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Twig Diameter and Weight Relationships for Important Browse Species in Northern Minnesota

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Several studies have demonstrated that high correlations exist between weight and basal diameter of twigs of various woody species (Shafer 1963, Basile and Hutchings 1966, Telfer 1969, and Lyon 1970). This relationship is of potential value for determining utilization and production of woody browse on game ranges. Initially, a regression equation of weight on diameter at the proximal end of the current year's growth (DCG) is determined for each species by clipping and weighing about 50 unbrowsed twigs. Once the appropriate regression equation of weight on diameter is derived, field work consists of tallying browsed and unbrowsed twigs by species and diameters at the point of browsing (DPB). The mean DPB is calculated from this data, and the mean weight per browsed twig is obtained from the regression equation and multiplied by the number of browsed twigs per acre to determine the total weight of the twigs removed by browsing. A utilization estimate may be determined by dividing total weight of twigs removed by total twig weight for each species per unit area (Shafer 1963). A regression equation calculated from 50 unbrowsed twigs will produce a regression coefficient with a variation of between 10 and 20 percent at the 0.95 level of significance (Peek et al. 1971). Similarly, 50 DPB's will suffice to estimate utilization for each species in each area.

A one-thousandth-acre (3.7-foot radius) circular plot provides a convenient size within which to count twigs in the field. Only twigs over one inch long, and within the browsing range of moose or deer (6 feet above ground level for deer, 10 feet for moose) should be counted. Measurements at the Cloquet Forestry Center in two beaked hazel stands (Corylus cornuta) showed that 50 plots sufficed to establish a production-utilization estimate with a level of accuracy equal to 95% of the mean, but this will vary with the species composition and degree of aggregation of the shrub community.

Regression equations which are developed for one location for a given species may not be applicable to other locations if soil, moisture and overstory canopy closure varies. Peek et al. (1971) showed from 48 comparisons of regressions of eight woody species collected from five locations across northern Minnesota that 25 comparisons were significantly different from each other (P 0.01) and 20 comparisons differed by a margin greater than 20%, the level at which the differences were considered to have practical significance.

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This report presents regression equations for nineteen woody species of twig weight on twig diameter and length, as derived from five different sites in northern Minnesota (Tables 1 and 2). Twig length data are presented because these measurements can be obtained with a ruler rather than a vernier caliper, and may be more useful for studies involving growth and production.

Methods

Current year's growth over one inch long was clipped from several different plants of each species. As wide a range of twig sizes as possible were collected for each site. The diameter of the proximal portion of the twig and its length was measured to the nearest 0.05 cm. The twigs were oven dried in a forced draft furnace at 95° C. for 24 hours and weighed to the nearest 0.01 gram.

Study Areas

Nine species were collected from the Agassiz National Wildlife Refuge in northwestern Minnesota; the species were taken on level terrain with poorly drained peat soils and no overstory canopy. Twelve species were collected near Isabella in northeastern Minnesota on level terrain with well-drained shallow sandy soil and approximately 50 percent canopy closure of aspen-birch overstory. Eight species were collected from each of two locations in the Jonvik deer yard along the north shore of Lake Superior. One site (1968 collection) was on well-drained, shallow sandy-clay soil in an old clearing with a southerly exposure. The other site (1969 collection) was on a shallow poorly-drained sandy soil under a sparse canopy of balsam fir (Abies balsamea), northern white-cedar (Thuja occidentalis) and paper birch (Betula papyrifera).

Results and Conclusions

A general relationship existed between mean twig weights and site characteristics which is worth further investigation. Comparison of species collected on the Agassiz, Jonvik and Isabella sites shows the Populus tremuloides, P. balsamifera and Salix discolor twig weights averaged highest at Agassiz and lowest at Isabella. Cornus stolonifera twig weights averaged higher at the 1969 Jonvik site than at Agassiz or the 1968 Jonvik site, with the Isabella site again having lowest twig weights. Sorbus americana twigs also averaged considerably heavier at the Jonvik sites than at Isabella. Corylus cornuta mean weights averaged lowest for the Cloquet stands and highest for the 1969 Jonvik site.

Lengths and diameters of twigs generally paralleled trends in weights between areas. However, Cornus stolonifera, P. balsamifera and Salix discolor twigs averaged longer and narrower at Agassiz than at the Jonvik sites. Although stand characteristics under which twigs were collected varied among sites, the data suggested that inherent site differences such as soil characteristics and the prevailing climate may be reflected in twig characteristics examined. Since these species are major forage sources for various wildlife, particularly for deer and moose, it is suggested that in addition the variation in their associated nutritive contents is worth quantification.

