rounding.
[2]Based on growing-stock trees only.

No aspen plots were characterized as xeric, so only four classes are presented here—xeromesic, mesic, hydromesic, and hydric. Seventy-one percent of all aspen plots were classed as mesic, 24 percent were hydromesic, 3 percent were xeromesic, and 2 percent were hydric. Mesic plots had the highest average site index (67) and thus the highest potential productivity (76 cubic feet/acre/year). Xeromesic was next (SI 63, 69 cubic feet/acre/year), then hydromesic (SI 61, 66 cubic feet/acre/year), and last hydric (SI 57, 58 cubic feet/acre/year). Only 41 percent of the mesic plots achieved less than half their potential in growing-stock trees, but 54 percent of the xeromesic plots, 59 percent of the hydromesic plots, and 78 percent of the hydric plots attained less than half their potential. Thirty percent of the mesic plots and only 4 percent of the hydric plots achieved more than 75 percent of their potential. These data indicate that mesic plots tend to have the highest potential for aspen and highest achievement of potential, and the hydric plots the lowest potential and the lowest achievement of potential.

A look at the distribution of plots by achievement class within the State reveals some interesting differences among survey units (table 13). If all live trees are counted, roughly 45 to 50 percent of the plots in each survey unit attain more than 75 percent of their potential. However, if only growing stock basal area is counted, then the percentage of plots achieving 75 percent of their potential is different between survey units—30 percent in the northern units, 20 percent in the central unit, and about 15 percent in the southern units. Apparently the percentage of nongrowing-stock trees in aspen stands increases from north to south. Understocking of growing-stock trees appears to be more of a problem in the southern part of the State than it is in the north, but only 5 percent of the State's aspen type is in these two southern units.

The percent of stands achieving less than 50 percent of their potential does vary with stand age, but there is no discernable age trend.

CONCLUSIONS

Much forest area classified as aspen type in Wisconsin is capable of producing high cubic-foot volumes but is currently achieving less than its potential. If all aspen stands were fully stocked with growing-stock trees and achieved their full potential, the present inventory of aspen growing stock would be approximately 80 percent higher than it is now. The possibilities and techniques for reaching full stocking on aspen sites for a wide range of conditions need to be researched. Whether full productivity is economically, ecologically, or environmentally feasible also must be determined.

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Table 1.—*Area of aspen type in Wisconsin by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*

Potential cubic feet/ acre/year	Potential achieved[1]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	[2]5	0	0	0	0	0	0	0	5
	26-50	0	7	7	9	0	0	0	0	22
	51-75	0	5	9	17	9	0	0	0	40
	76+	12	18	16	11	5	0	0	0	61
	TOTAL	17	30	31	37	14	0	0	0	129
81-100	0-25	[2]38	14	18	10	2	0	0	0	83
	26-50	19	32	51	113	40	12	4	2	274
	51-75	11	40	69	140	80	9	0	2	351
	76+	112	114	72	179	88	11	6	0	582
	TOTAL	181	200	210	442	211	32	11	4	129
61-80	0-25	[2]40	9	15	13	4	0	0	4	86
	26-50	25	12	23	80	51	4	2	0	196
	51-75	32	48	60	143	102	24	4	2	414
	76+	175	92	42	144	101	33	2	0	590
	TOTAL	272	161	140	380	257	62	8	6	128
41-60	0-25	[2]43	12	21	2	2	3	0	0	83
	26-50	22	21	25	33	15	14	2	0	133
	51-75	26	38	25	45	44	10	7	0	195
	76+	142	60	27	75	39	12	4	4	363
	TOTAL	232	131	99	155	101	39	13	4	774
21-40	0-25	[2]30	15	2	0	2	2	0	0	51
	26-50	6	9	14	28	2	0	0	0	59
	51-75	8	9	7	18	4	0	2	2	51
	76+	19	32	7	9	4	2	2	0	75
	TOTAL	63	65	29	55	13	4	4	2	236
TOTAL	0-25	[2]156	50	57	25	10	5	0	4	308
	26-50	73	81	119	263	108	30	8	2	684
	51-75	77	139	170	363	239	43	13	6	1,051
	76+	460	315	164	418	238	59	15	4	1,672
	TOTAL	766	586	509	1,069	595	137	37	17	3,715

[1]Based on all live trees.
[2]Includes plots classed as nonstocked aspen type.

