Identifying and Tagging Tree Species for Removal and Revitalization Within the Dalhousie University Ocean Pond

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Executive Summary

The Ocean Pond is a space on Dalhousie Campus that was developed by faculty and students to create an area that replicated the natural forest ecosystem of Nova Scotia (Clark, 2006). The native ecosystem in Nova Scotia is Acadian forest, which is an ecosystem that consists of tree species such as Eastern White Pine and Red Spruce (Simpson, 2008). The Ocean Pond has not been maintained in recent years and for this reason, with the assistance of Sue Gass and Amy Mui, we chose to research how to revitalize the pond and we began the process ourselves. We worked in the Ocean Pond to identify, tag, and measure invasive tree species for removal. In order to identify the species and decide which to remove, we worked with James Steenburg and Kendra Marshman. We chose to remove two invasive tree species which were the European Ash and the Norway Maple. We used flagging tape to identify each tree. Afterwards, we measured the diameter at breast height of each tree we had tagged so that they can be removed. We recorded this data and analyzed the results. The majority of trees we tagged for removal were European Ash trees and the total diameter at breast height for all the trees measure was 904.9 centimeters. After the invasive tree species are removed, they will be replaced with species native to Nova Scotia. The first two species we recommend to replant with are Red Oak and Eastern White Pine because these trees are native to the Acadian Forest and they were present on Dalhousie University campus before the land was cleared. These species are also a good choice because they will likely survive climate change. The third species we recommend for replanting with is Black Ash. This species is culturally significant to some indigenous groups within Nova Scotia (Unama'ki Institute of Natural Resources, 2005) and is a native species to Nova Scotia.

As part of the revitalization process, we chose to consider how to make the Ocean Pond more appealing as an outdoor learning classroom or laboratory. We identified which classes may be able to involve use and maintenance of the Ocean Pond in their curriculum in order to reach their learning objectives. We found that there are many different classes from a variety of faculties that would benefit from using the Ocean Pond including biology, environmental science, and geography. In order to make the Ocean Pond a more appealing area for classes we recommend adding benches and pathways. There is already space around the edges of the pond where benches for about 20 people would fit comfortably. We also recommend adding more signage to attract attention to the pond.

Going forward, the Ocean Pond should be monitored regularly for invasive species. There are many tree, bush, and other plant species that we were unable to identify and may need to be

removed as well. We also recommend that a maintenance plan is developed to ensure that there is yearly upkeep of the Ocean Pond in order to preserve the area as a native Nova Scotian Habitat, as was originally intended.

Introduction

The Acadian forest, nestled in between the Northern Hardwood Forest in the south and the Boreal Forest in the north, covers the majority of the Maritime Provinces as well as sections of New England, Gaspe Peninsula, and parts of Maine (Simpson, 2008). Due to its proximity to the other two forest types that surround it, the Acadian Forest shares similar characteristics to them. It has a variety of tree species that include both soft and hardwood trees such as Red Oak, Eastern White Pine, Black Ash, and Red Spruce, a total of 32 native species in all (Simpson, 2008). The combination of the tree species of the Northern Hardwood Forest and the Boreal Forest makes the Acadian Forest one of the most diverse temperate forests. Due to temperature differences between the two forests that surround the Acadian Forest, the trees that cover it have since adapted to the less extreme climate and have become more tolerant to temperature than those in the Boreal and Northern Hardwood Forests (Simpson, 2008). However, climate change has increased the temperature at a much faster rate than is natural and therefore affects the diversity of the trees because the hardwoods are more acclimated to the cold and will not thrive in warmer conditions. Also affecting the diversity, both in terms of age distribution of trees and biological diversity, of the forest are the variety of human disturbances such as unnatural forest fires, introduction of nonnative species, clear cutting, and homogeneous tree plantations (Sanders, 2005). This puts even more stress on the forests because they are also exposed to other natural disturbances such as pests, natural fires, and windstorms (Flannigan, et. al, 1998). Despite so many changes to the environment, the Acadian forest is constantly adapting to the changes in the environment.

One of the results of rising temperatures, and other changes to the environment, in the Acadian Forest is the dominance of tree species that are able to thrive in warmer climates and the proliferation of introduced species that are better suited than the more temperature-sensitive native species (Sanders, 2005). Another result of the alteration of the environment is the change from old growth forests to forests with very small and young trees (Simpson, 2008). Unlike the ancient trees of the old growth forest, the younger trees that have become the overwhelming majority are usually short lived (Simpson, 2008). These smaller and younger species of trees in the modern Acadian forests are so successful because they thrive in the new conditions and

altered environment and ultimately outcompete the late successional trees that were once the dominant species (Mosseler, et al.,2003). The various modifications to the ecosystem, due to various modifications to the ecosystem, is not only specific to trees and plant life: the change has also brought about the disappearance of some animal species and has heavily impacted fauna diversity and their ability to sustain a healthy population (Master, 2010).

