Mature Forest Identification in Cecil County

Purpose

As forests mature, they grow in biomass, structure, and complexity (Weber and Boss, 2009). Beneath the canopy, shade-tolerant plants replace shade-intolerant plants. Mature ecosystems have greater stored biomass and organic matter, higher diversity, increased cycling of detritus and nutrients, improved efficiency, and greater stability (Odum, 1969). Significantly, they also have more stored carbon. In Charles and Prince George's counties, Maryland, Weber and Allen (2010) found that later successional forest stands had fewer exotic plants than earlier successional stands. In Harford County, Weber (Conservation Fund et al., 2018) similarly found that later successional forest had fewer exotic plants than earlier successional, especially where >50 m from the nearest edge.

Forest-dependent breeding birds, many of which are of conservation concern, are considered "umbrella species" whose needs encompass those of many other animal and plant species (Canterbury et al., 2000; Jones et al., 2000; O'Connell et al., 2000). Weber et al. (2008) found that in eastern Maryland, forest bird richness and abundance were highest in undisturbed, mature broadleaf forest with wetlands and streams nearby.

Although young forest also provides numerous benefits to wildlife and humans, we wanted to be able to identify mature forest in Cecil County, as potentially being exceptionally important to conserve.

Methodology

As part of the Cecil County green infrastructure assessment, we identified forest patches from 1-m land cover and other data (see associated document for details). Within these, we examined canopy height (MD-wide data, 30 m pixels), and 1992 land cover (NLCD). We used a 28 m height threshold; following findings in Weber and Boss (2009), if canopy height >28 m and the NLCD class was deciduous forest or forested wetland in 1992, forest was likely to be mature, especially if in a floodplain or ravine.

Some early successional trees, notably tulip poplar (*Liriodendron tulipifera*), grow quickly, and could reach a 28 m height in 35-45 years (Beck, 1990). However, we lacked a remotely-sensed means to discriminate between different species of deciduous trees.

We therefore tested the GIS model by comparing it to aerial photos and ground observations. To visit as many points as possible in a limited amount of time, we selected points using the following criteria:

- On state-owned land or county parks
- <100 m from a parking area
- >30 m from the nearest forest edge or different modeled age class (mature/non-mature). (>50 m didn't generate enough points)

Combining these criteria left polygons for mature and non-mature forest <100 from a parking lot and >30 m from the nearest forest edge or different modeled age class. From these, we selected one site each within three of the four county parks that were finalists for wildlife surveys (the fourth did not contain forest that met the above criteria). To increase the sample size to 20 mature sites and 20 young, we selected the 18 largest (by area) mature forest candidates and 19 largest young forest candidates. The reason for picking the largest was because these were more likely to be relatively homogenous. We then identified the center point of each of these polygons. These were our sample sites.

We found that 69% of forest with canopy height >28 m was classified as deciduous forest or forested wetland in 1992. Examining ESRI aerial imagery and 1995 Google Earth imagery, the 1992 land cover contained notable inaccuracies. Comparing canopy height to 2011 NLCD, the vast majority of height >28 m was classified as deciduous forest or woody wetlands. Very little was mixed or evergreen (2%). We therefore decided to just rely on canopy height >28 m within forest patches identified from the 1 m land cover.

First, we examined aerial photos. From Allen and Weber (2016), mature canopy trees were likely to have crown diameters >35-40 ft. Crown diameters in aerial photos were too variable to be of use, though.

Therefore, we relied on visiting the points in the field. At each point, we measured the diameter at breast height (dbh) of the 10 nearest canopy trees and recorded their species and whether there were vines on the trunk. We also recorded signs and extent of disturbance; coverage of invasive species; the % cover and most common species in the upper and lower subcanopy, shrub layer, and ground layer; and the abundance and composition of tree seedlings.

Results

Table 1 shows our findings. Canopy height and diameter (dbh) were strongly correlated (78%), as expected. Canopy height was uncorrelated, however, with the number of layers or the percent invasive plant cover.

Plots with oaks dominant or co-dominant in the canopy were less likely to have >5% invasive plant coverage ($X^2 = 12.408$, $p < 0.0005$). Early successional forest was more likely to have >5% invasive plant coverage than later successional forest ($X^2 = 8.269$, $p < 0.005$).