Table 2.—*Area of aspen type in Northeastern Survey Unit of Wisconsin, by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	0	0	0	0	0	0	0	0	0
	26-50	0	5	0	2	0	0	0	0	7
	51-75	0	0	0	5	0	0	0	0	5
	76+	0	2	7	2	0	0	0	0	11
	TOTAL	0	7	7	9	0	0	0	0	23
81-100	0-25	[3]4	7	2	4	2	0	0	0	19
	26-50	2	14	14	36	2	9	2	0	79
	51-75	0	16	13	43	35	2	0	2	111
	76+	40	40	17	39	27	6	4	0	172
	TOTAL	46	76	46	122	66	17	6	2	382
61-80	0-25	[3]9	6	8	5	2	0	0	2	32
	26-50	8	2	13	36	25	0	0	0	84
	51-75	6	11	23	38	33	8	0	2	120
	76+	59	22	15	69	58	12	0	0	234
	TOTAL	82	42	59	148	117	20	0	4	471
41-60	0-25	[3]2	0	8	2	0	0	0	0	12
	26-50	6	6	12	7	0	4	0	0	34
	51-75	4	7	10	22	29	6	2	0	79
	76+	34	21	8	23	22	10	2	2	122
	TOTAL	45	34	38	54	51	19	4	2	247
21-40	0-25	[3]11	2	2	0	2	0	0	0	17
	26-50	2	4	6	8	2	0	0	0	23
	51-75	2	4	2	9	4	0	0	0	21
	76+	7	5	4	2	4	2	0	0	25
	TOTAL	22	16	14	19	13	2	0	0	86
TOTAL	0-25	[3]26	15	20	11	6	0	0	2	80
	26-50	17	31	46	89	29	13	2	0	227
	51-75	11	38	48	116	100	15	2	4	336
	76+	140	90	51	136	111	30	6	2	565
	TOTAL	194	174	164	352	246	58	11	8	1,207

[1]Columns may not add due to rounding.
[2]Based on all live trees.
[3]Includes plots classed as nonstocked aspen type.

Table 3.—*Area of aspen type in Northwestern Survey Unit of Wisconsin, by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	0	0	0	0	0	0	0	0	0
	26-50	0	3	2	4	0	0	0	0	9
	51-75	0	0	7	8	0	0	0	0	15
	76+	4	7	7	6	0	0	0	0	24
	Total	4	10	16	19	0	0	0	0	49
81-100	0-25	[3]30	3	12	6	0	0	0	0	50
	26-50	15	10	27	66	29	3	2	2	154
	51-75	8	7	33	56	36	4	0	0	145
	76+	44	59	36	108	43	2	2	0	295
	Total	97	79	108	237	108	9	4	2	645
61-80	0-25	[3]22	3	0	8	2	0	0	2	37
	26-50	13	5	7	29	24	4	0	0	82
	51-75	21	30	20	66	53	17	4	0	211
	76+	83	31	11	52	34	17	0	0	228
	Total	138	69	38	155	114	37	4	2	558
41-60	0-25	[3]22	5	11	0	2	3	0	0	43
	26-50	12	7	7	18	13	10	2	0	69
	51-75	19	17	0	2	11	2	2	0	55
	76+	65	27	2	19	11	2	2	0	128
	Total	118	57	20	39	37	17	7	0	294
21-40	0-25	[3]4	10	0	0	0	2	0	0	17
	26-50	4	3	2	12	0	0	0	0	21
	51-75	7	2	2	2	0	0	0	2	16
	76+	4	22	0	2	0	0	0	0	28
	Total	20	37	5	16	0	2	0	2	81
TOTAL	0-25	[3]77	20	23	14	4	5	0	2	146
	26-50	43	27	45	130	66	17	5	2	335
	51-75	55	57	62	135	100	23	7	2	442
	76+	200	146	56	187	88	21	4	0	704
	Total	376	251	187	467	259	66	15	7	1,627

[1]Columns may not add due to rounding.
[2]Based on all live trees.
[3]Includes plots classed as nonstocked aspen type.

