2016 Urban Forest Analysis within Three Parks in Burlington, Vermont

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Forest Ecosystem Monitoring Cooperative (formerly Vermont Monitoring Cooperative)

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Executive Summary

In 2016, students from the University of Vermont's Rubenstein School of Environment and Natural Resources NR-1 class collaborated with the Vermont Monitoring Cooperative (VMC, now called the Forest Ecosystem Monitoring Cooperative or FEMC), Vermont Urban Community and Forestry, and the Burlington Parks and Recreation Department to conduct a forest inventory within three public parks in Burlington, Vermont – Oakledge Park, McKenzie Park and land formerly owned by Burlington College. The goal of this project is to provide a baseline inventory against which to track possible afforestation efforts at the three parks. The three most common tree species between the three parks were eastern white pine (16.4%), northern white cedar (12.5%) and boxelder (10.6%). The most abundant DBH class was the 3 to 6 inch DBH trees which made up 35.1% of the present trees. The interior and transition strata possess the most tree species, mature trees, and saplings. Future monitoring should be focused on the interior and transition to determine whether the findings of this initial effort are part of long-term trends or merely anomalies which will ultimately provide direction on the specific trees and locations to focus on to maintain the future health of the Burlington, VT urban forests.

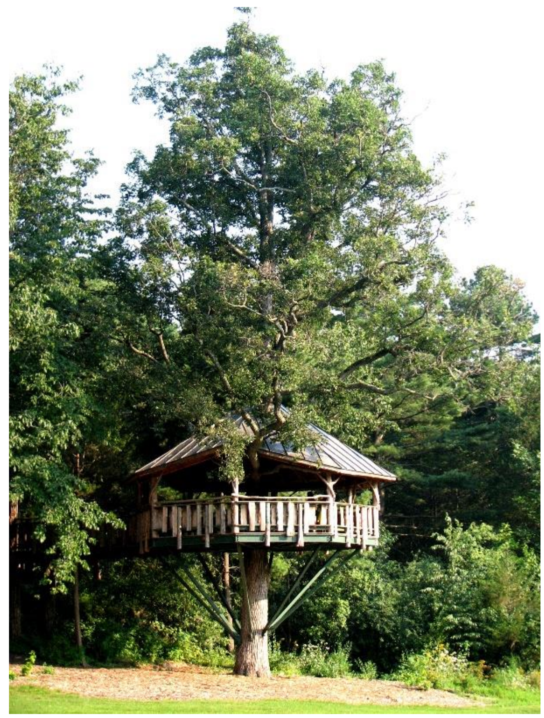

Figure 1. Tree house that sits on a large white oak at the outer edge of Oakledge Park's forest. Photo by Don Shall, www.flickr.com/photos/donshall/3843776286

Methods

Sixty-one randomly placed plots were stratified between interior woodland, transitional woodland, and exterior/open land cover classes as determined by aerial imagery using ArcGIS (Figure 3) for each park (Figure 6, Figure 5, Figure 4). Nearly 200 students were broken into groups and assigned plots with graduate TAs as well as VMC staff monitoring their work. The students followed the i-Tree Eco V5 protocol developed by the USDA Forest Service. The students collected tree species, tree status, land use code, diameter at breast height (DBH) of up to six stems, total height, height to live top, height to crown base, east-west crown width, north-south crown width, percent crown missing,

Figure 2. UVM student establishing plot 129 at Oakledge Park

percent dieback in crown, percent impervious under tree, percent shrub under tree, and crown light exposure. The students used compasses for collecting the direction from center, a measuring tape for distance and width measurements, a diameter-tape for the DBH measurements, and a clinometer for measuring heights. Their data were entered into the i-Tree Eco V5 program to analyze and produce the written report attached. After the students collected their data, VMC staff trained in the inventory methods conducted quality assurance visits to 5% of the plots at each park to ensure that the field data were collected accurately.

