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Green Above-Stump Weights for Red Oak, Red Maple, and White Birch in Northern Michigan

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GREEN ABOVE-STUMP WEIGHTS FOR RED OAK, RED MAPLE, AND WHITE BIRCH IN NORTHERN MICHIGAN

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The trend toward more fully mechanized whole-tree chipping has created a need for information concerning green tree weights. For example, it is presently common to use net green weight of chips as a measurement for the basis of payment to the logger in whole-tree harvesting, rather than cord, board-foot, or cubic-foot measures.

Green weight tables for the above-stump portions of trees by species, d.b.h., and tree height are necessary to obtain preharvest estimates of biomass to be removed from the forest in chipping operations. Such tables are also essential for studying the cost and productivity of the felling/bunching, skidding, chipping, and transporting phases of chip-harvesting operations. Therefore, green weight tables are becoming a required tool for studying and analyzing whole-tree logging operations.

Weight tables for several tree species have been published for areas outside the Lake States. Young's work in Maine (Young *et al.* 1980), Monteith's in New York (Monteith 1979), and Moehring's in the South (Moehring *et al.* 1973) provide excellent information for biomass research and logging applications. Green-weight tables for the above-stump portions of five northern Michigan tree species have been published (Steinhilb and Erickson 1970, 1972; Steinhilb and Winsauer 1976; Winsauer and Steinhilb 1981). This paper provides above-stump green-weight information, including foliage, for three additional northern Michigan species commonly chipped for fiber and energy production: red oak (*Quercus rubra*), red maple (*Acer rubrum*), and white birch (*Betula papyrifera*).

THE STUDY

Two mixed hardwood stands containing pole-sized and small sawtimber trees were selected for study in Baraga County, Michigan. These stands had an average basal area of 105 sq ft/acre (24.15 m/ha) in trees 2 inches (5.1 cm) d.b.h. and larger. Tree d.b.h. ranged from 2 inches (5.1 cm) through 20 inches (50.8 cm), with an average d.b.h. of 4.8 inches (12.2 cm). The most prevalent tree species were red maple, red oak, quaking aspen (*Populus tremuloides*), and white birch, with smaller amounts of red (*Pinus resinosa*) and white pine (*P. strobus*), sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), and hemlock (*Tsuga canadensis*). Age of the stands was 65 years. Site index was 60 for both red oak and red pine.

Personnel from the Forestry Sciences Laboratories at Marquette and Houghton, Michigan, and the School of Forestry and Wood Products at Michigan Technological University, Houghton, Michigan, cooperated to conduct the study in the fall of 1980. The Pettibone Corporation¹ of Baraga, Michigan, provided a rubber-tired cable skidder to move the trees from the stump to the weighing area.

¹The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. It does not constitute an official endorsement or approval of any product or service by the United States Department of Agriculture to the exclusion of others which may be suitable.

FIELD PROCEDURES

All red maple, red oak, and white birch trees within 5 feet of transects that were run through the stands were numbered with paint; species and d.b.h. were recorded. From the list of recorded trees, 30 to 40 trees of each species were selected for weighing; an attempt was made to select approximately equal numbers of trees (three to four) in each diameter class. Data were collected for 36 red oak, 33 white birch, and 48 red maple trees (table 1). Sample trees were felled by a chain saw and skidded to a nearby open area for weighing.

The height of each tree from butt to tip and the bole length from butt to a 4.0-inch (10.2-cm) top diameter outside bark was measured and recorded. The entire above-stump portion of the tree was then weighed within a few hours of felling by suspending it from a knuckle boom loader mounted on a small wheeled skidder (fig. 1). The loader boom was equipped with a load cell located between the log grapple and the boom. (The load cell had an accuracy of ± 0.5 percent of the load being weighed.) The tree was then lowered to the ground, all limbs removed from the bole, and the top severed at 4.0 inches (10.2 cm) diameter outside bark. The delimbed bole was then suspended and the green weight recorded. The difference between the above-stump tree weight and the bole weight was considered to be residue weight.

