WOOD RESOURCE

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Aspen has not been cut extensively in the West; in fact, it has been grossly underutilized. For example, as recently as 1975, the aspen harvest from National Forests in four Forest Service regions in the Rocky Mountain area was 7.64 million board feet.[1] Additional minor volumes were cut on special-use permits for products such as fuel and corral poles. The total amount cut represented only 0.1% of the net volume available in these aspen forests.

Supply

There are 4.4 million acres of commercial aspen forest in the West (Green and Van Hooser 1983). More than one-half is in Colorado (table 1). Commercial forest land is that on which cutting is permitted, and which can produce, under management, at least 20 cubic feet of industrial wood per acre annually.

Earlier publications (Choate 1963, 1965, 1966; Miller and Choate 1964; Spencer 1966), reported more acreage of commercial aspen forest. The change is a result of reclassification of aspen acreage from commercial to noncommercial after site productivity was reevaluated and after harvesting on some lands was prohibited.

[1]Information provided by USDA Forest Service Intermountain, Northern, Rocky Mountain, and Southwestern Regional Offices.

The net bole volume of aspen growing stock[2] in the interior West was nearly 4.25 billion cubic feet in 1977 (table 2). More than 70% was in Colorado and Utah. It included pure aspen stands as well as aspen mixed with conifers, even though the latter are not classed as aspen. The net volume of sawtimber on commercial forest land in the West is shown in table 3. These data emphasize the relatively small diameter of most aspen sawtimber.

Basal Area

Basal area is a measure of how densely a stand of trees occupies an area. It is better than tree population as a measure of site occupancy, because it is less dependent upon tree size. Basal area and number of trees together are better than either considered alone.

Baker (1925) showed basal area increasing both with age and with site quality. His tables were based on a large, but localized sample. The relationships are somewhat exaggerated, because the tables included only

[2]Growing stock trees are live trees in all size classes that meet the standards of quality and vigor. Cull trees, because of decay or poor form, or trees of very poor vigor are not included. Growing stock volume is the bole volume, in cubic feet, of those trees from the stump to a 4-inch (10-cm) diameter, with deductions for rot (Green and Van Hooser 1983).

Table 1.—Area (in thousands of acres) of aspen forest type by stand size class on commercial timberland[1] in the West (Greene and Van Hooser 1983).

	Sawtimber	Poletimber	Stand size class[2] Saplings	Nonstocked	All classes
Colorado	664.1	1,447.7	378.5	363.4	2,853.7
Utah	235.6	352.6	98.7	30.1	717.0
New Mexico	168.6	138.8	31.0	—	338.4
Wyoming	67.5	79.8	39.3	23.7	210.3
Arizona	41.6	34.9	35.6	—	112.1
Idaho	23.0	39.1	36.4	—	98.5
Montana	0.6	21.6	21.8	0.3	44.3
Nevada	6.5	—	—	—	6.5
Western South Dakota	14.7	4.0	2.0	—	20.7
Total	1,222.2	2,118.5	643.3	417.5	4,401.5

[1]Commercial timberland is forest land capable of producing at least 20 cubic feet of industrial wood per acre per year and not reserved for uses which are not compatible with timber production.

[2]Stand size class is determined by the predominant size in the stand. Aspen trees in the West classed as sawtimber are 11 inches d.b.h. or larger; poletimber trees are 5 to 11 inches d.b.h.; and saplings are 1 to 5 inches d.b.h. Sawtimber stands are at least 10% stocked with growing stock trees, with 50% or more in sawtimber or poletimber, and with sawtimber at least equal to poletimber. Poletimber stands have the same stocking requirements, except poletimber stocking exceeds sawtimber. Sapling/seedling stands have the same stocking requirements, except more than 50% of the stocking is in saplings and/or seedlings.

