Report to Dominion North Carolina Power
Monitoring the Establishment and Survival of Floodplain Tree Seedlings: Roanoke River
Year 1: 2007

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Objectives

The primary objective of this project is to monitor establishment and survival of seedlings of floodplain tree species seedlings with site, flood regime, and inter-annual variation in flood conditions. Special attention is being given to identifying effects of within-week peaking operations at Roanoke Rapids Power Station on tree seedling establishment and survival.

Methodology

***Site selection*:** We selected 25 transects from the 75 NSF transects established by Townsend, Peet & Hupp in 2001 and distributed along the river to assure a diversity of conditions (Fig. 1; for details see http://tinyurl.com/38qbz3). We used established vegetation records along with flow and flood inundation models to ensure that all vegetation types as well as the range of variability in flooding in those vegetation types were captured by the transects selected.

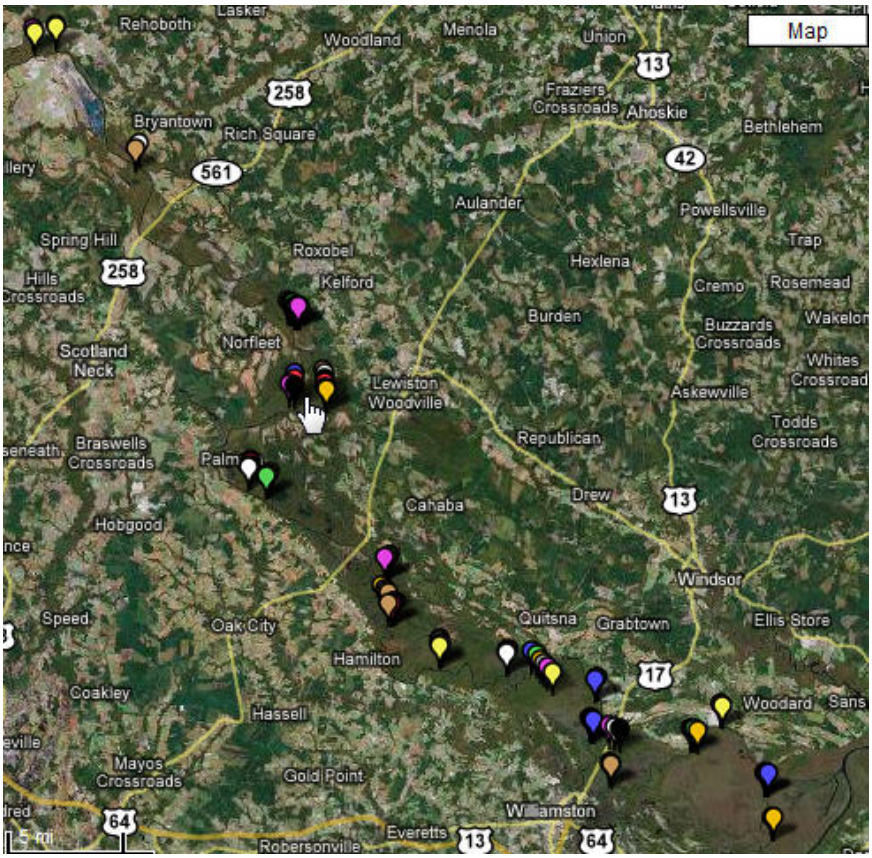

Fig. 1. Locations of most of the 99 plots and all of the 26 transects.

***Plot locations*:** Along each selected transect, permanent seedling monitoring plots were spaced out to represent different geomorphic locations, generally from levee top to back swamp (Fig. 2). Plots were placed near claypads installed by USGS so as to maximize available site information and facilitate relocation. These locations had been previously geo-referenced and the dominant vegetation had been recorded. The total number of plots located along each transect varies from 2 to 7 plots with the total number determined by the heterogeneity of the floodplain. In total, 99 plots were established, and 26 of these plots were located within the proposed zone of influence of Dominion Power as determined from the flood analysis extension (Table 1). These were areas that would be inundated as a result of peaking between 6-14k cfs for five days.

Figure 2. Blowup of part of Fig.1 showing plots associated with four transects.