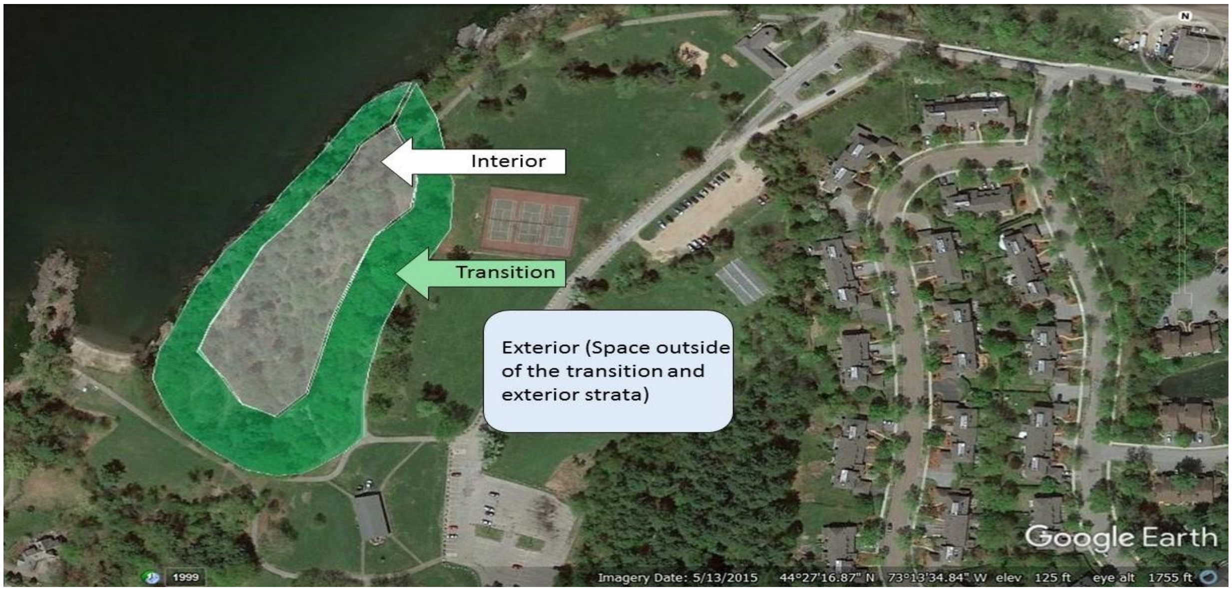

Figure 3. Example of three strata boundaries within Oakledge Park, Burlington, Vermont.