Dalhousie University staff and students, in an attempt to replicate a pristine Nova Scotian forest ecosystem for student learning on Studley Campus, planned out and implemented a small man-made and self sustained ecosystem consisting of a small pond and some habitable space for trees, shrubs, and other wildlife to flourish. Because of the demand for a greener campus, a healthy environment, and for a natural ecosystem specifically for student learning, some graduate students, Dr. Willison,the Facilities Management, and Ocean Ltd. partnered up to plan and implement such an area (Clark, 2006). After university wide support for new sustainability initiatives, policy, and improved environmental management the Ocean Ltd. company provided rocks, a liner, and created what is now known as the Ocean Pond in 1997 (Vermeer, et.al, 1994). This name was given to the small pond because all of the materials and work to implement the project was donated by the Ocean Ltd. company. Once finished, native species of trees and other flora was introduced and left to grow and reproduce (Vermeer, et.al, 1994).

The Ocean Pond was originally intended to be a man-made ecosystem representative of pristine Nova Scotia forests. In other words, it was mean to be a small-scale Acadian forest ecosystem. It was left alone for many years in an area surrounded by mostly decorative introduced species, however, and it is very likely that some of the trees inhabiting the Ocean Pond now are not native species. In an attempt to restore the Ocean Pond back to a native ecosystem, information was gathered from Dalhousie University staff, online resources, and by going to the pond. Using tape and measuring tools, two invasive tree species were tagged and measured. Tagging was done for easy identification of the trees that are to be measured before removal due to a university policy called the Tree Protection and Biomass Replacement Policy which requires that “the removal of a tree must replace the tree with an equal 1:1 ratio of new vegetation” (2014). While keeping policy and helpfulness in mind, we developed a research question which we determined would produce the most beneficial answer: which species of trees native to Nova Scotia would best sustain biodiversity in the Ocean Pond after removal of the invasive tree species and how can Dalhousie course learning objectives be incorporated into the ongoing maintenance and revitalization of this ecosystem? In accordance the Dalhousie University Natural Plan, which states that “[a] long-term goal is to achieve a sustainable network of campus vegetation while allowing the campus to change and develop over time” (2014), this project strives to gather and

then record data that will be helpful to Dalhousie University for the sustainable management of the Ocean Pond, specifically the identification and measurement of invasive tree species, information required for removal of said trees.

Methods

We began our research project by meeting with Susan Gass and Amy Mui on March 15th, 2018 to discuss which direction to take our research and gain information about why the Ocean Pond was formed and why it is no longer maintained. In order to best address our research question, we chose to take a quantitative methods approach. We considered taking a more qualitative approach by investigating student's perceptions of the Ocean Pond but decided the quantitative approach better aligned with our research goals. Next, we met with James Steenburg and Kendra Marshman on March 21st, 2018 at the Ocean Pond. With James and Kendra's expertise, we identified as many species within the ocean pond as possible. We were restricted in our ability to identify species without the foliage on the flora. To identify species without their leaves, we relied primarily on the shape and colour of the buds and the texture and colour of the bark. While we were at the Ocean Pond, we measured the size of the Pond to the nearest foot using a tape measure supplied by Sue Gass. We recorded the measurements and drew a rough draft map of the Ocean Pond area. While we identified the species within the pond, we recorded the approximate location of all the plants we could identify.

After we identified as many species as we could, we discussed which species to tag for removal from the Ocean Pond. Once we came to a conclusion, our team began tagging two tree species with tagging tape. Over the next week we met multiple times at the Ocean Pond to continue, and finally complete, the tagging process. On March 27th, 2018 we met with Kendra Marshman at the Pond again in order to learn how to measure the diameter at breast height (DBH) of trees. In our previous meeting Kendra and James had informed us that diameter at breast height must be measured before trees can be removed from campus according to the Dalhousie University Natural Environment Plan (Dalhousie University, 2014). In order to comply with this plan we measured the diameter at breast of height in centimeters of all the trees we had tagged that had a diameter equal to or larger than 0.5 centimeters. We used calipers to measure the diameter of the trees 1.3 meters above the ground and we used DBH tapes to measure any trees that had a diameter of 7.0 centimeters or larger. We borrowed the calipers, DBH tapes, and clipboards from Peter Dunkirk. We recorded the diameter at breast height of the trees on paper and then later entered it into an Excel spreadsheet for analysis. We visited the Ocean Pond twice

to measure all of the trees we had previously tagged. While we measured, we marked the tagging tape already on the trees to ensure we did not lose track of which trees had been measured. After the data was entered in to the Excel spreadsheet we calculated the average diameter at breast height, the percentage of the number of trees tagged from each species, and the total tree diameter.

