

VEGETATION OF THE MARY FLAGLER CARY ARBORETUM:

WOODY SPECIES OF THE UPLAND FORESTS

Compiled by C.D. Canham, December 1984

SUMMARY:

The attached tables present the absolute and relative abundance of trees, saplings, shrubs and woody seedlings within the upland forests of the Mary Flagler Cary Arboretum. The results are based on a sample of 77 plots randomly located within the major blocks of contiguous, closed forests of the Arboretum. Except where noted, the results are averaged over all 77 plots in order to provide a composite picture of the relative importance of different species within the upland forests.

TREES:

Tables 1 and 2 present the relative abundance of tree species within the upland forests of the Arboretum. The results are based on a sample of all stems > 10 cm DBH (diameter breast height) within the 77 - 500 m² plots randomly located within the closed forests of the Arboretum.

33 species are present in the tree strata of the 77 plots. However, four species: Quercus prinus (chestnut oak), Quercus rubra (red oak), Acer rubrum (red maple), and Acer saccharum (sugar maple) contribute over 50% of the total density and basal area of stems > 10 cm DBH. The abundance of these four species is a function of two different sets of processes. One is the wide range of environmental conditions within the upland forests of the Arboretum, particularly along a soil moisture gradient (with chestnut oak and sugar maple representing the xeric and mesic ends of the gradient respectively). The other major influence is the stratification of species within individual stands due to differences in shade tolerance and the successional status of forests within the Arboretum. For example, red oak is most abundant as a canopy and subcanopy tree, and much less abundant in the understory. It has relatively high growth rates but is less shade tolerant than the two maples. In many stands it co-occurs with both sugar and red maples of the same approximate age, but has assumed a dominant position in the canopy. The future status of the subcanopy red maples in these stands is uncertain (because of a relatively short lifespan) but subcanopy sugar maples are capable of eventually replacing the canopy red oaks.

There are some anomalies in the results: Pseudotsuga menziesii (Douglas fir) is certainly not native, but was present in a small plantation off of Canoo Hill Road. Prunus avium is another non-native species, but is present through bird dispersal of seeds. Interestingly, Ailanthus altissima (tree of heaven) has not been successful in invading the closed forests (although it is known to do so in other regions) even though it is present along roadsides within the Arboretum.

SAPLINGS:

The densities of saplings (stems > 1.0 m in height and < 10 cm DBH) were recorded in two 125 m² quadrats within each of the 77 plots. Four understory tree species, Ostrya virginiana (Hop hornbeam), Hammamelis virginiana (witch hazel), Cornus florida (flowering dogwood) and Amelanchier spp. (shadbush species) account for approximately 45% of the total density of stems in the sapling size classes (Table 3). These species are each present in roughly half of the plots, with densities ranging from 282 to 676 stems per hectare in the plots in which they occur. These understory tree species are particularly abundant in the smaller sapling size classes (< 6 cm DBH) (Table 4). The data for Cornus florida reflect the effects of a major dieback of dogwoods within the Arboretum in the last several years. The average overall density of 171 stems per hectare represents an approximately 50% loss of stems (based on counts of standing dead dogwoods in the plots). Of the present population, 90% show signs of infection by the Anthracose fungus believed to be the cause of the dieback, and are expected to die within the next several years.

Several species occur in less than 25% of the stands, but are locally abundant when found: Acer pennsylvanicum (striped maple), Carpinus caroliniana (musclewood), Fagus grandifolia (beech) and Tsuga canadensis (eastern hemlock). In contrast, saplings of Acer saccharum and Acer rubrum are present in from 65 - 71% of the stands at relatively high densities (300 - 480 stems per hectare) (Table 3). The oaks (Quercus spp.) are present as saplings in relatively few stands (< 30%) and in relatively low densities (< 160 stems per hectare) (Table 3).

WOODY SEEDLINGS:

Woody seedlings (all stems < 1.0 m in height) were sampled in eight 0.5 m² quadrats randomly located within each of the 77 plots. Two canopy tree species, Acer rubrum and Faxinus americana (white ash), contribute 43% of the total density of woody seedlings within the plots. Interestingly, these two species are often considered to be only moderately shade tolerant, particularly in comparison with seedlings of shade tolerant species such as Acer saccharum, Fagus grandifolia and Tsuga canadensis which are present in much lower densities (Table 5). Prunus serotina (black cherry) seedlings are relatively abundant, but black cherry is much less important in the sapling size classes.