Oakledge Park

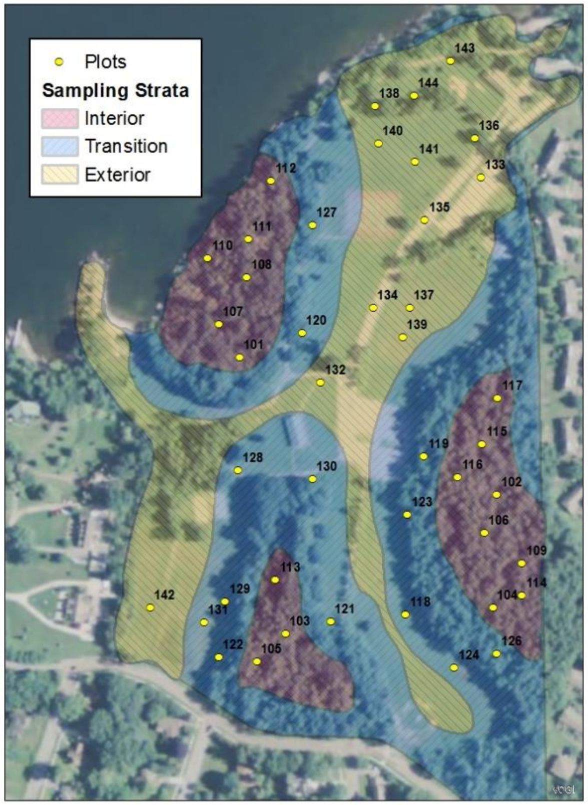

Figure 6. Map of Oakledge Park with plots 101-144

Burlington College

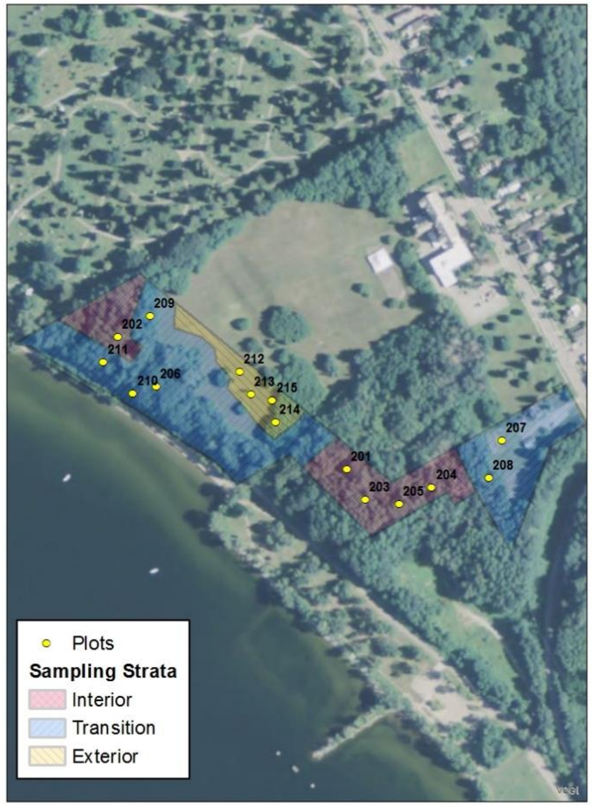

Figure 5. Map of Burlington College with plots 201-215

McKenzie Park

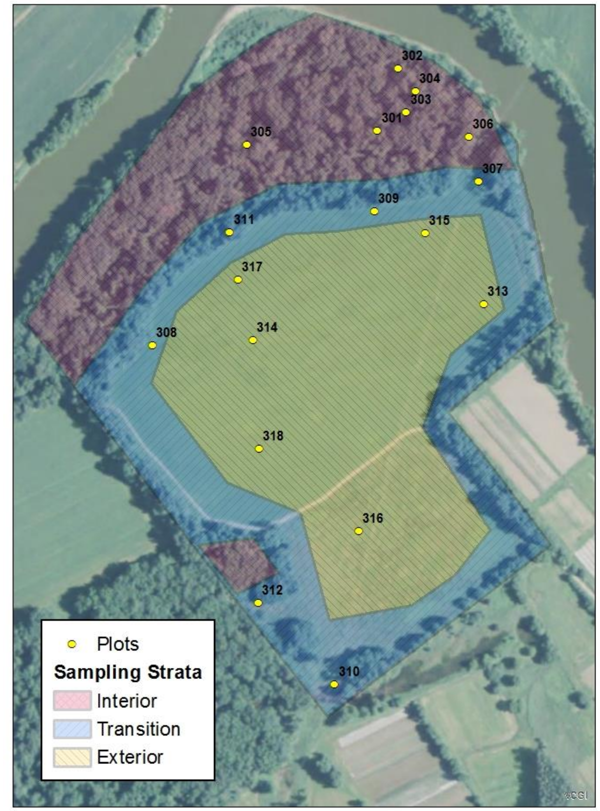

Figure 4. Map of McKenzie Park with plots 301-318

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Site Observations

Personally working with the students on the ground, I was able to make observations about the sites that I feel were not represented in the report. Oakledge Park is a heavily used park that resulted in many of the plots being near trails or open public areas. This could make it difficult to consider how new growth will occur without also considering disturbance. The plots on the western side of the park have a rocky substrate leaving little room for seedlings to develop. At McKenzie Park, the ground cover within the interior strata were classified as herb and grass. Japanese knotweed and stinging nettle made up the understory of these interior plots. Based on the abundance of these two herbs they will continue to disperse throughout the understory without proper maintenance, preventing the growth of other species. Burlington College had several plots with large black locust trees. However, there were dense thickets of black locust saplings on the northwestern side of the park not accounted for. This made it difficult to measure these saplings but from visual estimates, many of these saplings were less than three inches in diameter.

Figure 7. Black locust saplings to the right of plot 209's center.

Key Findings

Species Composition of the Dominant DBH Class

From the i-Tree analysis, the trees that are currently dominating the overstory of Burlington parks are eastern white pine, northern-white cedar, and boxelder. The report states that a third of the trees fall within the three to six-inch DBH class. Without any management intervention or major disturbance, these species will likely make up the future forest composition. Through further analysis of the species composition for the three- to six-inch DBH class the most abundant species were northern white cedar (17%) followed by red maple (13%), European buckthorn (11%) and eastern white pine (11%). This suggests that red maple could eventually overtake boxelder in relative dominance within these parks (Figure 8).

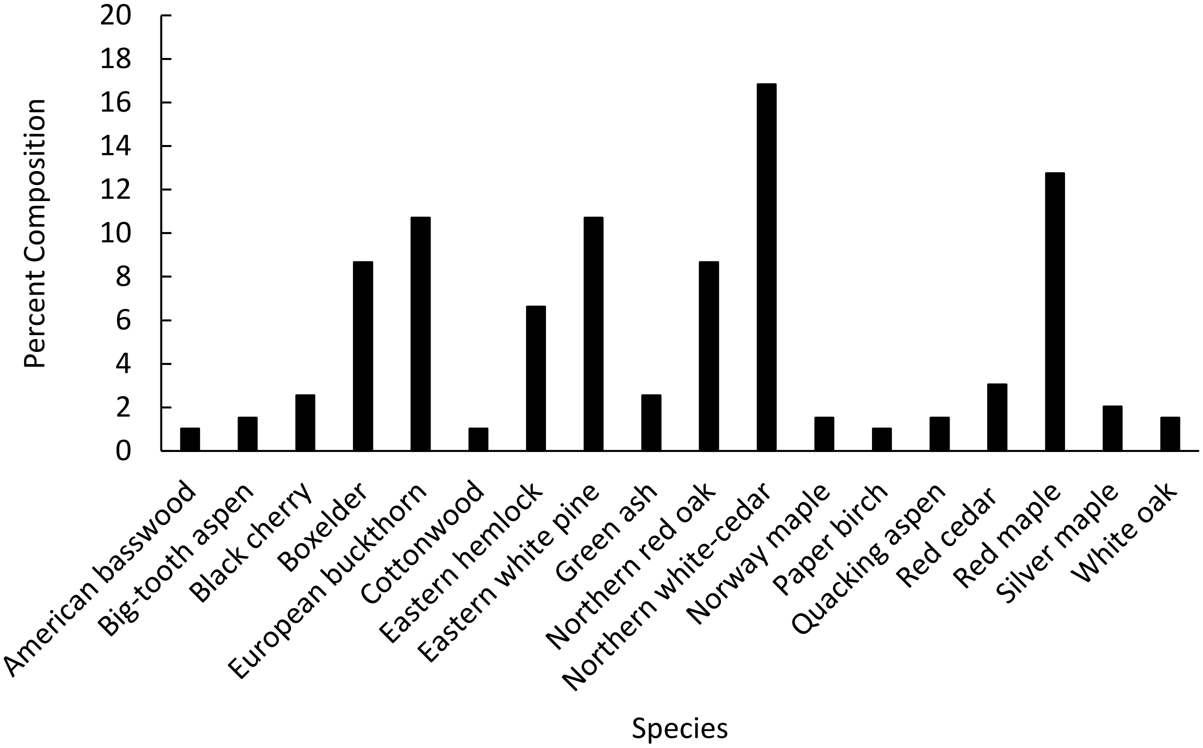

Figure 8. Species composition by percentage of DBH class 3 to 6 inches.

