Managing Invasive Species in an Urban Old-Growth Forest

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Introduction

The Thain Family Forest at The New York Botanical Garden is the largest remnant of old-growth forest that once covered New York City. A long-term study is being conducted in the Forest to observe vegetation change over time. When the Garden was first established on its current site in 1895, the Forest was known as the "Hemlock Grove" because the stand closest to the Bronx River was dominated by the Canadian hemlock (*Tsuga canadensis*). In 1923, it was observed that the natural regeneration of *T. canadensis* was less abundant in the Forest when compared to northern forests dominated by *T. canadensis* (Britton, 1926). This was the first indication that the *T. canadensis* was declining in the Forest. In 1985, Hurricane Gloria introduced the Hemlock Wooly Adelgid, leading to further decline of hemlock. This is one change in forest composition that has been well documented in the Forest inventory data sets from 1937, 2002, 2006, and 2011. These surveys have observed the dynamics of forest composition over time but have also informed current forest management. By analyzing raw data of 2002 and 2006, Garden staff noticed an increase of invasive plant species, particularly, Amur corktree (*Phellodendron amurense*), Japanese angelica tree (*Aralia elata*), and Amur honeysuckle (*Lonicera maackii*). In 2008, the Garden began to actively managing these three species in order to reduce their impacts on the overall ecosystem and to prevent them from becoming the dominant species in the Thain Family Forest.

Project Goals:
1. Analyze data sets from 1937, 2002, and 2006 to document the change of forest composition.
2. Create a new data set for 2011 and compare it with earlier data sets.
3. Monitor the ongoing management of invasive plant species.

Hypotheses:
1. The decline of *T. canadensis* will result in a composition shift to native hardwood tree species.
2. Three invasive plant species targeted as management priorities (*P. amurense, A. elata,* and *L. maackii*) will decline in frequency and density across the Forest.

Methods

Inventory Data

Fourteen 10-meter-wide transects starting on the western boundary of the Forest running east to the Bronx River bank were established 60 meters apart. These transects were established in 1985 (Rudnicky and McDonnell, 1989). This sample is 15% of the 20 hectare Forest west of the Bronx River.

The 1937 data set was collected by overlaying the transects divided into 246 10 meter x 10 meter plots on existing Works Progress Administration Maps where trees ≥15cm were identified to at least genus with DBH (diameter at breast height, 4.5 feet) noted on the maps.

Figure 1. Anne Hunter and Alyssa Beasley collecting DBH data.

The 2002 data set was collected in the field and recorded the identity and DBH for all stems ≥5 cm, this study resulted in 247 10 meter x 10 meter plots. Both the 2006 and 2011 data sets were collected for all stems ≥ 1cm and resulted in a total of 245 and 248 plots, respectively. Regardless of the difference in plot numbers for each sampling, the data sets are all a 15% sample of the 20 hectare Forest west of the Bronx River.

Invasive Species Management

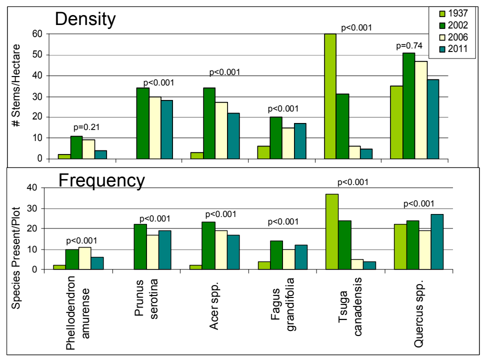
Priority management areas were laid out spatially based on the frequency per plot of each of the invasive plant species (*P. amurense, A. elata,* and *L. maackii*). The plants were managed using both mechanical and chemical methods. Mechanical methods involved cutting down large *P. amurense* and grinding stumps, and removing *A. elata* and *L. maackii* using the Weed Wrench™ (www.weedwrench.com) and Honeysuckle Popper® (www.misterhoneysuckle.com). For large trees away from a pedestrian paths, the plants were injected with Diamondback™ glyphosate shells using an Ez-ject™ lance (www.ezject.com).