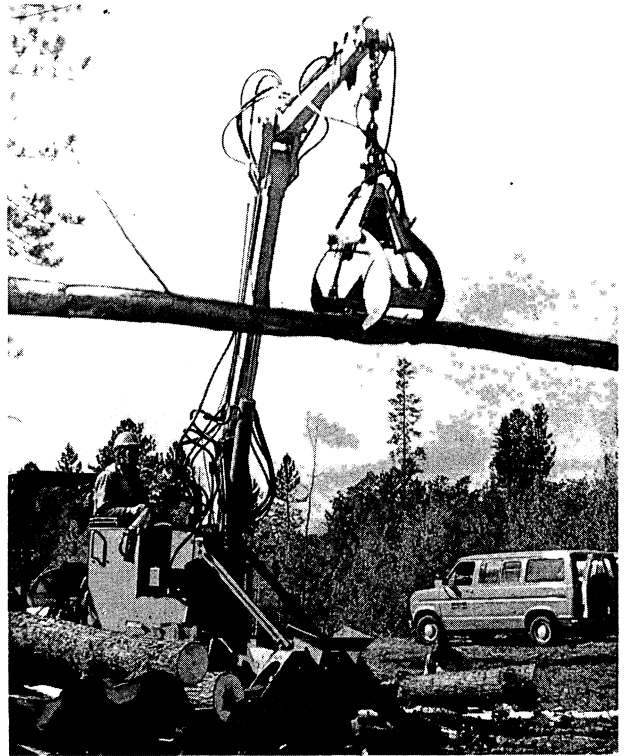


Figure 1.—Method and equipment for weighing trees.

Bole weight—The green weight of the wood and bark of the delimbed tree bole from butt to 4 inches diameter outside bark.

Residue weight—The green weight of wood, bark, and foliage of all limbs removed from the bole and the top of the tree from a diameter of 4 inches outside bark to the tip.

DEFINITIONS

Above-stump weight—The green weight of wood, bark, and foliage of the above-stump portion of the tree.

Table 1.—Range of field data

	Red maple	Red oak	White birch
D.b.h. (in.)	2.0–16.8	3.4–17.1	1.6–15.6
D.b.h. (cm)	5.1–42.7	8.6–43.4	4.1–39.6
Tree height (ft)	22–81	25–74	22–85
Tree height (m)	6.7–24.7	7.6–22.6	6.7–25.9
Green tree weight (lb)	30–4,352	60–4,738	5–3,190
Green tree weight (kg)	14–1,974.0	27.2–2,144.6	2–1,447
Bole length (ft)	7–67	10–60	3–58
Bole length (m)	2.1–20.4	3–18.3	9–17.7
Green bole weight (lb)	53–3,163	86–2,956	25–2,258
Green bole weight (kg)	24–1,434.7	39–1,340.8	11–1,024.2

ANALYTIC PROCEDURE

The data for each species were analyzed separately for above-stump green weight, bole green weight, and residue green weight. The form of the estimating equations was:

Green weight of component = $A + B(\text{d.b.h.})^2$ (tree height).

Table 2 gives the estimating equations and standard errors of estimate.

RESULTS

The green above-stump tree weights, bole weights, and residue weights for red oak are presented in table 3, red maple in table 4 and values for white birch in table 5. The area inside the lines in each table comprises the range of the field data.

Table 2.—Regression equations for estimating above-stump green weight of trees, boles, and residues for red oak, red maple, and white birch

RED OAK			
Green weight (Y) (In pounds)	Regression equation	Standard error	Number of trees sampled
Tree weight, including foliage	$Y = 2.7 + 0.198 (\text{d.b.h.})^2 (\text{tree height})$	1.18 (d.b.h.) ²	36
Bole weight to 4-inch top	$Y = -28.0 + 0.158 (\text{d.b.h.})^2 (\text{tree height})$	0.85 (d.b.h.) ²	34
Residue weight, including foliage	$Y = 19.0 + 0.044 (\text{d.b.h.})^2 (\text{tree height})$	1.22 (d.b.h.) ²	33
RED MAPLE			
Tree weight, including foliage	$Y = 19.9 + 0.164 (\text{d.b.h.})^2 (\text{tree height})$	1.45 (d.b.h.) ²	48
Bole weight to 4-inch top	$Y = -16.8 + 0.127 (\text{d.b.h.})^2 (\text{tree height})$	0.87 (d.b.h.) ²	30
Residue weight, including foliage	$Y = 46.2 + 0.034 (\text{d.b.h.})^2 (\text{tree height})$	1.16 (d.b.h.) ²	30
WHITE BIRCH			
Tree weight, including foliage	$Y = 8.7 + 0.173 (\text{d.b.h.})^2 (\text{tree height})$	1.91 (d.b.h.) ²	33
Bole weight to 4-inch top	$Y = -35.9 + 0.137 (\text{d.b.h.})^2 (\text{tree height})$	0.93 (d.b.h.) ²	25
Residue weight, including foliage	$Y = 36.2 + 0.038 (\text{d.b.h.})^2 (\text{tree height})$	1.16 (d.b.h.) ²	25