Literature Cited

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Table 1. Summary of twig diameter and weight data from four areas in Minnesota

Location	Species	Number of Twigs Measured	Correlation Coefficient (Diameter and Weight)	Twig Length (mm) at Proximal End Mean	Twig Length (mm) at Proximal End Range	Oven Dry Weight (gms) Mean	Oven Dry Weight (gms) Range	Regression Equation
Agassiz Refuge	Cornus stolonifera	61	93	3.21	2.2-4.4	1.17	0.3-3.3	Y=0.385(d)-0.066
	Populus balsamifera	60	91	5.44	3.7-10.2	3.16	0.7-12.3	Y=0.628(d)-0.256
	Populus tremuloides	62	88	5.05	2.6-10.4	1.84	0.2-11.2	Y=0.422(d)-0.291
	Salix discolor	57	94	4.19	2.8-7.5	2.55	0.4-8.4	Y=0.676(d)-0.282
	Salix cordata	48	90	4.98	3.5-7.4	5.07	1.3-11.0	Y=1.077(d)-0.293
	Salix lucida	56	95	5.79	3.9-8.1	4.91	1.1-5.9	Y=0.903(d)-0.318
	Salix bebbiana	49	92	4.25	2.9-5.9	2.71	0.7-7.0	Y=0.669(d)-0.133
	Salix interior	46	92	3.84	2.3-5.9	2.38	0.3-7.7	Y=0.685(d)-0.250
	Salix petiolaris	55	70	4.02	2.9-5.4	2.94	1.1-6.2	Y=0.751(d)-0.007
Cloquet Center	Corylus cornuta	50	75	1.67	1.1-2.9	0.064	0.01-0.6	Y=0.042(d)+0.035
	Corylus cornuta	50	72	1.87	1.3-2.9	0.082	0.01-0.7	Y=0.046(d)+0.046
Isabella Area	Abies balsamea	51	91	3.67	2.1-7.0	1.799	0.4-8.8	Y=0.5497(d)-0.218
	Acer spicatum	59	92	3.05	2.0-4.8	0.653	0.1-2.0	Y=0.299(d)-0.045
	Amelanchier sp.	61	92	2.37	2.0-4.0	0.710	0.1-3.6	Y=0.339(d)-0.093
	Betula papyrifera	72	89	2.44	1.5-4.5	0.465	0.1-2.4	Y=0.217(d)-0.064
	Corylus cornuta	59	90	2.55	1.6-4.3	0.509	0.1-2.5	Y=0.225(d)-0.065
	Cornus stolonifera	60	92	2.90	1.5-5.6	0.988	0.1-4.7	Y=0.410(d)-0.201
	Populus tremuloides	50	95	3.13	1.8-7.7	0.597	0.1-4.4	Y=0.252(d)-0.192
	Prunus pennsylvanica	49	91	2.84	1.5-6.5	0.975	0.1-8.0	Y=0.416(d)-0.206
	Prunus virginiana	47	90	2.99	2.0-5.0	0.734	0.1-4.9	Y=0.280(d)-0.102
	Salix discolor	58	89	3.09	1.7-4.9	1.355	0.2-5.8	Y=0.477(d)-0.119
	Salix humilis	67	92	3.35	2.0-6.3	1.599	0.2-8.8	Y=0.571(d)-0.314
	Sorbus americana	58	63	4.76	2.9-7.5	1.023	0.1-4.6	Y=0.227(d)-0.058
Jonvik Deer Yard (1968 collection)	Acer spicatum	50	86	4.16	1/	0.84	1/	Y=0.210(d)-0.034
	Betula papyrifera	48	86	3.54		0.78		Y=0.231(d)-0.038
	Corylus cornuta	46	86	3.77		0.68		Y=0.196(d)-0.059
	Cornus stolonifera	48	79	3.63		1.16		Y=0.337(d)-0.063
	Populus balsamifera	50	93	5.66		2.06		Y=0.396(d)-0.183
	Populus tremuloides	48	90	4.63		1.49		Y=0.349(d)-0.129
	Salix discolor	50	96	4.04		1.81		Y=0.504(d)-0.227
	Sorbus americana	50	84	6.82		3.09		Y=0.482(d)-0.197
Jonvik Deer Yard (1969 collection)	Acer spicatum	50	83	4.32	3.0-6.1	1.08	0.4-3.5	Y=0.261(d)-0.048
	Betula papyrifera	50	94	3.81	2.2-6.2	1.18	0.2-3.8	Y=0.338(d)-0.338
	Cornus stolonifera	50	94	4.31	2.7-6.5	1.95	0.5-6.4	Y=0.489(d)-0.158
	Corylus cornuta	49	91	4.24	2.0-6.1	1.28	0.1-3.2	Y=0.319(d)-0.075
	Populus balsamifera	50	92	5.48	3.0-10.5	2.24	0.4-10.4	Y=0.477(d)-0.374
	Populus tremuloides	50	89	4.55	2.1-8.5	1.57	0.2-8.8	Y=0.400(d)-0.250
	Salix discolor	50	92	3.95	2.8-7.0	1.42	0.2-7.9	Y=0.411(d)-0.203
	Sorbus americana	50	92	7.34	4.3-13.2	4.83	0.7-21.2	Y=0.774(d)-0.854