Table 4.—*Area of aspen type in Central Survey Unit of Wisconsin, by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	[3]2	0	0	0	0	0	0	0	2
	26-50	0	0	4	0	0	0	0	0	4
	51-75	0	5	2	2	2	0	0	0	12
	76+	2	5	2	2	2	0	0	0	14
	Total	5	10	9	5	4	0	0	0	32
81-100	0-25	[3]5	5	5	0	0	0	0	0	14
	26-50	0	2	7	7	7	0	0	0	23
	51-75	2	17	14	34	4	0	0	0	71
	76+	19	9	14	30	16	0	0	0	88
	Total	27	33	39	71	27	0	0	0	197
61-80	0-25	[3]10	0	7	0	0	0	0	0	17
	26-50	2	5	2	15	2	0	2	0	28
	51-75	2	7	16	39	15	0	0	0	80
	76+	17	36	17	18	9	2	2	0	101
	Total	32	48	42	71	26	2	4	0	226
41-60	0-25	[3]15	5	2	0	0	0	0	0	22
	26-50	2	7	4	8	2	0	0	0	24
	51-75	2	7	12	18	5	2	2	0	49
	76+	37	12	17	23	5	0	0	2	95
	Total	56	32	35	50	11	2	2	2	191
21-40	0-25	[3]13	2	0	0	0	0	0	0	15
	26-50	0	2	2	2	0	0	0	0	7
	51-75	0	2	2	7	0	0	2	0	14
	76+	7	2	0	5	0	0	2	0	17
	Total	20	9	5	14	0	0	4	0	53
TOTAL	0-25	[3]45	12	14	0	0	0	0	0	71
	26-50	5	17	20	32	11	0	2	0	87
	51-75	7	39	46	100	27	2	4	0	226
	76+	83	64	50	78	31	2	4	2	315
	Total	140	132	131	211	69	5	10	2	699

[1]Columns may not add due to rounding.
[2]Based on all live trees.
[3]Includes plots classed as nonstocked aspen type.

Table 5.—*Area of aspen type in Southwestern Survey Unit of Wisconsin, by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	0	0	0	0	0	0	0	0	0
	26-50	0	0	0	2	0	0	0	0	2
	51-75	0	0	0	2	5	0	0	0	7
	76+	6	3	0	0	3	0	0	0	12
	Total	6	3	0	4	7	0	0	0	21
81-100	0-25	0	0	0	0	0	0	0	0	0
	26-50	3	3	0	4	2	0	0	0	12
	51-75	0	0	2	6	0	3	0	0	11
	76+	3	0	0	2	3	3	0	0	11
	Total	6	3	2	12	5	5	0	0	33
61-80	0-25	0	0	0	0	0	0	0	0	0
	26-50	0	0	0	0	0	0	0	0	0
	51-75	0	0	0	0	0	0	0	0	0
	76+	2	0	0	2	0	3	0	0	7
	Total	2	0	0	2	0	3	0	0	7
41-60	0-25	0	0	0	0	0	0	0	0	0
	26-50	3	0	0	0	0	0	0	0	3
	51-75	0	0	3	0	0	0	0	0	3
	76+	6	0	0	2	2	0	0	0	11
	Total	9	0	3	2	2	0	0	0	17
21-40	0-25	0	0	0	0	0	0	0	0	0
	26-50	0	0	0	0	0	0	0	0	0
	51-75	0	0	0	0	0	0	0	0	0
	76+	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0	0
TOTAL	0-25	0	0	0	0	0	0	0	0	0
	26-50	5	3	0	7	2	0	0	0	17
	51-75	0	0	5	8	5	3	0	0	21
	76+	18	3	0	6	7	5	0	0	40
	Total	23	6	5	21	14	8	0	0	78

[1]Columns may not add due to rounding.
[2]Based on all live trees.

Table 6.—*Area of aspen type in Southeastern Survey Unit of Wisconsin, by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	[3]2	0	0	0	0	0	0	0	2
	26-50	0	0	0	0	0	0	0	0	0
	51-75	0	0	0	0	2	0	0	0	2
	76+	0	0	0	0	0	0	0	0	0
	Total	2	0	0	0	2	0	0	0	5
81-100	0-25	0	0	0	0	0	0	0	0	0
	26-50	0	3	2	0	0	0	0	0	5
	51-75	0	0	8	0	5	0	0	0	13
	76+	5	6	4	0	0	0	0	0	16
	Total	5	9	14	0	5	0	0	0	33
61-80	0-25	0	0	0	0	0	0	0	0	0
	26-50	2	0	0	0	0	0	0	0	2
	51-75	3	0	0	0	0	0	0	0	3
	76+	13	3	0	3	0	0	0	0	20
	Total	19	3	0	3	0	0	0	0	25
41-60	0-25	[3]4	2	0	0	0	0	0	0	6
	26-50	0	0	3	0	0	0	0	0	3
	51-75	0	6	0	3	0	0	0	0	9
	76+	0	0	0	7	0	0	0	0	7
	Total	4	8	3	10	0	0	0	0	25
21-40	0-25	[3]2	0	0	0	0	0	0	0	2
	26-50	0	0	2	6	0	0	0	0	8
	51-75	0	0	0	0	0	0	0	0	0
	76+	0	3	3	0	0	0	0	0	6
	Total	2	3	5	6	0	0	0	0	16
TOTAL	0-25	[3]8	2	0	0	0	0	0	0	11
	26-50	2	3	8	6	0	0	0	0	18
	51-75	3	6	8	3	7	0	0	0	26
	76+	19	12	7	10	0	0	0	0	49
	Total	32	23	22	19	7	0	0	0	104