Table 3.—Red oak green weights (values inside the lines show the range of the sample data)

D. b. h class (inches)	Tree height (feet)						
	20	30	40	50	60	70	80
Green tree weight (pounds)							
2	19	26	34	42	50		
4	66	98	129	161	193	224	
6	145	217	288	359	430	502	573
8		383	510	636	763	890	1016
10		597	795	993	1191	1389	1587
12			1143	1428	1713	1999	2284
14			1555	1943	2331	2719	3107
16			2030	2537	3044	3551	4058
18			2569	3210	3852	4493	5135
20				3963	4755	5547	6339
Green bole weight (pounds)							
6		143	200	256	313	370	
8		275	376	478	579	680	781
10		446	604	762	920	1078	1236
12			882	1110	1337	1565	1792
14			1211	1520	1830	2140	2449
16			1590	1994	2399	2803	3208
18			2020	2532	3044	3555	4067
20			2500	3132	3764	4396	5028
Green residue weight (pounds)							
6		67	82	98	114	130	
8		103	132	160	188	216	244
10		151	195	239	283	327	371
12			272	336	399	463	526
14			364	450	536	623	709
16			470	582	695	807	920
18			589	732	874	1017	1159
20			723	899	1075	1251	1427

Table 4.—Red maple green weights (values inside the lines show the range of the sample data)

D. b. h. class (inches)	Tree height (feet)						
	20	30	40	50	60	70	80
Green tree weight (pounds)							
2	33	40	46	53	59		
4	72	99	125	151	177		
6	138	197	256	315	374	433	492
8	230	335	440	545	650	755	860
10	348	512	676	840	1004	1168	1332
12		728	965	1201	1437	1673	1909
14		984	1306	1627	1949	2270	2591
16			1699	2119	2539	2959	3379
18				2677	3208	3739	4271
20				3300	3956	4612	5268
Green bole weight (pounds)							
6	120	166	212	258	303		
8	227	308	390	471	552	633	
10	364	491	618	745	872	999	
12		532	715	898	1080	1263	1446
14			979	1228	1477	1726	1975
16			1284	1609	1934	2259	2584
18				2041	2452	2864	3275
20				2523	3031	3539	4047
Green residue weight (pounds)							
6	83	95	107	120	132		
8	111	133	155	177	199	220	
10	148	182	216	250	284	318	
12		193	242	291	340	389	438
14			313	379	446	513	579
16			394	481	568	655	743
18				597	707	817	927
20					862	998	1134

Table 5.—White birch green weights (values inside the lines show the range of the sample data)

D. b. h. class (inches)	Tree height (feet)						
	20	30	40	50	60	70	80
	Green tree weight (pounds)						
2	23	29	36	43	50		
4	64	92	119	147	175		
6	133	196	258	320	382	445	507
8	230	341	452	562	673	784	894
10	355	528	701	874	1047	1220	1393
12		756	1005	1254	1503	1753	2002
14		1026	1365	1704	2043	2382	2721
16		1337	1780	2223	2666	3109	3552
18			2251	2811	3372	3932	4493
20				3469	4161	4853	5545
	Green bole weight (pounds)						
6	112	161	211	260	309		
8	227	315	403	490	578		
10	375	512	649	786	923	1060	
12	556	753	951	1148	1345	1542	
14	770	1038	1307	1575	1844	2112	
16		1367	1718	2068	2419	2770	
18		1740	2184	2627	3017	3515	
20		2156	2704	3252	3800	4348	
	Green residue weight (pounds)						
6	77	91	105	118	132		
8	109	133	158	182	206	231	
10	150	188	226	264	302	340	
12	200	255	310	365	419	474	
14		334	409	483	558	632	
16		425	523	620	717	814	
18		529	652	775	898	1021	
20		644	796	948	1100	1252	

The reader is cautioned to use the tables with care, since they were constructed from samples of only 25 to 48 trees of each species collected from a limited area in Baraga County, Michigan. The most accurate estimates of biomass will probably result when the tables are applied to stands similar in age, composition, tree size, and site index.

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Green above-stump weights for red oak, red maple, and white birch in northern Michigan. Res. Pap. NC-230. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1983. 4p.

Presents the green weights of the above-stump portion of trees, boles, and residue for red oak, red maple, and white birch in northern Michigan. Estimating equations and green weight tables are included for the tree components of each species.

KEY WORDS: Red oak, red maple, white birch, tree, bole, residue, mechanized harvesting.