Table 1: Number of plots in zones delineated by the predicted five-day peaking necessary for inundation

Flow x 5 days to inundate (cfs)	# plots
0 flow	1
0 to 6k	13
6k to 14k	26
14k to 20k	28
20k to 35k	17
35 to 100k	7
not determined	7

***Field protocols* (*Figure 3*):**

Plot Establishment Protocol: This is a one-time task, now completed. Approximately 2 m from each selected claypad point, one 25 m seedling survey line was established perpendicular to the NSF transect, and a second 25 m line was located parallel to the first approximately 10 m farther from the river along the NSF transect. Metal stakes (half-inch thin-wall steel electrical conduit) were placed at 5m intervals beginning at zero along both survey lines.

Seedling monitoring protocol: This is a continuing process conducted every year. Seedlings are sampled within the 5-10 m interval and the 15-20 m interval of each 25m line for a total in each plot of 4 seedling monitoring plots of 5 m length. All first-year seedlings, identified by the presence of cotyledons or the lack of wood in the stem, are counted by species within a transect 0.5 m wide in 1 m increments along the survey line. The X-Y coordinates and the height (cm) of all older (> 1 year old; up to 1 m in height) seedlings are recorded within 1 m transects for each of the four sampling plots. Where seedlings are very dense, the plot is reduced to 0.5 m during the initial monitoring to maintain accuracy. During 2007, we found it necessary to reduce the transect width for only three of the 99 plots. Large seedlings are scarcer, so a larger plot is required. For seedlings between 0.25 m and 1 m in height we widenthe sampling plot to 2 m (and continued to record X-Y coordinates).