Table 2.—Net volume[1] (in millions of cubic feet) of aspen growing stock on commercial timberland in the West (Greene and Van Hooser 1983)

	Diameter class (*inches*)											
	5.0–6.0	7.0–8.0	9.0–10.9	11.0–12.0	13.0–14.9	15.0–16.9	17.0–18.9	19.0–20.9	21.0–22.9	23.0–24.9	≧25	All classes
Colorado	338.9	640.6	567.1	351.8	200.8	108.2	59.9	30.5	5.9	6.2	0.3	2,310.2
Utah	155.3	179.4	133.8	119.8	72.5	43.0	22.8	6.1	4.7	3.2	1.6	742.2
New Mexico	101.9	120.0	108.7	95.0	65.6	48.4	32.2	17.8	9.5	0.1	0	599.2
Wyoming	56.3	51.1	51.8	10.7	19.1	7.7	2.3	0.1	0	0	0	199.1
Arizona	27.8	32.2	33.7	39.0	32.0	21.2	16.3	9.2	6.0	1.0	1.2	219.6
Idaho	16.0	20.6	15.3	16.1	7.9	1.2	0.6	0	0	0	0	77.7
Montana	13.0	18.2	13.8	9.4	2.7	2.6	1.1	1.1	0	([2])	0	61.9
Nevada	3.0	2.1	2.1	3.4	1.5	0.1	0.1	0.1	([2])	0	0	12.4
Western South Dakota	4.6	2.3	1.2	0.3	0	0	0	0	0	0	0	8.4
Total	716.8	1,066.5	927.5	645.5	402.1	232.4	135.3	64.9	26.1	10.5	3.1	4,230.7

[1]*After deduction for rot and defect. To a 4-inch (10-cm) top diameter.*
[2]*Less than 0.05 million cubic feet.*

Table 3.—Net volume (in millions of cubic feet) of sawtimber on commercial forest land in 1977, International 1/4 inch rule (Green and Van Hooser 1983)

	Diameter class (*inches*)								
State	12	14	16	18	20	22	24	≧25	All classes
Colorado	1,780.3	1,027.5	570.2	325.9	168.6	32.0	34.9	2.1	3,941.5
New Mexico	533.0	387.0	288.3	193.9	110.6	59.9	0.7	0	1,573.4
Utah	555.4	342.5	211.2	112.4	29.9	24.1	16.7	9.1	1,301.3
Arizona	194.8	163.4	109.4	86.9	50.3	31.9	5.1	5.9	647.7
Wyoming	62.2	135.0	56.9	13.5	0.6	0	0	0	268.2
Idaho	76.5	37.1	5.4	2.4	0	0	0	0	121.4
Montana	47.0	14.8	13.0	5.3	6.3	0	0.2	0	86.6
Nevada	14.9	6.6	0.4	0.4	0.2	0.1	0	0	22.6
Western South Dakota	1.5	0	0	0	0	0	0	0	1.5
Total	3,265.6	2,113.9	1,254.8	740.7	366.5	148.0	57.6	17.1	7,964.2

trees 4 inches (10 cm) d.b.h. and larger; the proportion of these trees in the stand also increased with both age and site quality. However, his data for stands of 90 years and older, on site classes 1 through 3 were essentially free of bias, because even-aged, mature stands on such sites have very few trees smaller than 4 inches (10 cm) d.b.h. His basal area (in square feet per acre) data for these site classes follow.

Age	Site class		
(years)	1	2	3
90	161	146	128
110	172	158	138
130	181	166	146

Extensive sampling in Saskatchewan, showed a similar correlation of basal area with site and age (Kirby et al. 1957).

Basal areas vary widely among stands, even among clones within a stand (Jones and Trujillo 1975a, Wall 1971). Basal areas tended to be greater in Newfoundland and Alaska than in central Canada, and greater in central Canada than in the Lake States (Page 1972). Basal areas in Saskatchewan (Kirby et al. 1957) were substantially less than those of central Utah stands with similar height growth rates (Baker 1925).

Basal areas encountered while sampling hundreds of aspen stands in Utah and Idaho ranged from about 30 to 250 square feet per acre.[3] In Colorado, southern Wyoming, and northeastern Utah, basal areas in sampled pure aspen stands ranged from 10 to 380 square feet per acre.[4] In mixed stands in Arizona, Reynolds (1969) found 299 square feet of aspen in an aspen-ponderosa pine mix that had a total basal area of 460 square feet per acre. In general, before an aspen stand deteriorates in old age, most single-storied aspen stands in the West seem to be near maximum stocking for the particular combination of age, site, and clone.