[1]Columns may not add due to rounding.
[2]Based on all live trees.
[3]Includes plots classed as nonstocked aspen type.

Table 7.—*Area of aspen type in Wisconsin by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	[3]5	0	2	4	0	0	0	0	11
	26-50	2	14	14	6	5	0	0	0	41
	51-75	8	6	9	21	7	0	0	0	51
	76+	2	10	7	4	3	0	0	0	25
	Total	17	30	31	37	14	0	0	0	129
81-100	0-25	[3]49	33	57	38	20	3	0	0	200
	26-50	22	52	65	142	60	14	4	4	364
	51-75	30	47	59	167	63	6	0	0	373
	76+	79	67	29	95	68	9	6	0	353
	Total	181	200	210	442	211	32	11	4	1,290
61-80	0-25	[3]71	16	34	34	33	2	2	4	196
	26-50	46	47	40	140	64	24	2	2	366
	51-75	39	61	40	117	85	14	4	0	360
	76+	117	37	26	88	74	22	0	0	365
	Total	272	161	140	380	257	62	8	6	1,286
41-60	0-25	[3]72	37	41	28	11	5	0	0	194
	26-50	41	33	32	40	35	18	7	0	206
	51-75	31	26	17	53	31	8	2	2	171
	76+	88	33	9	34	24	8	4	2	203
	Total	232	131	99	155	101	39	13	4	774
21-40	0-25	[3]36	29	9	4	4	2	0	0	85
	26-50	11	5	8	35	4	0	2	2	67
	51-75	0	10	9	7	0	0	0	0	26
	76+	16	21	2	9	4	2	2	0	58
	Total	63	65	29	55	13	4	4	2	236
TOTAL	0-25	[3]233	115	143	109	67	12	2	4	686
	26-50	122	152	159	364	168	56	15	8	1,044
	51-75	108	151	133	366	186	29	7	2	981
	76+	302	168	74	231	174	40	13	2	1,004
	Total	766	586	509	1,069	595	137	37	17	3,715

[1]Columns may not add due to rounding.
[2]Based on growing-stock trees only.
[3]Includes plots classed as nonstocked aspen type.

Table 8.—*Area of aspen type in Northeastern Survey Unit of Wisconsin, by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	0	0	0	2	0	0	0	0	2
	26-50	0	5	0	2	0	0	0	0	7
	51-75	0	0	4	2	0	0	0	0	7
	76+	0	2	2	2	0	0	0	0	7
	Total	0	7	7	9	0	0	0	0	23
81-100	0-25	[3]6	13	10	15	4	0	0	0	47
	26-50	0	23	13	38	11	9	2	2	99
	51-75	12	21	17	48	27	4	0	0	129
	76+	28	19	7	21	25	4	4	0	106
	Total	46	76	46	122	66	17	6	2	382
61-80	0-25	[3]15	8	13	9	9	0	0	2	57
	26-50	6	8	19	51	26	8	0	2	120
	51-75	12	15	14	38	44	2	0	0	126
	76+	49	10	13	49	38	10	0	0	168
	Total	82	42	59	148	117	20	0	4	471
41-60	0-25	[3]9	2	18	6	2	0	0	0	37
	26-50	10	6	8	18	11	6	2	0	60
	51-75	6	12	8	19	24	6	0	0	74
	76+	20	14	5	11	13	8	2	2	75
	Total	45	34	38	54	51	19	4	2	247
21-40	0-25	[3]13	6	4	2	4	0	0	0	30
	26-50	2	2	4	12	4	0	0	0	24
	51-75	0	2	4	2	0	0	0	0	8
	76+	7	5	2	2	4	2	0	0	23
	Total	22	16	14	19	13	2	0	0	86
TOTAL	0-25	[3]42	30	45	35	19	0	0	2	173
	26-50	18	45	43	122	52	23	4	4	310
	51-75	30	49	47	110	95	12	0	0	344
	76+	104	50	28	86	80	24	6	2	380
	Total	194	174	164	352	246	58	11	8	1,207

[1]Columns may not add due to rounding.
[2]Based on growing-stock trees only.
[3]Includes plots classed as nonstocked aspen type.