1/ No data

Table 2. Summary of twig length weight data from four areas in Minnesota

Location	Species	Number of Twigs Measured	Correlation Coefficient (Diameter and Weight)	Twig Length (mm) at Proximal End Mean	Twig Length (mm) at Proximal End Range	Oven Dry Weight (gms) Mean	Oven Dry Weight (gms) Range	Regression Equation
Agassiz Refuge	Cornus stolonifera	61	93	39.0	19.5-66.0	1.17	0.3-3.3	Y=0.0319(L)-0.0
	Populus balsamifera	60	88	49.0	23.5-84.0	3.16	0.7-12.3	Y=0.0697(L)-0.2
	Populus tremuloides	62	75	49.5	27.9-80.9	1.84	0.2-11.2	Y=0.0417(L)-0.2
	Salix discolor	57	83	50.5	26.0-92.3	2.55	0.4-8.4	Y=0.0549(L)-0.2
	Salix cordata	48	89	67.6	31.5-99.5	5.07	1.3-11.0	Y=0.0794(L)-0.2
	Salix lucida	56	89	56.7	37.0-63.0	4.91	1.1-5.9	Y=0.0920(L)-0.3
	Salix bebbiana	49	86	54.8	29.0-81.5	2.71	0.7-7.0	Y=0.0518(L)-0.1
	Salix interior	46	88	61.3	30.0-95.8	2.38	0.3-7.7	Y=0.0430(L)-0.2
	Salix petiolaris	55	86	65.9	46.0-95.9	2.94	1.1-6.2	Y=0.0462(L)-0.1
Cloquet Center	Corylus cornuta	50	82	10.9	3.0-20.0	0.064	0.01-0.6	Y=0.0058(L)-0
	Corylus cornuta	50	79	10.3	0.7-40.7	0.082	0.01-0.7	Y=0.0079(L)-0
Isabella Area	Abies balsamea	51	94	20.3	9.0-47.7	1.799	0.4-8.8	Y=0.0995(L)-0.2
	Acer spicatum	59	91	25.9	11.5-44.3	0.653	0.1-2.0	Y=0.0269(L)-0.0
	Amelanchier sp.	61	91	25.7	2.7-64.3	0.710	0.1-3.6	Y=0.0317(L)-0.1
	Betula papyrifera	72	89	26.0	10.0-60.0	0.465	0.1-2.4	Y=0.0207(L)-0.0
	Corylus cornuta	59	92	28.8	11.5-68.0	0.509	0.1-	Y=0.0204(L)-0.0
	Cornus stolonifera	60	94	28.4	10.7-67.7	0.988	0.1-	Y=0.0426(L)-0.2
	Populus tremuloides	50	88	26.6	11.0-69.5	0.597	0.1-	Y=0.0293(L)-0.1
	Prunus pennsylvanica	49	86	37.1	15.2-84.2	0.975	0.1-	Y=0.0317(L)-0
	Prunus virginiana	47	92	20.1	8.1-45.4	0.734	0.1-	Y=0.0423(L)-0.
	Sorbus americana	58	83	14.5	0.7-30.3	1.023	0.1-	Y=0.0749(L)-0.0
	Salix discolor	58	93	41.3	17.8-83.1	1.355	0.2-	Y=0.0362(L)-0.1
	Salix humilis	67	89	40.1	13.0-96.0	1.599	0.2-	Y=0.0475(L)-0.3
Jonvik Deer Yard (1968 collection)	Acer spicatum	50	94	25.4	1/	0.84	1/	Y=0.0341(L)-0.0
	Betula papyrifera	48	91	29.0		0.84		Y=0.0278(L)-0.0
	Corylus cornuta	46	94	22.9		0.68		Y=0.0329(L)-0.0
	Cornus stolonifera	48	89	28.1		1.16		Y=0.0429(L)-0.0
	Populus balsamifera	50	90	32.9		2.06		Y=0.0679(L)-0.1
	Populus tremuloides	48	89	36.4		1.49		Y=0.0443(L)-0.1
	Sorbus americana	50	84	26.7		3.09		Y=0.1229(L)-0.1
	Salix discolor	50	89	41.0		1.81		Y=0.0490(L)-0.1
Jonvik Deer Yard	Acer spicatum	50	93	37.2	24.9-66.6	1.08	0.4-3.5	Y=0.0306(L)-0.059
	Betula papyrifera	50	94	39.3	16.5-65.3	1.18	0.2-3.8	Y=0.0328(L)-0.109
	Corylus cornuta	49	90	30.9	12.8-49.4	1.28	0.1-3.2	Y=0.0435(L)-0.067
	Cornus stolonifera	50	94	46.4	22.4-81.5	1.95	0.5-6.4	Y=0.0457(L)-0.172
	Populus balsamifera	50	88	36.4	14.5-70.0	2.24	0.4-10.4	Y=0.0713(L)-0.020
	Populus tremuloides	50	81	36.7	14.0-72.3	1.57	0.2-8.8	Y=0.0489(L)-0.227
	Sorbus americana	50	82	36.9	19.3-66.0	4.83	0.7-21.2	Y=0.1498(L)-0.704
	Salix discolor	50	87	42.7	12.5-91.3	1.42	0.2-7.9	Y=0.0382(L)-0.212

1/No data

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