Figure 2. Volunteers weeding *P. amurense* seedlings.

Since 2008, approximately 800 *P. amurense* trees ≥6 inches DBH have been removed from the Forest along with thousands of smaller *P. amurense, A. elata* and *L. maackii.* In addition to the removal of these invasive plant species, the Garden has restored the managed areas by planting native species. Since 2008, 6,000 trees and shrubs, along with 2,000 herbaceous plants grown from locally collected seed have been planted in the Forest. This work has been accomplished by Garden staff and over 12,000 volunteer hours.

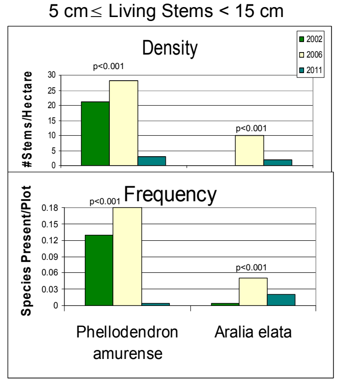
Results

Living Stems ≥ 15 cm



In the largest size class of living stems greater than or equal to 15 cm DBH, *P. amurense* density data shows that there has been no significant change between 1937 and 2011. However, frequency has significantly increased from 1937 to 2002 with a decrease in 2011. *Quercus* spp. density has shown no significant change between 1937 and 2011, density did increase but, has now come back to 1937 levels. This size class also shows a significant decrease of *T. canadensis* and increase of *P. serotina, Acer* spp., and *F. grandifolia.* Another interesting result not depicted in this graph is that the basal area of the entire Forest in 2011 was 23.4 sq.m/ha, essentially the same size as the Forest in 1937, 23.3 sq.m/ha.

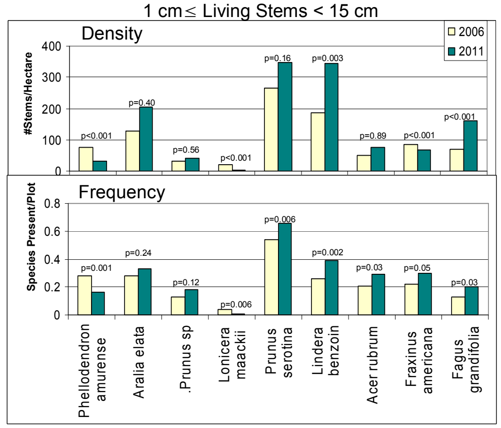
5 cm≤ Living Stems < 15 cm



This graph shows the smallest size class in the 2002 data set compared to 2006 and 2011, all living stems greater than or equal to 5 cm and less than 15 cm. These data clearly show a significant increase in *A. elata* and *P. amurense* between 2002 and 2006 with a decline in both in 2011.

Figure 3. Volunteers weeding *L. maackii* using the Honeysuckle Popper™.

1 cm≤ Living Stems < 15 cm



In 2006 and 2011, the surveys included an even smaller size class of living stems greater than or equal to 1 cm and less than 15 cm. The purpose of this increase in data collection was to improve the monitoring and detection of species on the rise throughout the Forest. This data set reveals a significant decrease in *P. amurense* and *L. maackii.* Though the change is not significant, there appears to be a continued rise of *A. elata* in this smaller size class between 2006 and 2011 in both stem frequency and density throughout the Forest. *Lindera benzoin, Fraxinus americana, and Fagus grandifolia, Prunus serotina,* and *Acer rubrum* are increasing in frequency where *P. serotina, L. benzoin,* and *F. grandifolia* are increasing in density.