[3]*Unpublished data on file at the Intermountain Forest and Range Experiment Station's Forestry Sciences Laboratory, Logan, Utah.*
[4]*Unpublished data collected by H. Todd Mowrer, and Wayne D. Shepperd, on file at the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.*

Measuring and Predicting Volume and Growth

Biomass is a useful concept for expressing ecosystem productivity, especially in ecosystem modeling. In the strictest sense, biomass is the total weight of organic matter per unit of space in an ecosystem. Commonly, however, it is used with respect to a single component of the vegetation (Ford-Robertson 1971). Too frequently, because of the difficulty of determining the dry weight of root systems, biomass data do not include roots. When only the aboveground standing crop of trees is considered, without regard to other parts of the biotic community, the concept of biomass is compromised. In such cases, "aboveground dry weight of trees" is the correct term.

Equations have been developed for estimating the ovendry weight of various aboveground components of aspen trees using simple measurements of height and diameter (Bartos and Johnston 1978, Bella 1968, Schlaegel 1975a, Zavitkovski 1971). Some, such as Bartos and Johnston (1978), found diameter alone to be the dominant variable. They developed exponential curves, with R^2 values of 0.997, of above-ground tree "biomass" as a function only of diameter at breast height.

Using Schlaegel's equations, the aboveground dry weight per acre of each diameter class and of entire overstory stands also can be estimated. In addition, Schlaegel (1975a) presented equations for cubic volume and green weight, and tables for each of those variables.

The aboveground dry weight per acre has been estimated for a few stands and sites in the West and elsewhere (table 4). Extremely high values, probably near maximum, of basal area and biomass are illustrated in figure 1.

Volume

The volume of usable wood in a stand, called "net volume," strongly influences what management operations are economically feasible. On a regional basis, it also is important for determining what manufacturing facilities are feasible in the area (see the WOOD UTILIZATION chapter). Therefore, efficient and accurate methods of estimating net volume of standing trees are important.

Usually, net volume estimates are obtained in two steps. First, the gross volume of that portion of the bole large enough for the products of interest is estimated. Second, the gross volume is reduced by a factor, based on observable defects such as crooks, external indications of decay, and local experience. For example, Hinds (1963) produced a guide for estimating cull caused by heartrot of aspen that is based on the number and location of *Phellinus tremulae* conks.

Gross volume estimates usually are based upon measurements of diameter and tree height. Depending upon the system used, height is expressed as total tree height or as the number of log lengths that can be cut from a tree to a specified top diameter, assuming no defects.

Table 4.—The aboveground ovendry weight of aspen in various stands.

Location	Description		Weight (lb/acre)	Reference
Northern Utah	Includes leaves and dead wood.			
	Average age 48 years, height 23 feet, 4.6 inches d.b.h.		55,000	Bartos and Johnston (1978)
	47 years, 36 feet, 5.3 inches		83,000	
Western Wyoming	116 years, 42 feet, 8.7 inches		78,000	
Manitoba	13 years old, 25 feet tall, no leaves.		31,800	Bella and Jarvis (1967)
Minnesota	Trees with leaves, down timber, undergrowth.		203,590	Bray and Dudkiewicz (1963)
	Standing overstory trees only.		184,470	
Escudilla Mt., Arizona	Standing live trees including leaves	*Dominant height*		Jones and Trujillo (1975a)
	All stands 22 years old, heavily stocked.	39 feet	113,900	
		35 feet	68,900	
		31 feet	48,400	
Alberta	Stand 55 years old.		259,000	Peterson et al. (1970)
Ontario	Site index 90 at base age 50.	*Stand age*		Pollard (1971)
	Live trees, not including leaves.	4 years	15,300	
		5 years	21,500	
		6 years	28,200	
		7 years	30,500	
Ontario	Site index 75 at base age 50. Stand 50 years old. Apparently live trees only, no leaves.		81,900	Pollard (1972a)