Comparison of the current composition of the top dominant trees in the 3 to 6 inch DBH class

Additionally, I analyzed the three dominant species within the three to six-inch DBH class to compare their percent composition within each of the three strata (exterior, transition and interior). The percent composition of each species was compared to the total number of trees within that stratum which included all DBH size classes. Northern white cedar was the only species out of the three found within the exterior strata. Northern white cedar makes up 36% of the trees found within the exterior. Northern white cedar was the most abundant out of the three species within the interior as well, contributing to 14% of the interior trees. Eastern white pine was the most abundant within the transition zone (21%). The strata that contained the highest abundance of these three species was the transition zone (39%) (Figure 9). This analysis provides insight into where these three species are currently growing as well as where future generations may establish themselves.

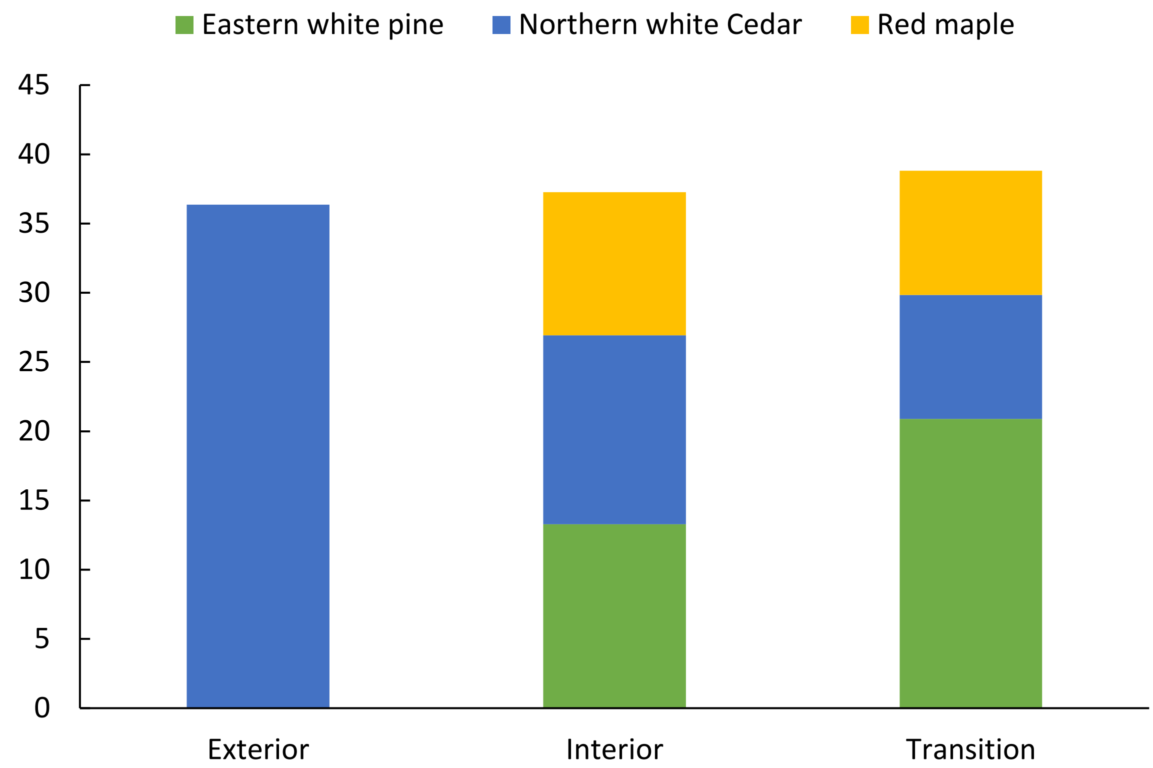

Figure 9. The percent composition of eastern white pine, northern white cedar and red maple between the strata surveyed within each park.

Invasive species

The three invasive species found within the parks were European buckthorn, black locust, and Norway maple. A comparison between each invasive species and their percent composition revealed areas where invasive species management should be considered to ensure spread does not occur. The percent composition for each species was calculated by comparing the count of each invasive species to the total number of trees at that stratum. The stratum that had the most invasive species was the interior (9%) followed by the transition (6%) and exterior (0%). The most abundant invasive species in the interior was black locust while the most abundant species in the transition zone was European buckthorn (Figure 10).