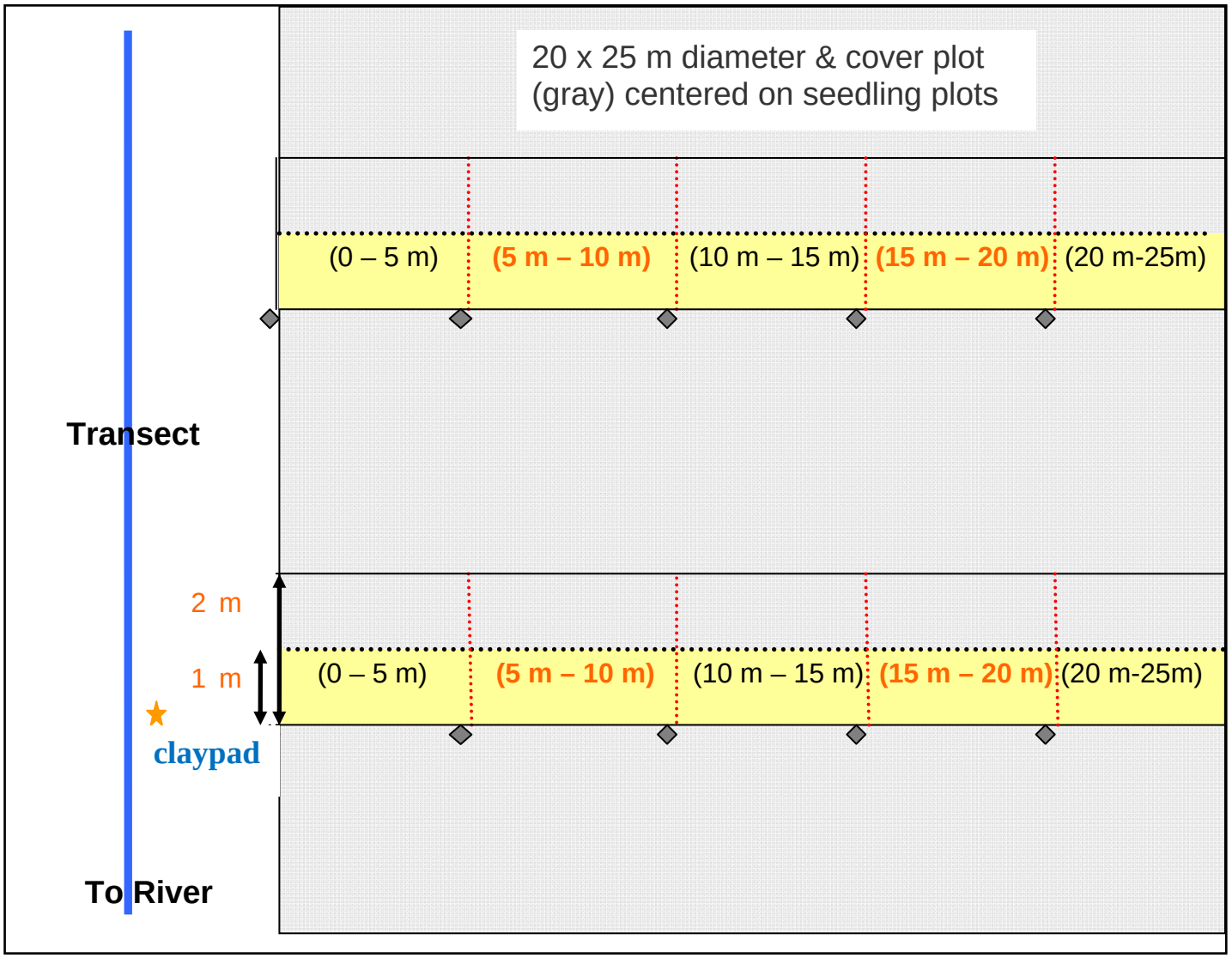

Figure 3. Plot layout. The seedling transect lines are immediately below the 1 m wide yellow seedling transects. The large plot runs 25m left to right, and 20 m up and down. The seedling transect lines are 10 m apart and each is 5 m in from the edge of the plot.

Recount protocol: Recount is conducted annually after the initial count has been completed. All seedlings are counted by species in one-meter long subsections of the original sampling transects and recorded only as first year and older and individual stems are not remeasured. This lower-intensity resample allows us to assess within year mortality, with particular emphasis on the new seedlings.

Large tree protocol: Plot establishment is a one-time task, and tree measurement is anticipated to be conducted at 5-year intervals. A 20 x 25 m plot (0.05 ha = 0.124 acres) was established centered over each seedling plots Within each 20x25m plot all tree stems were recorded by species and diameter breast height. Tree cover was also estimated for each species. The diameter at breast height (DBH) was recorded for all woody individuals taller than 1 m. Percent cover of herbaceous species was visually estimated, as were total ground cover and total canopy cover. We do not anticipate resampling these larger plots until year 5.

Results

Overall trends

During the initial sampling 22623 seedlings were recorded across all plots, of which 11654 were first-year seedlings. These seedlings were mapped over an 8-week period from late-May 2007 to late-July 2007. During the resample, 12612 seedlings were counted, only 4027 of which were first-year seedlings. This resampling was completed in a 3-week period from late-July to early-August (Table 2).

Table 2: Cumulative number of seedlings by age class observed during the initial sample compared to the end of season recount

Age Class	Sample #1	Recount
<1year	11654	4027
>1year	10969	8585
Total	22623	12612

In total, 36 species were identified in the seedling regeneration layer. The most abundant species were *Acer rubrum, Acer negundo, Carpinus caroliniana, Fraxinus spp*, and *Ulmus americana*. Also, some species such as *Populus heterophylla* and *Nyssa aquatica*, were much more abundant as first-year seedlings than as older seedlings and saplings (Table 3).

Zonal trends for recount (Table 4, Table 5)

In the wettest plots (those predicted to flood with a 5-day sustained streamflow of <6k cfs), we observed the lowest density of first-year seedlings on average, and the highest density of older (>1st year) seedlings. However, the observed densities were highly variable. The number of first-year seedlings ranged from 0 to 232, and the number of older seedlings ranged from 1 to 296. The most abundant first-year seedlings were *N. aquatica* and *P. heterophylla*, while the most abundant older seedlings were *C. caroliniana*, *Fraxinus spp,* and *A. negundo.*

In plots located within Dominion's zone of influence (those predicted to flood with a 5-day sustained streamflow between 6-14k cfs) we recorded the highest density of first-year seedlings on average, but the lowest density of older seedlings on average. The high average abundance of first-year seedlings can be attributed to the abundance of *P. heterophylla*, *A. rubum* and, *Fraxinus spp*. Again, the values at the plot level were highly variable, ranging from 0 to 373 first-year and from 1 to 474 older seedlings.