Discussion

The Thain Family Forest is a dynamic ecosystem, with the decline of *T. canadensis* other native hardwood species are now the dominant species in the Forest canopy. Today, the canopy is mostly oak, red maple, and black cherry. Oaks in particular, have maintained the same density since 1937 and have increased in frequency. The management of larger Amur corktrees has resulted in a decrease in stem frequency and a decrease in density back to 1937 levels. Management has worked; however, continued management is still required to decrease the overall threat of this species to the Forest ecosystem. It is still present and could easily increase again to 2002 and 2006 levels if left unmanaged.

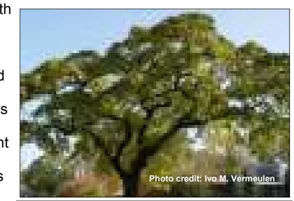


Figure 4. *P. amurense* planted in the Living Collections at the Garden.

The management techniques of removing specimens of *P. amurense* and *A. elata* has resulted in a significant decrease both the density and frequency of stems ≥ 5 cm and < 15 cm, however, the smallest size class including stems ≥ 1 cm and <15 cm has revealed an increase in *A. elata* stems. This species colonizes vegetatively through extensive root systems and is very difficult to control. Though the mechanical and chemical approaches decreased the larger size class of this species, a future management strategy should focus on the smallest stems. This increase in smaller stems could also be the response of the colony after control measures have been applied. Even though the larger specimens were removed, enough roots were left to allow for regeneration. *A. elata* is still a threat and will continue to be actively managed. *P. amurense* is still present in the smallest size class and prolific germination of seed has been observed in canopy openings where larger specimens were removed. Figure 2. displays volunteers weeding the thousands of seedlings present after one season in the canopy gap. Initial management has worked but, continued management is needed to reduce the threat of this species. The management of *L. maackii* has been the most successful out of all three priority invasive plant species. According to the 2011 data set, it has essentially been eradicated from the Forest.

The results of the smallest size class reveal a new species of concern that is rising in the Forest, though not significant, *Prunus sp.* or "weedy cherry," an undetermined cherry species has naturalized from the Garden's Living Collections. This species should be identified and management strategies considered. Similar to the largest size class, *P. serotina, L. benzoin, A. rubrum, F. americana,* and *F. grandifolia* are all on the rise and therefore the hypothesized future of the Forest. An increase in *F. americana* is of concern with the spread and increased threat of Emerald Ash Borer, a devastating invasive insect currently 50 miles from the Garden. Unfortunately, it poses a threat to forest regeneration and these young trees will most likely not be the future of the Forest canopy.

Future Steps

Further statistical analyses are necessary to fully understand the dynamics of the Forest ecosystem. Such analyses should include a cluster analysis to establish the dominant canopy types across the Forest, evaluation of all invasive plant species present in the data set, and spatial analyses that involve digitizing the transect data in ArcGIS. Mapping these data in ArcGIS would greatly enhance their use as a management tool. Future surveys will assess how the restoration planting is impacting Forest composition and monitor how invasive insects and diseases impact the Forest. Throughout its history Chestnut Blight, Hemlock Wooly Adelgid, and Elongated Hemlock Scale have all impacted the Forest. Today, Viburnum Leaf Beetle, Emerald Ash Borer, and Asian Longhorned Beetle are three known threats to the Forest. Future surveys can help document the impacts of present and future threats.

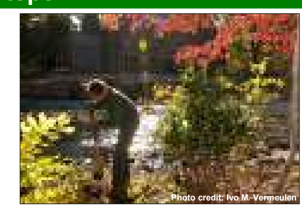


Figure 5. Anthony Copioli planting restoration trees.

References

Britton, N.L. 1926. An Attempt to Aid the Natural Propagation of Hemlocks. *Journal of The New York Botanical Garden*, 27(313): 6-9.

Rudnicky, J.L. and M.J. McDonnell. 1989. Forty-eight years of canopy change in a hardwood-hemlock forest in New York City. *Bulletin of the Torrey Botanical Club*, 116(1): 52-64.

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