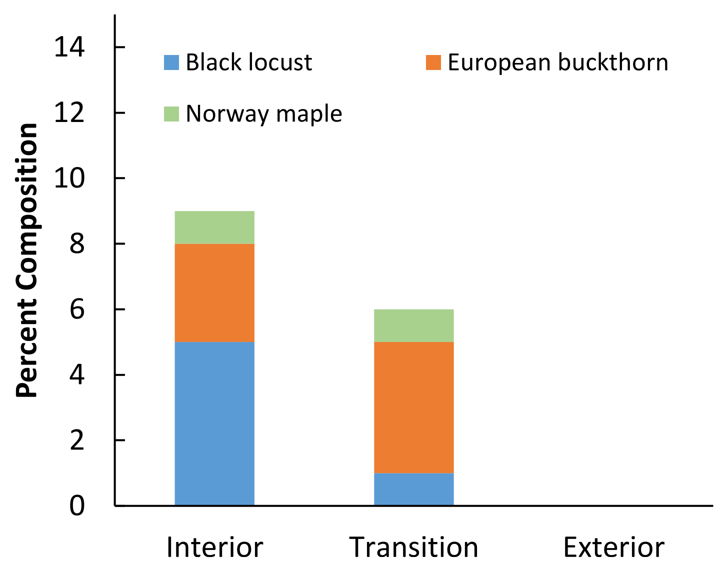

Figure 10. The percent composition of invasive species compared to all trees within that stratum between each stratum.

Composition of Large Trees by Strata

Figure 11. Large black locust snags at plot 202, Burlington College.

Comparing the large trees (anything taller than 50 feet) between each stratum revealed where the larger trees were located and which species developed the greatest number of large trees. The stratum with the highest number of large trees was the interior (69%) followed by the transition zone (29%). The most abundant large tree species were eastern white pine, which made up 36% of the large trees between all the parks, green ash (10%), black locust (9%), and red maple (9%) (Figure 12). Monitoring within the interior plots with special attention to eastern white pine, green ash, and red maple will provide an idea of the health and condition of these already-present larger trees. The larger trees ideally contribute to the majority of the canopy cover, and losing these trees could change the makeup of the understory, affecting the future composition of the overstory. Because black locust is one of the top large tree species, management would ensure that spread does not inhibit the growth of native species.

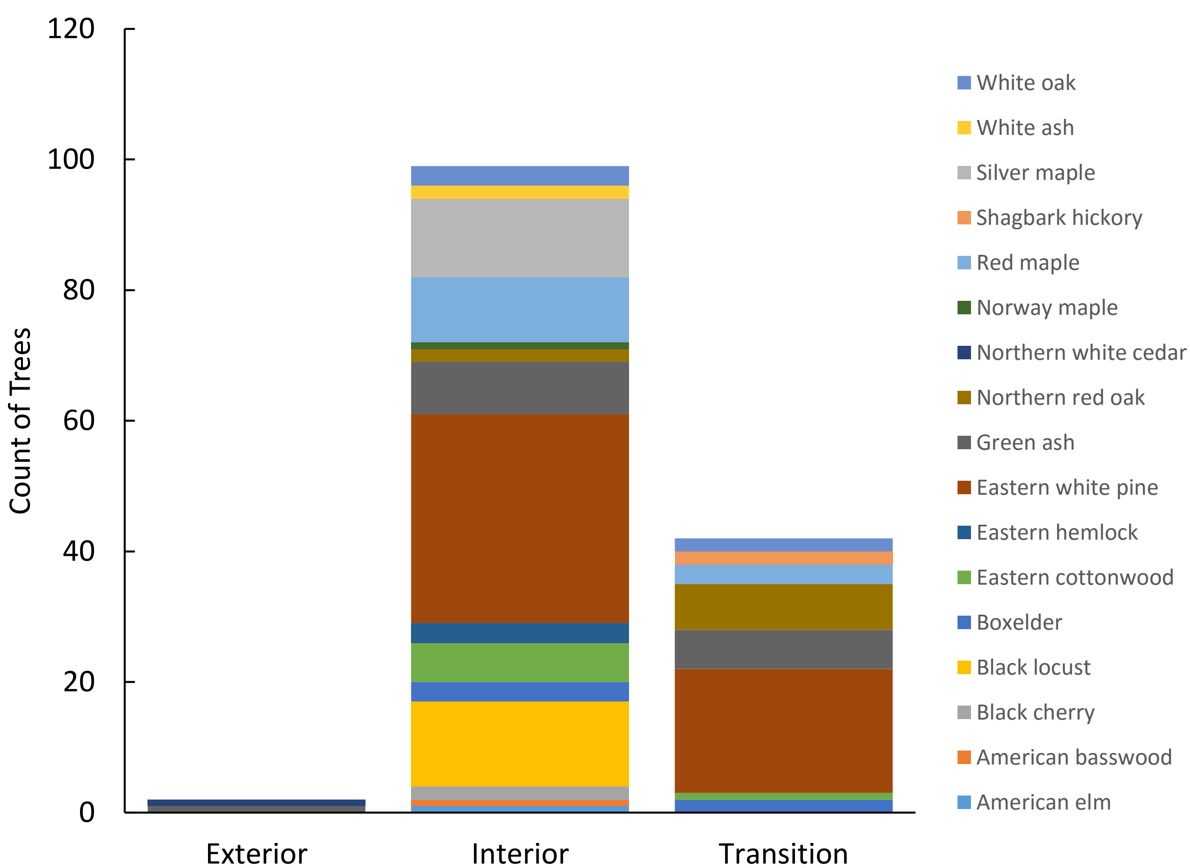

Figure 12. Comparison between all large trees (>50 feet in total height) in each of the three strata inventoried.