Most plots were located at sites predicted to flood at a 5-day sustained flow of >14k cfs. The abundance of seedlings in these plots was more variable but overall somewhat in between the previous two zones.

Evaluation of first-year sampling and expectations for year 2:

Using the expectations in the original proposal as benchmarks, our first-year sampling was highly successful. We had projected to sample between 20 and 30 of the Townsend et al. transects, and we successfully sampled 26. We may well be able to add an additional 5-10 transects in 2008 as there will be less work to do at the established plots in year 2. We established more than maximum number of expected plots, originally projecting between 40 and 90, and actually collecting 99. Moreover, we captured the range of conditions in both vegetation and hydroperiod as outlined previously. In addition to seedling plot establishment, we also collected data to determine the composition and structure of the understory and overstory vegetation, which will be useful for interpreting the degree to which the regeneration layer is correlated with the surrounding community; an important addition not included in the proposal.

Our identification of species improved over the course of the field season as well. This greatly increased the efficiency of plot establishment as the season progressed. Some inconsistences will be apparent in table 3 owing to improvement in taxonomic ability as the season progress (in particular,some Lindera seedlings were initially identified as Diospyros). We anticipate not taxonomic difficulties in future years.

Next season, we will first focus our attention on resampling the previously established plots. We will use datasheets preprinted with data from the previous season (species and coordinates) which should increase our accuracy in relocating individuals and should also enable taxonomic inaccuracies from the initial sampling to be identified and corrected. We expect that this first re-sampling will proceed faster than the initial sampling as most plots have been established and the canopy trees will not need to be resampled. The additional time will be spent filling gaps that we identify from the analysis of the first-year data. This will include establishing additional plots to capture more individuals of rare species in the seedling sample. While common species such as the maples (*Acer spp*.) and ashes (*Fraxinus spp*.) were well represented in the sample, we would like to increase the sample size for less common species, particularly the oaks (*Quercus spp.)* To accomplish this we will target plot establishment in areas that have a high percent cover of oaks in the canopy layer.

Table 3: Number of individuals by species in two age classes observed in the first and second sampling events

Species	Family	< 1 year		> 1 year	
		Sample #1	Recount	Sample #1	Recount
Acer barbatum	Aceraceae	0	0	3	0
Acer negundo	Aceraceae	202	16	1611	1197
Acer rubrum	aceraceae	1304	537	1387	933
Acer saccharinum	Aceraceae	93	333	73	94
Acer sp.	Aceraceae	9	0	0	0
Aesculus sylvatica	Sapindaceae	4	0	12	3
Asimina triloba	Annonaceae	9	25	217	140
Betula nigra	Betulaceae	0	0	10	3
Carya aquatica	Juglandaceae	1	2	25	60
Carpinus caroliniana	Betulaceae	227	31	1700	1457
Carya cordiformis	Juglandaceae	0	0	42	42
Carya sp.	Juglandaceae	2	0	46	0
Carya ovata	Juglandaceae	0	0	0	6
Celtis laevigata	Ulmaceae	160	210	367	271
Crataegus sp.	Rosaceae	3	10	143	114
Diospyros virginiana	Ebenaceae	41	1	211	37
Fraxinus caroliniana	Oleaceae	90	65	554	122
Fraxinus pennsylvanica	Oleaceae	332	194	1956	1931
Fraxinus profunda	Oleaceae	2	1	110	97
Fraxinus sp.	Oleaceae	21	0	72	16
Ilex decidua	Aquifoliaceae	31	33	388	352
Ilex opaca	Aquifoliaceae	0	0	2	1
Liquidambar styraciflua	Hamamelidaceae	31	53	378	224
Lindera benzoin	Lauraceae	1	41	51	211
Nyssa aquatica	Cornaceae	246	353	19	12
Platanus occidentalis	Platanaceae	3	1	10	2
Populus heterophylla	Salicaceae	4267	1052	69	44
Quercus laurifolia	Fagaceae	0	2	39	29
Quercus lyrata	Fagaceae	3	5	6	23
Quercus pagoda	Fagaceae	0	4	0	10
Quercus phellos	Fagaceae	0	1	2	1
Quercus shumardii	Fagaceae	5	2	18	6
Quercus sp.	Fagaceae	11	0	6	4
Salix nigra	Salicaceae	0	0	1	0
Sassafras albidum	Lauraceae	1	0	1	2
Taxodium distichum	Cupressaceae	22	37	53	32
Ulmus alata	Ulmaceae	0	21	7	14
Ulmus americana	Ulmaceae	4406	997	1039	792
Viburnum sp.	Caprifoliaceae	0	0	339	303