Kemp[5] developed equations in 1958 that are used by the Forest Service to estimate gross volumes of standing aspen in the northern portion of the interior (table 5) West. Table 6 is one of several tables derived from those equations. Equations and tables developed by Hatch[6] have been used for the aspen in northern Utah. Although they have not been published, the tables by Kemp and by Hatch probably are the best currently available for the areas in which they are used for inventory purposes.[7]

Edminster et al. (1982) developed volume tables from a very large and widely distributed sample of aspen in Colorado. A useful one for sawtimber volume estimation is shown as table 7. Hann and Bare (1978a) developed a more versatile system for estimating the volumes of aspen based on data from northern New Mexico. It allows for forked and damaged trees, separately, and accommodates various standards of top utilization as well as different log rules. A companion publication (Hann and Bare 1978b) gives volume tables for unforked trees. However, because of sample size limitations, the equations should be used with caution for larger trees (greater than 10 inches d.b.h.).

Shepperd and Mowrer (1984) developed whole stand volume tables from the equations in Edminster et al. (1982), which predict stand volumes for aspen, given average stand basal area and average stand height. These tables allow quick stand volume estimates to be made from simple cruise data.

[5]*Kemp, P. D. 1958. Volume tables for western tree species. (Unpaged.) Intermountain Forest and Range Experiment Station, Ogden, Utah.*

[6]*Hatch, Charles. Volume equations for several species, including aspen, on the Salmon and Ashley National Forests; on file at the Intermountain Forest and Range Experiment Station, Ogden, Utah.*

[7]*Personal communication with David C. Chojnacky, Renewable Resources Evaluation Unit, Intermountain Forest and Range Experiment Station, Ogden, Utah.*

Figure 1.—A 0.1-acre plot selected to represent maximum stocking for aspen. Age 162 years, tallest trees 121 feet. Not including understory conifers, the stocking was: basal area 411 square feet per acre; dry weight (without leaves or roots) 700,800 pounds per acre; gross volume (International 1/4 inch rule) 115,500 board feet per acre. Site index was 78 feet at 80 years, which is good but not exceptional in the Southwest. Apache National Forest, Arizona.

Yield Equations and Tables

Yield equations and tables are used to predict the wood producing capacity of forest sites. Empirical yield tables are made with data from plots selected with few criteria of stocking or condition except that the site be considered forested. An empirical table represents approximately average conditions for the area.

Baker (1925) provided an empirical yield table for even-aged stands of aspen in the West (table 8). It shows gross volumes expected at different ages on sites of different qualities. Because aspen trees are relatively small, and because defects such as cull and crook are common, aspen stands that have a net yield of 12,000 board feet per acre (29,650 board feet per ha) are considered good.

Baker collected his data over several years, beginning in 1912. They are from a single area largely in central Utah, with a working radius feasible for the primitive travel common at the time.[8] His values seem too low for similar site classes in Colorado, Arizona, and New Mexico. A more recent study of volume production and decay losses in Colorado, on site classes 1 and 2, showed considerably more volume production (Hinds and Wengert 1977).

Yield tables and equations usually are keyed to site classes or indexes, defined by the heights of dominant trees at a given age. Baker made his site class table using early techniques. The site index curves that result from graphing these tabular values look rather unusual. Therefore, new site index curves and a table were made from stem analysis on widely distributed plots in Colorado and New Mexico (Jones 1966, 1967a). However, new yield data were not taken. Use of Jones's site index curves with Baker's yield tables result in predicted yields that appear too low for Colorado or New Mexico. Edminster et al. (1985) developed new site index curves for aspen in the central Rocky Mountains (fig. 2), which are more compatible with current forest inventory procedures.

Empirical yield equations made with data from unmanaged stands usually are not well suited for characterizing yield capacity of managed stands. The stocking and structure of mature unmanaged stands, especially overmature stands, are too irregular. Judging from tables in Green and Setzer (1974), the rough corrections used to adjust for this are not satisfactory. Because of the impacts of diseases and subsequent mortality in partially cut aspen stands (see the INTERMEDIATE TREATMENTS chapter), artificial density control actually may decrease yields (Walters et al. 1982).