Despite the virtual elimination of chestnut (Castanea dentata) from the canopies of eastern deciduous forests over the last 70 years, chestnut seedlings and saplings are still relatively common in many forests of southern New England. However, chestnut saplings were encountered in 13% of the plots in the forests of the Arboretum and seedlings occurred in the quadrats of only 2 plots (2.6%). These low densities, coupled with the relatively low density of chestnut stumps and logs (C.D. Canham, personal observations) suggest that chestnut was not a dominant component of the upland forests of the Arboretum prior to chestnut blight.

SHRUBS:

The cover of shrub species was recorded along a 20 m transect through the center of each plot. One species - Viburnum acerifolium (maple-leaved viburnum) - contributed 46% of the total cover of shrub species recorded within the 77 plots (Table 6). It was present in 70% of the plots, and when present, covered almost 8% of the surface of the plot. Two other shrub species, Parthenocissus quinquefolia (Virginia creeper) and Cornus racemosa contributed another 25% of the total cover of shrubs within the upland forests, but were present in a much smaller percentage of the plots (Table 6).

Four of the shrub species are non-native: Berberis thunbergii, Euonymus alatus, Lonicera tatarica and Rosa multiflora. While these species are often successful invaders of highly disturbed forests, none of the species was present in more than 3 of the plots within the Arboretum forests, and when present covered less than 1.1% of the plot.

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 ROSMUL = 20

TABLE 1: Overall abundance of trees (stems > 10 cm DBH) in the upland forests of the Mary Flagler Cary Arboretum.

LEGEND:

TOT DENS : Total density of stems > 10 cm DBH per hectare, averaged over the contiguous upland forests.
 TOT BA : Total basal area (m²/ha) of stems > 10 cm DBH per hectare, averaged over the contiguous upland forests.
 % DENS : Percent of the total density of stems > 10 cm DBH.
 % BA : Percent of the total basal area of stems > 10 cm DBH.
 % FREQ : Percent of the 77 plots in which a species occurred.

SPECIES	TOT DENS	TOT BA	% DENS	% BA	% FREQ
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Acer pennsylvanicum	0.260	0.002336	0.049	0.010	1.299
Acer rubrum	100.260	2.895246	18.756	12.282	75.325
Acer saccharum	58.182	1.726653	10.884	7.325	59.740
Amelanchier sp.	3.636	0.054984	0.680	0.233	11.688
Betula lenta	22.338	0.840350	4.179	3.565	31.169
Carya glabra	35.844	1.221985	6.706	5.184	50.649
Carya ovata	6.494	0.171831	1.215	0.729	18.182
Carya tomentosa	4.675	0.111347	0.875	0.472	5.195
Cornus florida	2.078	0.023751	0.389	0.101	10.390
Fagus grandifolia	2.078	0.167764	0.389	0.712	5.195
Fraxinus americana	18.442	0.530469	3.450	2.250	33.766
Fraxinus pennsylvanica	0.260	0.038071	0.049	0.162	1.299
Juniperus virginiana	3.636	0.069722	0.680	0.296	5.195
Liriodendron tulipifera	1.039	0.107888	0.194	0.458	2.597
Ostrya virginiana	4.675	0.063392	0.875	0.269	12.987
Pinus rigida	3.377	0.161960	0.632	0.687	3.896
Pinus resinosa	15.844	0.436419	2.964	1.851	1.299
Pinus strobus	33.247	1.709047	6.220	7.250	37.662
Populus grandidentata	0.260	0.005689	0.049	0.024	1.299
Prunus avium	0.519	0.007383	0.097	0.031	2.597
Prunus serotina	3.377	0.061351	0.632	0.260	6.494
Pseudotsuga menziesii	3.377	0.141965	0.632	0.602	1.299
Quercus alba	20.779	1.433939	3.887	6.083	38.961
Quercus bicolor	1.558	0.166248	0.292	0.705	3.896
Quercus prinus	71.688	4.638237	13.411	19.676	59.740
Quercus rubra	54.545	3.735520	10.204	15.847	62.338
Quercus velutina	21.299	1.484089	3.984	6.296	40.260
Rhamnus cathartica	0.260	0.002513	0.049	0.011	1.299
Sassafras albidum	0.260	0.002698	0.049	0.011	1.299
Tilia americana	1.039	0.030997	0.194	0.131	1.299
Tsuga canadensis	37.403	1.481678	6.997	6.286	22.078
Ulmus americana	1.558	0.039686	0.292	0.168	6.494
Ulmus sp.	0.260	0.007520	0.049	0.032	1.299
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TABLE 2: Relative abundance of tree species by canopy position.