Table 4: Average abundance of species in recount per plot in zones delineated by the predicted five-day peaking necessary for inundation

		First-year seedlings - Re-count			Older seedlings - Re-count		
	Flow x 5 days	0 - 6k	6-14K	>14k	0 - 6k	6-14K	>14k
Species	Family						
Acer barbatum	Aceraceae	0	0	0	0	0	0
Acer negundo	Aceraceae	0.1	0.2	0.2	24	3.8	13.8
Acer rubrum	aceraceae	0.9	10.6	4.6	3.4	15.2	8.6
Acer saccharinum	Aceraceae	0.1	0.1	6.3	5.2	0.3	0.3
Acer sp.	Aceraceae	0	0	0	0	0	0
Aesculus sylvatica	Sapindaceae	0	0	0	0	0.1	0
Asimina triloba	Annonaceae	0	0.1	0	0.7	1.1	1.5
Betula nigra	Betulaceae	0	0	0	0.2	0	0
Carya aquatica	Juglandaceae	0	0	0	1.1	1.4	0.1
Carpinus caroliniana	Betulaceae	0.1	0.2	0.5	31.7	8.3	14.9
Carya cordiformis	Juglandaceae	0	0	0	0	0	0.7
Carya sp.	Juglandaceae	0	0	0	0	0	0
Carya ovata	Juglandaceae	0	0	0	0.4	0	0
Celtis laevigata	Ulmaceae	0.6	0.7	3.4	4.2	1.8	2.8
Crataegus sp.	Rosaceae	0.3	0.1	0	2.7	0.4	0.8
Diospyros virginiana	Ebenaceae	0	0	0	1.3	0.3	0.2
Fraxinus spp	Oleaceae	5.6	1.6	1.2	26.8	19.1	24.3
Ilex decidua	Aquifoliaceae	0.5	0.3	0.3	6.4	3.1	3.2
Ilex opaca	Aquifoliaceae	0	0	0	0	0	0
Lindera benzoin	Lauraceae	0	0	0.8	0	0.5	3.4
Liquidambar styraciflua	Hamamelidaceae	0.2	0.8	0.5	3.2	1	2.6
Nyssa aquatica	Cornaceae	8.5	5.6	1.5	0.1	0.2	0.1
Platanus occidentalis	Platanaceae	0	0	0	0	0	0
Populus heterophylla	Salicaceae	5.4	29.2	4.1	0	0.9	0.3
Quercus laurifolia	Fagaceae	0	0	0	0.7	0.3	0.2
Quercus lyrata	Fagaceae	0	0	0.1	0.1	0.2	0.3
Quercus phellos	Fagaceae	0.1	0	0	0.1	0	0
Quercus pagoda	Fagaceae	0	0.1	0	0	0	0.2
Quercus sp.	Fagaceae	0	0	0	0	0	0.1
Quercus shumardii	Fagaceae	0	0.1	0	0	0	0.1
Sassafras albidum	Lauraceae	0	0	0	0.1	0	0
Salix nigra	Salicaceae	0	0	0	0	0	0
Taxodium distichum	Cupressaceae	0.2	0.5	0.4	0.8	0.5	0.2
Ulmus alata	Ulmaceae	0	0	0.4	0	0	0.3
Ulmus americana	Ulmaceae	1.1	15.5	10.8	15.3	9.5	5.8
Viburnum sp.	Caprifoliaceae	0	0	0	0	0.2	5.7
	Total number	23.786	65.962	34.885	128.57	68.154	90.423