Table 9.—*Area of aspen type in Northwestern Survey Unit of Wisconsin, by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	0	0	0	0	0	0	0	0	0
	26-50	0	5	9	4	0	0	0	0	18
	51-75	2	0	4	13	0	0	0	0	19
	76+	2	5	2	2	0	0	0	0	11
	Total	4	10	16	19	0	0	0	0	49
81-100	0-25	[3]36	10	36	17	16	3	0	0	117
	26-50	17	12	34	77	34	2	2	2	180
	51-75	11	15	23	90	26	2	0	0	166
	76+	33	42	16	54	32	2	2	0	182
	Total	97	79	108	237	108	9	4	2	645
61-80	0-25	[3]37	7	7	16	22	2	0	2	93
	26-50	28	15	16	60	32	17	2	0	170
	51-75	19	29	9	49	30	7	2	0	146
	76+	55	17	7	29	30	12	0	0	149
	Total	138	69	38	155	114	37	4	2	558
41-60	0-25	[3]31	12	14	16	9	5	0	0	86
	26-50	26	22	7	4	17	10	5	0	91
	51-75	15	5	0	6	2	2	0	0	30
	76+	46	17	0	12	9	0	2	0	86
	Total	118	57	20	39	37	17	7	0	294
21-40	0-25	[3]9	17	0	0	0	2	0	0	29
	26-50	6	2	5	12	0	0	0	2	28
	51-75	0	0	0	2	0	0	0	0	2
	76+	4	17	0	2	0	0	0	0	23
	Total	20	37	5	16	0	2	0	2	81
TOTAL	0-25	[3]112	47	56	49	46	12	0	2	325
	26-50	77	57	70	158	83	28	9	4	487
	51-75	46	49	36	160	58	12	2	0	364
	76+	140	97	25	100	71	14	4	0	451
	Total	376	251	187	467	429	66	15	7	1,627

[1]Columns may not add due to rounding.
[2]Based on growing-stock trees only.
[3]Includes plots classed as nonstocked aspen type.

Table 10.—*Area of aspen type in Central Survey Unit of Wisconsin, by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	[3]2	0	2	0	0	0	0	0	4
	26-50	0	5	5	0	2	0	0	0	12
	51-75	2	2	0	5	2	0	0	0	12
	76+	0	2	2	0	0	0	0	0	5
	Total	5	10	9	5	4	0	0	0	32
81-100	0-25	[3]5	5	9	2	0	0	0	0	21
	26-50	2	14	14	21	11	0	0	0	62
	51-75	7	12	9	30	5	0	0	0	63
	76+	12	2	7	18	11	0	0	0	51
	Total	27	33	39	71	27	0	0	0	197
61-80	0-25	[3]15	0	14	9	2	0	2	0	41
	26-50	5	24	5	28	6	0	0	0	68
	51-75	2	17	16	27	11	2	2	0	79
	76+	10	7	7	7	7	0	0	0	38
	Total	32	48	42	71	26	2	4	0	226
41-60	0-25	[3]25	15	9	6	0	0	0	0	55
	26-50	2	5	11	16	4	2	0	0	42
	51-75	7	10	10	20	5	0	2	2	56
	76+	22	2	5	7	2	0	0	0	38
	Total	56	32	35	50	11	2	2	2	191
21-40	0-25	[3]13	5	2	2	0	0	0	0	23
	26-50	2	0	0	5	0	0	2	0	9
	51-75	0	4	2	2	0	0	0	0	9
	76+	5	0	0	5	0	0	2	0	12
	Total	20	9	5	14	0	0	4	0	53
TOTAL	0-25	[3]60	24	37	19	2	0	2	0	144
	26-50	12	47	35	70	24	2	2	0	193
	51-75	19	45	37	84	22	2	4	2	218
	76+	49	14	21	37	21	0	2	0	144
	Total	140	132	131	211	69	5	10	2	699

[1]Columns may not add due to rounding.
[2]Based on growing-stock trees only.
[3]Includes plots classed as nonstocked aspen type.