LEGEND:

- % CD : Relative density among canopy trees (trees with > 25% of their crowns exposed to the sky).
 % CB : Relative basal area among canopy trees.
 % SD : Relative density among subcanopy trees (trees with < 25% of their crowns exposed to the sky).
 % SB : Relative basal area among subcanopy trees.
 % UD : Relative density among understory trees (stems > 10 cm DBH but completely overtopped by canopy and subcanopy trees).
 % UB : Relative basal area among understory trees.

SPECIES	% CD	% CB	% SD	% SB	% UD	% UB
Acer pennsylvanicum	0.000	0.000	0.127	0.037	0.000	0.000
Acer rubrum	15.511	9.757	23.949	18.301	15.625	12.527
Acer saccharum	6.810	5.388	10.446	9.116	18.333	16.823
Amelanchier sp.	0.000	0.000	1.146	0.652	1.042	0.707
Betula lenta	5.927	3.590	3.439	3.920	2.500	2.194
Carya glabra	7.062	5.258	5.860	4.566	7.500	6.630
Carya ovata	0.252	0.246	2.166	1.881	1.250	0.774
Carya tomentosa	0.504	0.250	1.019	0.817	1.250	1.106
Cornus florida	0.000	0.000	0.382	0.145	1.042	0.755
Fagus grandifolia	0.378	0.640	0.510	0.931	0.208	0.556
Fraxinus americana	3.909	2.381	3.185	1.913	3.125	2.326
Fraxinus pennsylvanica	0.126	0.249	0.000	0.000	0.000	0.000
Juniperus virginiana	0.504	0.169	0.637	0.385	1.042	1.007
Liriodendron tulipifera	0.252	0.631	0.127	0.129	0.208	0.166
Ostrya virginiana	0.252	0.050	0.764	0.314	2.083	1.863
Pinus rigida	1.261	0.856	0.382	0.488	0.000	0.000
Pinus resinosa	0.883	0.516	6.879	5.634	0.000	0.000
Pinus strobus	7.188	7.872	2.548	3.527	10.625	14.576
Populus grandidentata	0.126	0.037	0.000	0.000	0.000	0.000
Prunus avium	0.000	0.000	0.255	0.116	0.000	0.000
Prunus serotina	0.504	0.154	0.510	0.372	1.042	0.739
Pseudotsuga menziesii	0.378	0.468	0.637	0.836	1.042	0.897
Quercus alba	5.675	6.740	3.439	5.656	1.667	2.265
Quercus bicolor	0.378	0.819	0.255	0.556	0.208	0.296
Quercus prinus	20.807	24.042	11.210	13.095	4.792	6.653
Quercus rubra	12.358	16.664	11.975	17.646	3.750	3.417
Quercus velutina	6.179	8.048	3.439	3.644	1.250	1.105
Rhamnus cathartica	0.000	0.000	0.000	0.000	0.208	0.131
Sassafras albidum	0.000	0.000	0.000	0.000	0.208	0.140
Tilia americana	0.000	0.000	0.382	0.445	0.208	0.145
Tsuga canadensis	2.522	4.997	3.822	4.599	19.583	22.095
Ulmus americana	0.252	0.179	0.382	0.161	0.208	0.108
Ulmus sp.	0.000	0.000	0.127	0.119	0.000	0.000

TABLE 3: Absolute and relative density (per hectare) of saplings and understory trees (all stems > 1.0 m height and < 10 cm DBH) in upland forests of the Mary Flagler Cary Arboretum.

LEGEND: LOCAL DENSITY: Average density for only those plots in which a species was present
 PERCENT FREQUENCY: Percent of the 77 plots in which a species occurred.
 OVERALL DENSITY: Average density for all 77 plots.
 RELATIVE DENSITY: Percent of total density of saplings contributed by a species.