Species Diversity

Oakledge Park, McKenzie Park, and Burlington College had 38 tree species between them. Looking at the parks by strata, the interior stratum held the highest diversity with 26 tree species. The transition zone had the second highest with 21 species and the exterior had the least with four species (Figure 13). Although the exterior lacks diversity, there is a lower chance of invasive presence (Figure 10). Diversity is a great defense for forest ecosystems when dealing with species-specific disease as well as invasive species. The majority of the invasive species are located within the interior, but those areas will likely be more resistant due to their high diversity (Figure 13).

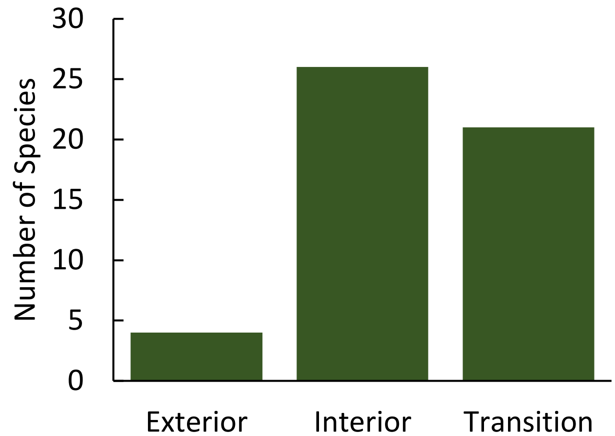

Figure 13. The numbers of species in each stratum. The stratum with the most species is the interior (26) followed by the transition zone (21) and the exterior (4).

Health of the Ten Important Species Reported by I-Tree

The i-Tree Eco V5 report calculates an 'importance value' (IV) to rank ten tree species from most important to least important. I-Tree calculated the importance value by summing the relative leaf area and relative composition. These species make up the majority of the canopy cover. Within the exterior plots, the only important species detected were boxelder, green ash, and northern white cedar. Out of these three species, boxelder had the highest average dieback rating while northern white cedar had the highest average percent crown missing rating (17%).

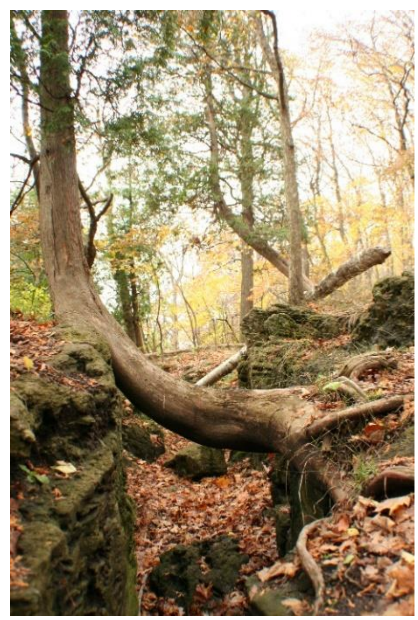

Figure 14. Thuja occidentalis by Mike O'Dowd. www.flickr.com/photos /modowd/273919527

Fifty-seven percent of the trees within the exterior plots were northern white cedars. Green ash was the second most abundant (29%) followed by boxelder (14%) in the exterior (Figure 16).

Within the interior, all ten species were present. These species had low average percent dieback ratings but had high average crown missing ratings. The three species with the highest average percent crown missing rating was boxelder (41%), eastern cottonwood (34%), and eastern white pine (30%). The species with the highest average percent dieback rating is eastern red cedar (53%) followed by eastern white pine (21%) and boxelder (20%) (Figure 16).

Figure 15. Acer negundo, boxelder by photo by Adrienne. www.flickr.com/photos/photosbyadrienne/10260384365

Only eight of the ten important species were present within the transition zone. There were no live or present black locust, eastern hemlock, or eastern red cedar in this stratum. Compared to the interior and exterior, the species within this stratum had dispersed health ratings. The species with the highest average percent crown missing rating were northern white cedar (37%), northern red oak (37%), and eastern white pine (33%). The species with the highest average percent dieback ratings were eastern cottonwood (48%), northern white cedar (41%), and boxelder (35%).

The percent composition of individual species was calculated from the total count of trees within that stratum for that species (Figure 16). These results could provide direction on where to focus monitoring of these ten important species. For example, if there were management interests on eastern white pine the focus would be on the transition plot. Eastern white pine makes up a third of the tree species within the transition zone. Eastern white pine in this stratum also has slightly higher health ratings (33% average crown missing, 25% average dieback) in comparison to the eastern white pine in the interior (30% average crown missing, 21% average dieback). Additional monitoring could look at the potential factors, if any, causing higher health ratings for eastern white pine in the transition zone.