Next, we researched which species should be used to replace the trees that we tagged for removal. When we first met with James Steenburg, he had suggested some species to consider. We met with Rochelle Owen on April 2nd, 2018 to hear her thoughts on which trees would be well suited to conditions in the Ocean Pond. We also used scientific journal articles and other internet sources to inform our choices. One of our objectives was to consider how the Ocean Pond could be beneficial to various classes at Dalhousie and research which classes could perhaps implement use and maintenance of the Ocean Pond into their curriculum. In order to choose appropriate classes, we read the course learning objectives for various courses at Dalhousie University and selected which courses could use the Ocean Pond to help achieve their desired learning outcomes. Lastly, we considered how we could physically alter the Ocean Pond in order to make it more enticing as a learning space for students, staff, classes, and the general public.

The largest limitation to this study was the time of year. The flora in the Ocean Pond are lacking foliage in March, and we were not able to identify many of the species in the Pond, even with help from James Steenburg. Another limitation is that our study only focused on tree species. There are likely other flora including shrubs and aquatic plants that should be removed from the pond as well. Another limitation is the size of trees. There were many very small trees that were difficult to identify without mature buds and they were easy to miss while tagging.

Results

The trees that we were able to identify with the help of James Steenburg were as follows: one Linden (*Tilia*), one Tamarack (*Larix laricina*), one Red Spruce (*Picea rubins*), one Scotch or Chinese Elms (*Ulmus*), one Grey Birch (*Betula populifolia*), one Red Oak (*Quercus rubra*), and many European Ash (*Fraxinus excelsior*) and Norway Maple (*Acer platanoides*) trees (*Figure 1*). Of the trees we identified, we decided to tag the Norway Maple and the European Ash. James Steenburg also tagged the elm tree. He was not sure if it was a Scotch Elm or a Chinese Elm but he said either way it should be removed from the pond. We chose not to look for other elm trees in the Pond because we did not feel confident in our ability to identify this species of tree without

the help of James. James also mentioned that there were other invasive species in the Ocean Pond, including a type of rose bush, but said he was not able to identify these species without foliage.

We chose to tag the Norway Maple (*Acer platanoides*) trees for removal from the Ocean Pond because Norway Maple is an invasive tree species (Steenburg, 2018). It was introduced to North America from Europe and it is often used as a street tree (Farrar, 2017) (Steenburg, 2018) and for ornamental purposes (Tree Canada, n.d.). Norway Maple suppresses the growth of native trees by casting shade over the understory and this can lead to erosion of the soil (Steenburg, 2018). The leaves of the Norway Maple look similar to those of the Sugar Maple (Farrar, 2017) (Steenburg, 2018), however, it has been found that the Norway maple can inhibited the growth of other maple tree species such as the Sugar Maple (Galbraith-Kent and Handel, 2011). The Norway maple is a shade tolerant species (Tree Canada, n.d.) and this likely contributed to its ability to thrive in the Ocean Pond despite the Pond being shaded by nearby buildings. We decided to remove the *Acer platanoides* trees from the pond because they are not native to Nova Scotia and are harmful to native species. We were able to identify this species by its bright red buds and its dark grey bark with ridges (Farrar, 2017) (Steenburg, 2018). The species is distinctive form the sugar maple because there is a white sap that resides in the leaf stems and can be seen if one is broken (Steenburg, 2018) (Tree Canada, n.d.).

We chose to tag the European Ash (*Fraxinus excelsior*) trees for removal from the pond as well. Although the species is not usually considered invasive, it is becoming very abundant and will likely begin to be considered invasive more often (Steenburg, 2018). According to the National Wildlife Federation, an invasive species is “a living organism that is not native to an ecosystem and causes harm” (National Wildlife Federation, n.d.) and this definition applies to the European Ash in the Ocean Pond. For these reasons we decided to consider the European Ash invasive in this case. The species was introduced to North America from Europe and it is often used for landscaping purposes (Farrar, 2017). Although there is not much research done on how the European Ash affects native species, any non-native species in high abundance is likely to take up space and resources and therefore restrict the growth of native species. For these reasons we decided that this species should be removed from the pond as well as the Norway Maple. We were able to identify this species because it has opposite branches and the buds are an inky black (Farrar, 2017); the ends of the branches sweep upwards (Steenburg, 2018) and the bark has a distinctive look.