SPECIES	LOCAL DENSITY	PERCENT FREQUENCY	OVERALL DENSITY	RELATIVE DENSITY
<i>Acer pennsylvanicum</i>	336.67	15.58	52.47	2.38
<i>Acer rubrum</i>	302.55	71.43	216.10	9.82
<i>Acer saccharum</i>	480.00	64.94	311.69	14.16
<i>Amelanchier</i> sp.	281.74	59.74	168.31	7.65
<i>Betula lutea</i>	120.00	1.30	1.56	0.07
<i>Betula lenta</i>	195.71	36.36	71.17	3.23
<i>Betula populifolia</i>	80.00	1.30	1.04	0.05
<i>Carpinus caroliniana</i>	400.00	23.38	93.51	4.25
<i>Castanea dentata</i>	100.00	12.99	12.99	0.59
<i>Carya glabra</i>	112.59	35.06	39.48	1.79
<i>Carya ovata</i>	115.56	11.69	13.51	0.61
<i>Carya tomentosa</i>	80.00	1.30	1.04	0.05
<i>Cornus florida</i>	320.98	53.25	170.91	7.77
<i>Crataegus</i> sp.	40.00	2.60	1.04	0.05
<i>Fagus grandifolia</i>	328.42	24.68	81.04	3.68
<i>Fraxinus americana</i>	127.50	62.34	79.48	3.61
<i>Fraxinus pennsylvanica</i>	160.00	1.30	2.08	0.09
<i>Fraxinus</i> sp.	120.00	1.30	1.56	0.07
<i>Hammamelis virginiana</i>	628.24	44.16	277.40	12.61
<i>Juniperus virginiana</i>	160.00	5.19	8.31	0.38
<i>Ostrya virginiana</i>	676.28	55.84	377.66	17.16
<i>Picea glauca</i>	40.00	1.30	0.52	0.02
<i>Pinus strobus</i>	80.00	16.88	13.51	0.61
<i>Populus grandidentata</i>	40.00	1.30	0.52	0.02
<i>Prunus serotina</i>	97.14	9.09	8.83	0.40
<i>Quercus alba</i>	106.67	15.58	16.62	0.76
<i>Quercus bicolor</i>	40.00	2.60	1.04	0.05
<i>Quercus illicifolia</i>	160.00	1.30	2.08	0.09
<i>Quercus prinus</i>	136.67	15.58	21.30	0.97
<i>Quercus rubra</i>	121.90	27.27	33.25	1.51
<i>Quercus velutina</i>	142.50	20.78	29.61	1.35
<i>Rhamnus cathartica</i>	128.89	11.69	15.06	0.68
<i>Sassafras albidum</i>	60.00	2.60	1.56	0.07
<i>Tsuga canadensis</i>	301.18	22.08	66.49	3.02
<i>Ulmus americana</i>	85.71	9.09	7.79	0.35

TABLE 4: Densities (per hectare) of saplings by 2 cm size classes.