More accurate yield equations and tables need to be developed with better data over the range of variability of aspen in the West. A better measure of net volume in aspen needs to be made for the western States. A new system also is needed to characterize sites and predict

[8]*Correspondence with F.S. Baker, on file at the Rocky Mountain Forest and Range Experiment Station's Forestry Sciences Laboratory, Flagstaff, Ariz.*

Table 5.—Equations for estimating gross cubic feet and board feet of standing aspen boles in the West.[1]

Volume Statistic	Equations[2]
Cubic feet, trees up to 20.9 inches d.b.h.	$V = -0.343 + 0.224 (D^2H/100)$
Cubic feet, trees 21 inches d.b.h. or larger	$V = 1.071 + 0.217 (D^2H/100)$
Board feet, International 1/4-inch rule, trees up to 20.9 inches d.b.h.	$V = -9.547 + 1.309 (D^2H/100)$
Board feet, International 1/4-inch rule, trees 21 inches d.b.h. or larger	$V = -12.441 + 1.325 (D^2H/100)$
Board feet, Scribner rule, trees up to 20.9 inches d.b.h.	$V = -18.544 + 1.197 (D^2H/100)$
Board feet, Scribner rule, trees 21 inches d.b.h. or larger	$V = -21.309 + 1.216 (D^2/H/100)$

[1]*Kemp, P. D. 1958. Volume tables for western tree species. (Unpaged.) Intermountain Forest and Range Experiment Station, Ogden, Utah.*
[2]*V = volume to a variable top diameter*
D = diameter breast high (inches)
H = total tree height (feet).

Table 6.—Board-foot volumes for aspen to a variable top, Scribner rule.[1]

	Total height (*feet*)									
d.b.h.	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**
(inches)										
11	39	54	68	83	97	112	125			
12	50	68	85	102	119	137	154	171		
13	62	83	103	123	143	164	184	204		
14		99	122	146	169	193	216	240	263	
15		116	143	170	197	224	251	278	305	
16			165	196	227	257	288	319	349	
17			189	224	258	293	327	362	397	431
18			214	253	292	331	369	408	447	486
19				284	327	370	414	457	500	543
20				317	364	412	460	508	556	604
21				354	408	461	515	569	622	676
22				391	450	508	567	626	685	744
23				429	493	558	622	686	751	815
24				469	539	609	679	749	819	889
25				511	587	663	739	815	891	967
26					636	719	801	883	965	1,047
27					687	777	865	954	1,042	1,131
28					741	837	932	1,027	1,122	1,218
29					797	899	1,001	1,104	1,206	1,308
30					854	964	1,073	1,183	1,292	1,401

[1]*Kemp, P. D. 1958. Volume tables for western tree species. (Unpaged.) Intermountain Forest and Range Experiment Station, Ogden, Utah.*

yield on aspen land in the West. The system should accommodate stands managed at different stocking levels, as well as stands receiving no management other than periodic clearcutting and controlled livestock use. A recently completed whole stand model for even-aged aspen stands should provide growth and yield information for a wide variety of stand densities and site index classes.[9]

[9]*Edminster, Carleton B., and H. Todd Mowrer. 1985. Growth and yield relationships for aspen in the central Rocky Mountains. Manuscript in preparation, intended for publication by the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.*

Counting Aspen Growth Rings

One of the fundamental activities required to collect new or updated inventory information is estimating tree ages, even though aspen rings are notoriously difficult to count. For this reason, different methods are discussed here briefly.