Table 11.—*Area of aspen type in Southwestern Wisconsin, Survey Unit by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	0	0	0	2	0	0	0	0	2
	26-50	2	0	0	0	0	0	0	0	2
	51-75	3	3	0	2	5	0	0	0	13
	76+	0	0	0	0	3	0	0	0	3
	Total	6	3	0	4	7	0	0	0	21
81-100	0-25	[3]3	3	0	4	0	0	0	0	9
	26-50	0	0	0	7	2	3	0	0	11
	51-75	0	0	2	0	3	0	0	0	5
	76+	3	0	0	2	0	3	0	0	8
	Total	6	3	2	12	5	5	0	0	33
61-80	0-25	0	0	0	0	0	0	0	0	0
	26-50	2	0	0	0	0	0	0	0	2
	51-75	0	0	0	2	0	3	0	0	5
	76+	0	0	0	0	0	0	0	0	0
	Total	2	0	0	2	0	3	0	0	7
41-60	0-25	[3]3	0	0	0	0	0	0	0	3
	26-50	3	0	3	2	2	0	0	0	10
	51-75	3	0	0	0	0	0	0	0	3
	76+	0	0	0	0	0	0	0	0	0
	Total	9	0	3	2	2	0	0	0	17
21-40	0-25	0	0	0	0	0	0	0	0	0
	26-50	0	0	0	0	0	0	0	0	0
	51-75	0	0	0	0	0	0	0	0	0
	76+	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0	0
TOTAL	0-25	[3]6	3	0	6	0	0	0	0	14
	26-50	7	0	3	9	4	3	0	0	26
	51-75	7	3	2	4	7	3	0	0	26
	76+	3	0	0	2	3	3	0	0	11
	Total	23	6	5	21	14	8	0	0	78

[1]Columns may not add due to rounding.
[2]Based on growing-stock trees only.
[3]Includes plots classed as nonstocked aspen type.

Table 12.—*Area of aspen type in Southeastern Survey Unit of Wisconsin by stand age class, potential site productivity class, and percent-of-achievement class, 1968 survey*[1]

Potential cubic feet/ acre/year	Potential achieved[2]	Stand Age 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	All ages
	Percent	*Thousand acres*								
101-120	0-25	[3]2	0	0	0	0	0	0	0	2
	26-50	0	0	0	0	2	0	0	0	2
	51-75	0	0	0	0	0	0	0	0	0
	76+	0	0	0	0	0	0	0	0	0
	Total	2	0	0	0	3	0	0	0	5
81-100	0-25	[3]0	3	2	0	0	0	0	0	5
	26-50	3	3	4	0	2	0	0	0	12
	51-75	0	0	8	0	3	0	0	0	11
	76+	3	3	0	0	0	0	0	0	6
	Total	5	9	14	0	5	0	0	0	33
61-80	0-25	[3]5	0	0	0	0	0	0	0	5
	26-50	5	0	0	0	0	0	0	0	5
	51-75	5	0	0	0	0	0	0	0	5
	76+	3	3	0	3	0	0	0	0	9
	Total	19	3	0	3	0	0	0	0	25
41-60	0-25	[3]4	8	0	0	0	0	0	0	12
	26-50	0	0	3	0	0	0	0	0	3
	51-75	0	0	0	7	0	0	0	0	7
	76+	0	0	0	3	0	0	0	0	3
	Total	4	8	3	10	0	0	0	0	25
21-40	0-25	[3]2	0	2	0	0	0	0	0	4
	26-50	0	0	0	6	0	0	0	0	6
	51-75	0	3	3	0	0	0	0	0	6
	76+	0	0	0	0	0	0	0	0	0
	Total	2	3	5	6	0	0	0	0	16
TOTAL	0-25	[3]13	11	5	0	0	0	0	0	29
	26-50	8	3	7	6	4	0	0	0	28
	51-75	5	3	10	7	3	0	0	0	29
	76+	6	6	0	6	0	0	0	0	18
	Total	32	23	22	19	7	0	0	0	104

[1]Columns may not add due to rounding.
[2]Based on growing-stock trees only.
[3]Includes plots classed as nonstocked aspen type.

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