Table 1. Plot data

ID	LiDAR ht (m)	Community type	Dominant canopy trees	mean canopy dbh (cm)	# layers ≥25% (excluding non-native)	% invasive cover	Oaks dominant or co-dom.	Tulip poplar dominant or co-dom.	Early successional?	Invasives <10%?
1	41	Successional mesic hardwood forest	*Liriodendron tulipifera, Juglans nigra*	67.4	3	85	n	y	y	n
2	35	Mid-successional mesic mixed hardwood forest	*Liriodendron tulipifera, Quercus coccinea*	69.4	2	5	y	y	n	y
4	38	Mid-successional mesic mixed hardwood forest	*Liriodendron tulipifera*	62.3	3	20	n	y	n	n
5	33	Floodplain forest	*Platanus occidentalis, Liriodendron tulipifera*	42.9	2	10	n	y	y	n
6	34	Silver maple floodplain forest	*Acer saccharinum*	37.3	3	5	n	n	y	y
7	31	Successional mesic hardwood forest	*Liquidambar styraciflua*	36.6	5	10	n	n	y	n
8	32	Floodplain forest	*Platanus occidentalis*	38.5	1	85	n	n	n	n
9	35	Successional tuliptree forest	*Liriodendron tulipifera*	49.2	3	85	n	y	y	n
11	32	Oak-heath forest	*Quercus prinus*	52.6	3	0	y	n	n	y
12	32	Mesic mixed hardwood forest	*Quercus falcata, Liquidambar styraciflua*	70.3	3	25	y	n	n	n
13	34	Oak-heath forest	*Liquidambar styraciflua, Quercus alba*	46.9	4	0	y	n	n	y
14	29	Mesic mixed hardwood forest	*Liriodendron tulipifera, Fagus grandifolia, Quercus alba*	37.6	3	0	y	y	n	y
16	37	Successional tuliptree forest	*Liriodendron tulipifera*	67.8	2	90	n	y	y	n
17	38	Mesic mixed hardwood forest	*Liriodendron tulipifera, Quercus falcata, Q. alba*	69.6	3	5	y	y	n	y
18	31	Successional tuliptree forest	*Liriodendron tulipifera*	49.4	2	85	n	y	y	n
21	21	Early successional mesic hardwood forest	*Acer rubrum, Sassafras albidum*	20.2	1	85	n	n	y	n
22	11	Old field	*Diospyros virginiana*	10.8	2	95	n	n	y	n
29	21	Young floodplain forest	*Liquidambar styraciflua, Acer rubrum*	15.2	3	65	n	n	y	n

ID	LiDAR ht (m)	Community type	Dominant canopy trees	mean canopy dbh (cm)	# layers ≥25% (excluding non-native)	% invasive cover	Oaks dominant or co-dom.	Tulip poplar dominant or co-dom.	Early successional?	Invasives <10%?
32	26	Successional mesic hardwood forest	*Acer rubrum*	21.3	2	40	n	n	y	n
33	26	Successional mixed hardwood forest	*Liriodendron tulipifera, Liquidambar styraciflua*	46.2	3	90	n	y	y	n
34	22	Successional mixed forest	*Pinus virginiana, Betula nigra, Prunus serotina*	41.9	3	80	n	n	y	n
35	15	Early successional mixed hardwood forest	*Prunus serotina*	33.7	3	85	n	n	y	n
36	24	Mixed hardwood forest	*Liquidambar styraciflua, Quercus prinus*	45.0	4	0	y	n	n	y
40	23	Successional mesic hardwood forest	*Liriodendron tulipifera, Acer rubrum*	38.5	4	25	n	y	y	n
41	32	Oak-heath forest	*Quercus alba, Q. prinus*	63.9	3	10	y	n	n	n
42	24	Oak-heath forest	*Quercus coccinea*	41.5	4	0	y	n	n	y
43	25	Mid-successional oak-pine forest	*Quercus alba, Pinus taeda, Q. coccinea*	33.7	3	0	y	n	n	y

Discussion

We found that LiDAR canopy height alone could not be used to predict forest condition. Trees do not all grow at the same rate. In particular, tulip poplars are a fast-growing early successional tree and can reach a height >28 m in just 35-45 years, forming a monoculture or near-monoculture above a ground layer dominated by invasive non-natives. Figure 1 was taken in oak-heath forest 32 m in height. No invasive species were present. The plot in Figure 2 had an even taller canopy (37 m), but was dominated by *Liriodendron tulipifera*. The ground was almost entirely covered by invasive species, outcompeting native *Claytonia virginica* and *Arisaema triphyllum*.