Table 1 in the Appendix contains the raw data for the diameter at breast height of all the trees we tagged with a diameter of 0.5 centimeters or greater, excluding the elm tree. We did not

include the elm tree in our analysis because we did not attempt to identify any more trees of this species and we focused on the Norway maple and European ash species instead. We recorded the diameter at breast height of 372 trees and 285 of these were European Ash (FREX), and 87 were Norway Maple (ACPL). This means that 77% of the trees we measured were European Ash trees and 23% were Norway Maple trees (*Figure 2*). We found that the average diameter at breast height for all of the trees we measured was 2.4 centimeters. The total tree diameter at breast height for all the trees measured was 904.9 centimeters. It is evident that the majority of the trees we tagged for removal were European Ash trees and that most of the trees had a small diameter at breast height and therefore the majority of the trees were young.

Discussion

The Ocean Pond is an underutilized space on the Dalhousie Studley campus, so we began this project to see what could be done to recreate the area to make it more attractive to professors, students, and those walking by, as well as making the space into a healthy native ecosystem. In order to recreate a natural ecosystem in the Ocean Pond, we developed recommendations using the tree species of the Acadian Forest region because they are species that will be tolerant to the Ocean Pond conditions, climate change and some are species with cultural significance.

Halifax, Nova Scotia is a part of the Acadian Forest region. The key six tree species of the Acadian Forest are Red Spruce (*Picea rubens*), Yellow Birch (*Betula alleghaniensis*), Eastern Hemlock (*Tsuga canadensis*), Sugar Maple (*Acer saccharum*), Red Oak (*Quercus rubra*), and Eastern White Pine (*Pinus strobus*). These species vary in population density throughout the province depending on the environment (Mosseler, Lynds, & Major, 2003). The Acadian Forest is primarily dominated by Red Spruce, Eastern Hemlock, and White Pine, known as the three major “longed-lived native species” (Mosseler, Lynds, & Major, 2003). Eastern White Pine tends to dominate drier environments, while Red Spruce prefers moist areas. The Eastern Hemlock is best suited to cooler environments, near large bodies of water. Unfortunately, the Adelgidae insect attacks and kills Hemlock trees (Forest Invasives, 2015), which makes it unsuitable for planting in the Ocean Pond.

The Ocean Pond receives a considerable amount of shade from the surrounding buildings and windy conditions coming off the water. To narrow down our species recommendations, we looked at which species will thrive in this environment. The tree species native to the campus area that were not cleared for pasture are the Red Oak and Eastern White Pine. Both of these

species are thriving in the area on the Dalhousie Studley Campus behind Sheriff hall. This natural indicator tells us that both species will most likely thrive in the Ocean Pond (Owen, 2018). Out of the six key Acadian Forest species, the Red Oak and Eastern White Pine trees are our recommendations for replanting the Ocean Pond with.

Incorporating climate change adaptation when planting trees is a growing field within forest management. It is predicted that climate change will impact forests by increasing insect infections, disease, and drastic weather patterns (Steenberg, Duinker & Bush, 2011). For our tree species recommendations, we wanted to explore which species will likely survive changing temperatures from climate change. Southern tree species are more likely to adapt to the changing temperatures, while northern species are more susceptible to insects, disease, and extreme weather. Southern species that are highly favorable in warmer climates include Red Maple, Eastern White Pine, American Beech, and Red Oak (Steenberg, Duinker, & Bush, 2011). This information tells us that the Red Oak and Eastern White Pine will continue to thrive in the Studley Campus environment into the future.

Black Ash (*Fraxinus nigra*) or Wisqoq has been used by the Mi'kmaq people in Nova Scotia for culturally significant practices and tools (Unama'ki Institute of Natural Resources, 2005). Black Ash was over-forested and cleared for agricultural land which lead to its current state of decline. Black Ash thrives in marshy areas with wet soil and can stay healthy in partial shade. (Unama'ki Institute of Natural Resources, 2005). The Ocean Pond is modelled after a wetland environment and is shaded so the Black Ash would thrive in the areas surrounding the pond.

Based on the natural characteristics of the Ocean Pond and discussions with professors and faculty members, we recommend that Dalhousie University replants Red Oak, Eastern White Pine, and Black Ash trees in the Ocean Pond. These species are most likely to thrive naturally in the Ocean Pond environment with little maintenance. The Black Ash should also be planted in order to provide an area that recognizes its cultural significance to the Mi'kmaq which would aid in the Ocean Pond becoming a place of value to members of the Dalhousie community.