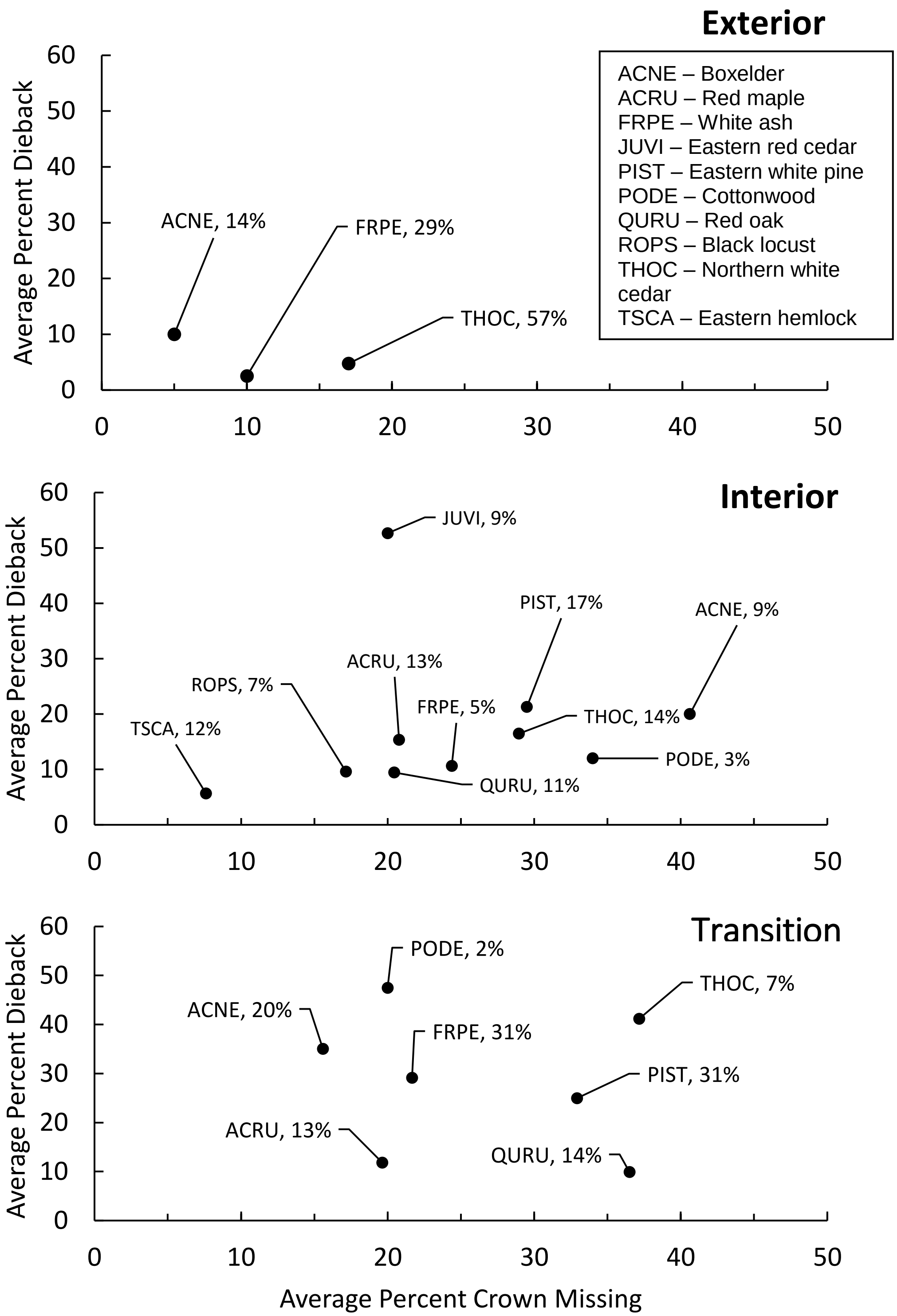

Figure 16. Comparison between the average percent crown missing and average percent dieback in crown of the most important tree species according to i-Tree Eco V5 by strata. A tree species with an average percent crown missing and average percent dieback of 0 indicates that the tree is perfectly healthy. A tree species with an average percent crown missing and average percent dieback of 100 indicates that the tree is dead. Each data label is the percent composition for that species compared to the total population of trees within the stratum.

Discussion of Findings

Overall, i-Tree Eco V5 analyzed the data collected at three Burlington, VT parks (Oakledge Park, McKenzie Park, and Burlington College) and produced a report according to the data entered into the program. I-Tree Eco determined that there are an estimated 7,210 trees within the three parks with a tree cover percentage of 40.3. The three most common tree species were eastern white pine (16.4%), northern white cedar (12.5%), and boxelder (10.6%). 35.1% of the trees are less than 6 inches in DBH. 94% of the tree species are native to North America while 91% are native to the state or district. The three invasive species found were European buckthorn (3.2%), black locust (2.7%), and Norway maple (0.7%).

Figure 17. Multi-use path in Oakledge Park, Burlington, VT. Photo taken by NNECAPA in April 2006. www.flickr.com/photos/nnecapa/2873617930

Based on these results future management and monitoring should focus on the interior and transition zone. Trees that fall in those strata will contribute most to the canopy cover as well as the future generation of forest. The interior and transition zone are also the strata with the highest presence of invasive species. The interior may not be high concern because the stratum contains high diversity and an abundance of mature trees. However, students observed that the Burlington College plots have a high abundance of black locust seedlings that were not measured which may cause disturbance for interior plots in the future. There is potential for many of these smaller seedlings to grow into the larger DBH classes if not maintained properly.