Table 5: Relative abundance of species (recount) in zones delineated by the predicted five-day peaking necessary for inundation

		First-year seedlings -- Re-count			Older seedlings -- Re-count		
	Flow x 5 days	0 - 6k	6-14K	>14k	0 - 6k	6-14K	>14k
Species	Family	% of total	% of total	% of total	% of total	% of total	% of total
Acer barbatum	Aceraceae	0.0	0.0	0.0	0.0	0.0	0.0
Acer negundo	Aceraceae	0.6	0.3	0.4	18.7	5.6	15.2
Acer rubrum	aceraceae	3.6	16.1	13.1	2.7	22.2	9.5
Acer saccharinum	Aceraceae	0.6	0.1	18.0	4.1	0.4	0.3
Acer sp.	Aceraceae	0.0	0.0	0.0	0.0	0.0	0.0
Aesculus sylvatica	Sapindaceae	0.0	0.0	0.0	0.0	0.1	0.0
Asimina triloba	Annonaceae	0.0	0.1	0.1	0.6	1.6	1.7
Betula nigra	Betulaceae	0.0	0.0	0.0	0.2	0.0	0.0
Carya aquatica	Juglandaceae	0.0	0.1	0.1	0.9	2.1	0.1
Carpinus caroliniana	Betulaceae	0.6	0.3	1.3	24.7	12.2	16.5
Carya cordiformis	Juglandaceae	0.0	0.0	0.0	0.0	0.1	0.8
Carya sp.	Juglandaceae	0.0	0.0	0.0	0.0	0.0	0.0
Carya ovata	Juglandaceae	0.0	0.0	0.0	0.3	0.0	0.0
Celtis laevigata	Ulmaceae	2.7	1.0	9.6	3.3	2.7	3.0
Crataegus sp.	Rosaceae	1.2	0.2	0.1	2.1	0.6	0.9
Diospyros virginiana	Ebenaceae	0.0	0.0	0.1	1.0	0.5	0.2
Fraxinus spp.	Oleaceae	23.7	2.4	3.3	20.8	27.9	26.9
Ilex decidua	Aquifoliaceae	2.1	0.5	0.9	4.9	4.6	3.5
Ilex opaca	Aquifoliaceae	0.0	0.0	0.0	0.0	0.1	0.0
Lindera benzoin	Lauraceae	0.0	0.0	2.1	0.0	0.7	3.8
Liquidambar styraciflua	Hamamelidaceae	0.9	1.3	1.4	2.5	1.5	2.9
Nyssa aquatica	Cornaceae	35.7	8.5	4.2	0.1	0.3	0.1
Platanus occidentalis	Platanaceae	0.0	0.1	0.0	0.0	0.0	0.0
Populus heterophylla	Salicaceae	22.5	44.3	11.7	0.0	1.3	0.3
Quercus laurifolia	Fagaceae	0.0	0.1	0.1	0.6	0.4	0.2
Quercus lyrata	Fagaceae	0.0	0.1	0.2	0.1	0.3	0.3
Quercus phellos	Fagaceae	0.3	0.0	0.0	0.1	0.0	0.0
Quercus pagoda	Fagaceae	0.0	0.2	0.1	0.0	0.0	0.2
Quercus sp.	Fagaceae	0.0	0.0	0.0	0.0	0.0	0.1
Quercus shumardii	Fagaceae	0.0	0.1	0.0	0.0	0.0	0.1
Sassafras albidum	Lauraceae	0.0	0.0	0.0	0.1	0.0	0.0
Salix nigra	Salicaceae	0.0	0.0	0.0	0.0	0.0	0.0
Taxodium distichum	Cupressaceae	0.9	0.8	1.1	0.6	0.7	0.2
Ulmus alata	Ulmaceae	0.0	0.0	1.2	0.0	0.0	0.3
Ulmus americana	Ulmaceae	4.5	23.6	30.9	11.9	14.0	6.5
Viburnum sp.	Caprifoliaceae	0.0	0.0	0.0	0.0	0.3	6.3