Figure 1. Mature oak-heath forest in Elk Neck State Park with a LiDAR canopy height of 32 m. Canopy dominated by Quercus prinus, mean dbh = 52.6 cm, and no invasive plants present.

Figure 2. Successional tuliptree forest in Elk Neck State Park with a LiDAR canopy height of 37 m. Canopy dominated by Liriodendron tulipifera, mean dbh = 67.8 cm, and ground 90% covered by Microstegium vimineum and Berberis thunbergii.

It would be interesting to digitize 1930's aerial photos, and see if forest patches existing back then corresponded to mature forest today, with large canopy trees, a complex structure and a diversity of late successional species. This would have been our first option if such data had been available.

We did not test core vs. non-core forest or distance to edge, but in neighboring Harford County, we found that invasive exotic plants were a problem at all county parks, dominating the ground and shrub cover in half the plots. However, core forest had, on average, significantly fewer invasive plants than non-core forest. All plots with <40% invasives were in core forest. Only 3 of 12 plots in core forest had >40% invasives. Core forest also had higher total scores than non-core forest.

Invasive plants were more common near forest edges than when >50 m from the edge. Wetter soils tended to have more invasives than dryer soils, and younger forest tended to have more invasives than older forest. A few of the plots (12.5%) had no invasive plants. All of these were in late-successional core forest, and were at least 80 meters from the nearest edge. Two were dry forest communities and one was mesic.

Many of the sites had little native groundcover (especially herbaceous plants). In the case of mesic sites, this might have been from deer overbrowsing, and we did spot a lot of deer or signs of deer (browsed plants, hoof prints, or droppings). Some sites dominated by invasives had few native plants, but some had many. At sites with too many deer, population control, coupled with fencing and restoration, might benefit forest understory composition.

Literature cited:

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FOREST AGE RAPID FIELD ASSESSMENT
(VERSION 2019-03)

Site name (e.g., park name) ____ Sample point ID________

Latitude_____________________ Longitude______________________ Date _________________

Investigators ____ Photos taken (yes/no) 1-N; 2-E; 3-S; 4-W

Signs of human and/or natural disturbances (describe):

Approximate percent of site visibly disturbed (e.g., % of area selectively logged or mowed):

Signs of past history, wildlife observed, and other notes:

Size and species of ten canopy trees closest to center point. (*make sure they are canopy trees!*)

	Species (write "snag" if dead)	**dbh in inches (if cm, please note)**	**Vines on trunk? (y/n)**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Mean dbh of live trees _________

Community type (ECG if known): ___________________________

Invasive exotic species % ground covered by exotic species: _________	**Extent of invasive exotic species (circle one)**				
	Absent	Present, but uncommon	Common but not dominant	Dominant	Site overrun
List the most common invasive species observed:					

Would the forest community benefit from active management such as invasive species control or tree planting?

VEGETATION STRUCTURE AND DOMINANT SPECIES

Stratum (note: not all strata may be present)	**% cover**	**Most common species**
Canopy layer		
Upper subcanopy (>10m; below canopy)		
Lower subcanopy (3-10m)		
Shrub layer (1-3m)		
Ground layer (<1 m)		

TREE SEEDLINGS (Check one)

(note: abundant is defined as >10 seedlings within a 5m radius center plot)

Seedlings of nut-producing trees (oaks, hickories, beech) abundant	
Seedlings of other late successional trees (hemlock, dogwood, etc.) abundant.	
Seedlings of nut-producing trees (oaks, hickories, beech) present, but not abundant	
Seedlings of other late successional trees present, but not abundant. Seedlings dominated by pioneer trees, or few seedlings of any type.	
Seedlings of only pioneer trees (e.g., pines, red cedar, sumac, sweetgum, sycamore, tulip poplar, red maple) present	
No seedlings present	
Only exotic seedlings present	