Increment cores usually are used to determine aspen age. However, increment coring can cause discoloration and decay of the tree in the vicinity of the core, especial-

Table 7.—Board-foot volume, Scribner rule, to a 6-inch top diameter inside bark, for aspen in Colorado (Edminster et al. 1982).

d.b.h.	Total height (*feet*) above ground: 30	40	50	60	70	80	90	100	Basis: trees
(*inches*)									
7	8	8	12	18	24	31			94
8	8	12	21	29	37	45			84
9	10	21	31	41	51	62			107
10	17	30	42	55	67	80	91		96
11	25	40	55	70	84	98	112		82
12	33	51	68	86	102	118	134		92
13		63	83	102	121	140	158	177	78
14		75	97	119	141	163	184	206	56
15		88	113	138	163	188	212	237	50
16		101	130	158	186	214	242	270	37
17			147	179	210	242	274	306	27
18			166	201	237	272	307	343	17
19			185	225	264	303	343	382	14
20			206	250	293	336	380	423	8
21			228	276	323	371	419	467	5
22				303	355	408	460	512	3
23				331	389	446	503	560	2
24				361	423	485	548	610	0
25					460	527	594	661	0
Basis: trees:	1	16	88	253	319	138	31	6	852

Block indicates extent of data.

Computed from: $V = 8$ for D^2H to 2,500;
$V = 0.011389D^2H - 20.5112$ for D^2H larger than 2,500 to 8,850;
$V = 0.010344D^2H - 11.2615$ for D^2H larger than 8,850.

Standard errors of estimate: ±7.1 board feet (±16.73% of mean); ±27.9 board feet (±19.33% of mean).

Coefficients of determination: 0.9021; 0.8696.

Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 8.—Empirical yield table for even-aged aspen stands (Baker 1925).[1]

	SITE 1 Volume per acre			SITE 2 Volume per acre			SITE 3 Volume per acre			SITE 4 Volume per acre		
Age	Basal area (*ft*²)	Total (*ft*³)	Saw-timber[2] (*bd ft*)	Basal area (*ft*²)	Total (*ft*³)	Saw-timber[2] (*bd ft*)	Basal area (*ft*²)	Total (*ft*³)	Saw-timber[2] (*bd ft*)	Basal area (*ft*²)	Total (*ft*³)	Saw-timber[2] (*bd ft*)
30	76	300	--	14	--	--	--	--	--	--	--	--
40	124	1,350	--	78	500	--	--	--	--	--	--	--
50	136	2,250	600	114	1,350	--	72	500	--	--	--	--
60	144	3,000	2,600	124	2,100	600	104	1,300	--	70	400	--
70	148	3,550	4,800	132	2,750	2,000	114	1,950	150	92	1,000	--
80	154	4,050	6,800	140	3,250	3,400	122	2,500	1,000	104	1,600	200
90	161	4,500	9,000	146	3,650	4,800	128	2,950	1,600	110	2,050	300
100	166	4,850	11,000	152	4,000	6,200	134	3,300	2,200	116	2,400	400
110	172	5,100	13,200	158	4,300	7,600	138	3,600	2,800	120	2,700	600
120	177	5,350	15,400	162	4,550	9,000	142	3,850	3,600	124	2,950	800
130	181	5,600	17,400	166	4,750	10,400	146	4,050	4,200	--	--	--
140	184	5,950	19,600	170	4,900	11,800	--	--	--	--	--	--
150	186	6,100	21,600	--	--	--	--	--	--	--	--	--

[1]*Includes only trees more than 4 inches (10 cm) d.b.h. All volumes are gross, without deductions for cull or form.*
[2]*Includes all trees 10 inches (25 cm) d.b.h. and larger. Merchantable length taken to a 9-inch top diameter.*

ly if the wound does not heal (LaFlamme 1979). Cross sections are better but usually are not practical to obtain.

Lynn (1964) heated cores in aluminum foil holders until the cores turned brown. Brace (1966) and Maini and Coupland (1964) reported that soaking cores in water made the rings more visible. Svoboda and Gullion (1972) used an inexpensive but satisfactory technique to underlight cores, using transmitted light rather than reflected light to count the rings. Rose (1957) soaked cores in light-weight penetrating oil for 1 week; the oil-impregnated cores became translucent, and the rings were easily counted using transmitted light. He found that a vacuum decreased the time required for oil impregnation to minutes. Jones (1967b) experimented with several wetting agents including benzidine, kerosene, light machine oil, water, and saliva.