SPECIES	SIZE CLASS (cm)				
	0 - 2	2 - 4	4 - 6	6 - 8	8 - 10
<i>Acer pennsylvanicum</i>	40.00	3.64	5.19	3.64	0.00
<i>Acer rubrum</i>	88.31	50.39	40.52	25.45	11.43
<i>Acer saccharum</i>	191.17	61.30	34.29	19.22	5.71
<i>Amelanchier</i> sp.	123.64	24.42	12.99	4.68	2.60
<i>Betula lutea</i>	1.56	0.00	0.00	0.00	0.00
<i>Betula lenta</i>	45.19	9.35	4.68	9.87	2.08
<i>Betula populifolia</i>	0.52	0.00	0.52	0.00	0.00
<i>Carpinus caroliniana</i>	81.56	7.79	2.60	1.56	0.00
<i>Castanea dentata</i>	10.39	1.56	1.04	0.00	0.00
<i>Carya glabra</i>	8.31	14.03	10.91	5.19	1.04
<i>Carya ovata</i>	4.16	4.68	1.56	1.56	1.56
<i>Carya tomentosa</i>	0.00	0.00	0.00	0.00	1.04
<i>Cornus florida</i>	107.01	37.92	16.62	7.79	1.56
<i>Crataegus</i> sp.	0.52	0.00	0.52	0.00	0.00
<i>Fagus grandifolia</i>	65.45	10.91	2.60	1.56	0.52
<i>Fraxinus americana</i>	37.40	17.66	12.47	8.83	3.12
<i>Fraxinus pennsylvanica</i>	1.04	0.52	0.52	0.00	0.00
<i>Fraxinus</i> sp.	1.56	0.00	0.00	0.00	0.00
<i>Hammamelis virginiana</i>	251.43	23.38	2.60	0.00	0.00
<i>Juniperus virginiana</i>	1.04	2.60	2.08	1.56	1.04
<i>Ostrya virginiana</i>	328.83	32.21	10.91	3.12	2.60
<i>Picea glauca</i>	0.00	0.00	0.00	0.00	0.52
<i>Pinus strobus</i>	1.04	1.04	5.19	3.64	2.60
<i>Populus grandidentata</i>	0.00	0.00	0.00	0.00	0.52
<i>Prunus serotina</i>	7.27	0.00	0.52	1.04	0.00
<i>Quercus alba</i>	8.31	2.60	4.16	1.04	0.52
<i>Quercus bicolor</i>	0.00	0.52	0.00	0.00	0.52
<i>Quercus illicifolia</i>	2.08	0.00	0.00	0.00	0.00
<i>Quercus prinus</i>	12.47	5.19	2.08	1.04	0.52
<i>Quercus rubra</i>	9.87	5.71	10.39	5.71	1.56
<i>Quercus velutina</i>	9.87	6.75	5.71	4.68	2.60
<i>Rhamnus cathartica</i>	11.95	2.08	1.04	0.00	0.00
<i>Sassafras albidum</i>	1.04	0.00	0.52	0.00	0.00
<i>Tsuga canadensis</i>	15.06	15.58	15.58	11.43	8.83
<i>Ulmus americana</i>	1.56	2.08	3.12	0.52	0.52
TOTALS	1469.61	343.90	210.91	123.12	52.99

TABLE 5: Densities (per m²) and frequencies of seedlings (stems < 1.0 m in height) in the upland forests of the Mary Flagler Cary Arboretum.

SPECIES	LOCAL DENSITY	PERCENT FREQUENCY	OVERALL DENSITY	RELATIVE DENSITY
<i>Acer pennsylvanicum</i>	1.4000	6.49	0.0909	2.2544
<i>Acer rubrum</i>	1.7400	64.94	1.1299	28.0193
<i>Acer saccharum</i>	0.9052	37.66	0.3409	8.4541
<i>Amelanchier</i> sp.	0.9071	45.45	0.4123	10.2254
<i>Betula lenta</i>	0.3000	6.49	0.0195	0.4831
<i>Carpinus caroliniana</i>	1.3333	3.90	0.0519	1.2882
<i>Castanea dentata</i>	0.2500	2.60	0.0065	0.1610
<i>Carya glabra</i>	0.3810	27.27	0.1039	2.5765
<i>Carya ovata</i>	0.4167	3.90	0.0162	0.4026
<i>Cornus florida</i>	0.9423	16.88	0.1591	3.9452
<i>Crataegus</i> sp.	0.2500	2.60	0.0065	0.1610
<i>Fagus grandifolia</i>	0.5833	3.90	0.0227	0.5636
<i>Fraxinus americana</i>	1.3357	45.45	0.6071	15.0564
<i>Hammamelis virginiana</i>	0.7375	25.97	0.1916	4.7504
<i>Juniperus virginiana</i>	0.6250	2.60	0.0162	0.4026
<i>Liriodendron tulipifera</i>	1.2500	1.30	0.0162	0.4026
<i>Ostrya virginiana</i>	0.5375	25.97	0.1396	3.4622
<i>Pinus strobus</i>	0.2500	1.30	0.0032	0.0805
<i>Prunus serotina</i>	0.5588	44.16	0.2468	6.1192
<i>Quercus alba</i>	0.4792	15.58	0.0747	1.8519
<i>Quercus illicifolia</i>	0.5000	1.30	0.0065	0.1610
<i>Quercus prinus</i>	0.5385	16.88	0.0909	2.2544
<i>Quercus rubra</i>	0.4821	18.18	0.0877	2.1739
<i>Quercus velutina</i>	0.5500	12.99	0.0714	1.7713
<i>Rhamnus cathartica</i>	0.5417	7.79	0.0422	1.0467
<i>Sassafras albidum</i>	0.4643	9.09	0.0422	1.0467
<i>Tsuga canadensis</i>	1.0000	1.30	0.0130	0.3221
<i>Ulmus americana</i>	0.2500	3.90	0.0097	0.2415