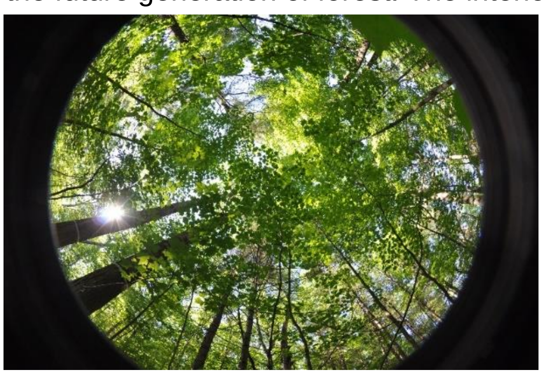

Figure 18.Hemispherical canopy cover photo of an urban forest in Vermont.

The transition zone has an abundance of European buckthorn that could raise some concern. The transition zone is not as diverse as the interior and lacks large trees. This makes the transition zone more susceptible to European buckthorn spread and outcompeting of its seedlings and saplings. European buckthorn was abundant within the Oakledge Park plots. Because this was the first year that these sites have been monitored, future efforts should continue to check the quality of the data as well as the growth of the trees over time. This could reveal patterns and trends not picked up from the first year of monitoring. If these inventory and monitoring efforts continue, crews should be trained to ensure that there is an understanding of the metrics being measured and the techniques required to collect them.

In addition to these forest health metrics there are ecosystem service metrics that were analyzed and reported within the i-Tree eco written report. These services include air pollution removal, carbon storage and sequestration, oxygen production, volume of avoided surface runoff, impact on building's energy usage, and structural and functional values. All field methods and calculations can be located in *Appendix I. I-Tree Eco Model and Field Measurements*. With further efforts, this data could be a valuable stepping-stone for the City of Burlington in planning and managing reforestation efforts in its public parks.

Data quality assessment

Due to the available time and resources, the sampling size area used in this study are too small to make any statistically strong arguments about the larger population. However, it does provide insight into the general make-up of the forest resources in these strata and parks. There were two cases at Burlington College where plots were inaccessible because they were dangerous due to construction as well as other interferences. There were a number of sampling errors during the monitoring process. To create the i-Tree report certain measurements must be collected to produce accurate results. Some of the data that the students collected was not properly collected or lacked the required data to produce a report based solely on the data they collected (Table 1).

Figure 19. Rhamnus cathartica by Matt Lavin, taken on September 24, 2012. www.flickr.com/photos/plant_diversity/8023755233

In cases where students never took the required measurements the quality check measurement was used as a substitute if the plot was one of the quality check plots. If the missing measurement was not part of the quality check, a measurement was calculated as a substitute. The calculation involved averaging the same measurement from surrounding trees under the criteria that they are of the same plot, general location, species, and size (+- 1 for all physical measurements).

Table 1. Percentage of trees affected by sampling errors. Measurements with an unclear measurement error had measurements that were recorded incorrectly or they deviated to far from the quality check standard and were adjusted in all cases.

Measurement	Error	Quality Check Standard	Percentage of trees affected
Azimuth	No measurement	+ - 5 degrees	7
Azimuth	Unclear measurements	+ - 5 degrees	44
Distance	Doesn't meet QC	+ - 1 foot	29
DBH	No measurement	+ - 3 inches	3
DBH	Unclear measurements	+ - 3 inches	26
Total Height	Unclear measurements	+ - 10 feet	35
Total Height	No measurement	+ - 10 feet	1
Height to Live Top	Unclear measurements	+ - 10 feet	39
Height to Crown Base	No measurement	+ - 10 feet	2
Height to Crown Base	Unclear measurements	+ - 10 feet	38
NS Crown Width	No measurement	+ - 10 feet	7
NS Crown Width	Unclear measurements	+ - 10 feet	39
EW Crown Width	No measurement	+ - 10 feet	2
EW Crown Width	Unclear measurements	+ - 10 feet	42
Percent Crown Missing	No measurement	+ - 10 percent	7
Percent Crown Missing	Unclear measurements	+ - 10 percent	34
Percent Dieback	No measurement	+ - 10 percent	7
Percent Dieback	Unclear measurements	+ - 10 percent	35
Percent Impervious	No measurement	+ - 10 percent	12
Percent Impervious	Unclear measurements	+ - 10 percent	37
Percent Shrub	No measurement	+ - 10 percent	7
Percent Shrub	Unclear measurements	+ - 10 percent	38
Crown Light Exposure	No measurement	+ - 2	7
Crown Light Exposure	Unclear measurements	+ - 2	35

Acknowledgments

This work draws on the efforts of multiple partners, including the Vermont Urban and Community Forestry program for providing coordinating and quality control field assistance; the Burlington Parks and Recreation Department for providing feedback on the project design and sampling scheme, and the students in UVM Rubenstein School of Environment and Natural Resources participating in the NR-01 service learning class. This work was made possible by long-term funding from the U.S. Department of Agriculture, Forest Service, Northeastern Area - State & Private Forestry.

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