A properly shaved surface will accentuate the rings. Trujillo (1975) found a vise attached to the tailgate of a pickup truck was a convenient accessory for shaving cores in the field. A sharp utility knife gave good results. Then the cores were oven-dried for 48 hours at 212°F (100°C). A cloth moistened with a 4% solution of pentachlorophenol in kerosene or mineral spirits was wiped lightly on the shaved side of the oven-dried cores, which were then redried at 212°F (100°C) for 4 hours. Counting was done with a binocular microscope using top lighting. After 1 year of storage, the rings still could be easily counted.

Campbell (1981) suggested three main sources of error for age determination of aspen cores: (1) narrow rings, (2) pith and central rings not present in the core, and (3) estimating the tree's age at core height. Generally, the margin of error for each of the three sources can be reduced substantially by boring the tree close to the ground on the uphill or concave side of any butt sweep. The resulting core will contain the tree's widest rings, will usually contain the pith or lack only a few central rings, and will have fewer years to estimate for the age at core height. Cores are stored in plastic drinking straws.

For laboratory analysis, Campbell (1981) recommended first soaking an aspen core in a wetting solution of water, methanol, and detergent. Next, clamp the core in a vise and shave it transversely across the vessel elements with a razor blade. Then illuminate the translucent core with fluorescent lighting from above and below and use a dissecting scope to count the rings. The

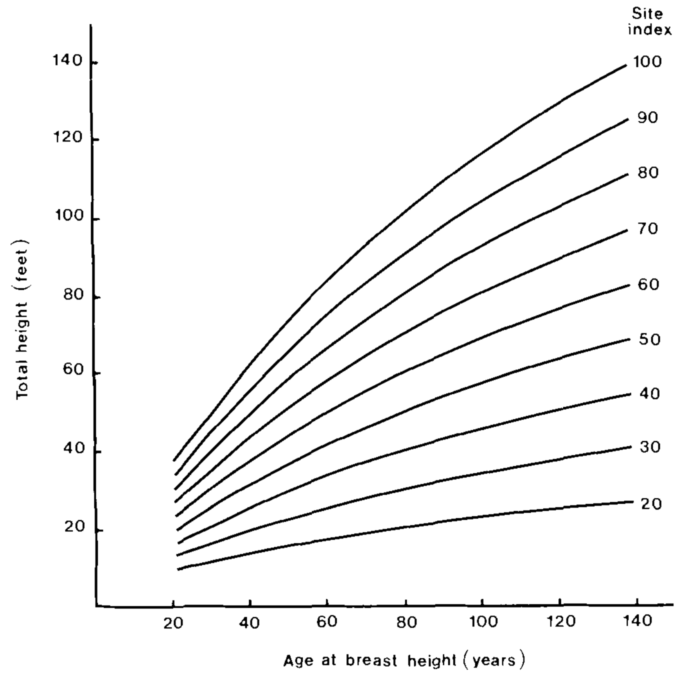

Figure 2.—Site index curves for aspen in the central Rocky Mountains. Base age 80 years after reaching breast height (Edminster et al. 1985).

tree's total age equals the sum of the rings actually counted, the years estimated to reach core height, and if the pith is absent, the estimated number of missing rings to the center.

If stem cross sections are available, they may be split through the pith, and one or more radii beveled with a sharp utility knife to facilitate ring counts. Normally, it is impossible to determine the age of decayed sections by ordinary methods, even when they are carefully prepared (Kirby 1953). Some will fall apart if they are oven-dried. Ghent (1954) described a way of impregnating decayed cross sections with paraffin wax before counting.

The only false rings Jones has observed probably resulted from outbreaks of the western tent caterpillar or other defoliating insects.[10] Maini and Coupland (1964) found false rings in aspen in the Canadian prairie-forest transition; false rings might be anticipated in similar fringe habitats of the interior western United States.

[10]Personal observations by John R. Jones, Rocky Mountain Forest and Range Experiment Station, Forestry Sciences Laboratory, Flagstaff, Ariz.