Part of our analysis was how to make the signs and information about the pond more attractive and accessible. It was concluded that there should be more signs implemented near and in the pond while also making those signs more attention grabbing with pictures and scientific facts. Some suggestions for new signs are to make them larger and more visible, add photographs, less text blocks, and spread them out across the campus (poster boards, online photos, physical signs etc.). This would help spread information on the pond, but it would also inform people that the Ocean Pond exists and that it is a valuable educational site. Information about the Acadian Forest and its native species could be included on the signs. Adding an

educational value to the signs may encourage classes to use the pond and spark interest in natural ecosystems in Nova Scotia.

To make the Ocean Pond a viable outdoor classroom, there needs to be some modifications to the site. An important addition would be adding benches and seating to accommodate about twenty people, this would allow for it to become a physical classroom where students can learn. There are other missing features that would improve the safety of the pond as well as make it a better learning space, suggestions include more lighting, gates that properly lock, pathways to the new seating, and warning signs such as “slippery”. Other than the few minor adjustments and additions to the site, it is a place that can be used as a classroom immediately as there are no barriers or reasons as to why it should not be utilized.

Certain classes would benefit from the use of the Ocean Pond that do not currently use it as a classroom or lab space. Table 2 lists and briefly describes why those particular classes can and should use the space, but there may be classes not on the list that would be interested in using the Pond as well. This outdoor learning space can be used by any class that the professor or lab coordinator believes would benefit the learning of their students. The suggested classes were based on the Dalhousie Academic Timetable of classes being offered in the 2018/2019 year, so this can be updated every year for new classes or to take off ones that are no longer being offered. Classes that can use this pond have been found in seven different faculties but, again, are not limited to these. Faculties that have been highlighted are biology, environmental science, environmental studies, geography, physics, planning, and sustainability. Topics of study can include invasive species, native species, planning of urban green space, sustainable project management, landscape analysis, and ecology as well as many others. The information that can be extracted from this pond is vast and should not be limited to the suggestions in this paper, however we are trying to portray how valuable this space is for students and professors alike.

The Ocean Pond is a beneficial space as it expands the amount of greenery on campus, which can improve the health of Dalhousie’s population (Thompson and Silveirinha de Oliveira, 2016). According to the World Health Organization (WHO) urban green spaces can have certain stress relief effects called *Psycho-physiological stress reduction theory* and *Attention Restoration Theory* (Thompson and Silveirinha de Oliveira, 2016). These theories suggest that when humans are around green spaces and natural settings they cause a “parasympathetic nervous system response” which leads to a feeling of relaxation and lowered stress levels (Thompson and Silveirinha de Oliveira, 2016). The theories also suggest that being around natural areas improves the ‘direct attention’ which in turn improves cognitive function and performance (Thompson and

Silveirinha de Oliveira, 2016). Therefore, having this natural green space on campus likely helps with student stress levels and may help improve academic performance.

Conclusion

The Ocean Pond is a viable learning space that can be easily transformed to entice professors to incorporate it into classes and students to enjoy it. There are current classes that can use the space within the objectives of the course, but professors need to be informed that it is an area that is available for use. This can be done by adding new signs, posting information on the Dalhousie University websites Dal.ca and DalOnline.ca, and students using this space in projects and reports. The Ocean Pond is not just a space that educates students, it can also lower their stress levels and improve attention due to the natural setting it provides.

The Halifax Peninsula urban forest consists of mostly introduced European species, specifically Norway Maple (Halifax Regional Municipality, 2013). The large Norway Maple demographic creates a lack of diversity within the area due to its invasive nature. Adding Acadian Forest species to Dalhousie's Ocean Pond will assist in creating some species diversity within the area. This will not only provide Dalhousie students and staff a learning opportunity, but also provide the City of Halifax an example of replantation of native species. The Halifax Peninsula urban forest species are an aging tree population (Halifax Regional Municipality, 2013), planting new trees is necessary to maintain the current canopy cover. The outcome of the Acadian Forest in the Ocean Pond could motivate the City of Halifax to replant our species recommendation throughout the Halifax Peninsula, creating an urban forest based on the Acadian Forest region.

There are many recommendations we have for the future moving forward with the Ocean Pond. The general upkeep of this space is crucial, keeping the benches clean, lights on, pathways clear and so on. There should also be a check for invasives done every few years to ensure there is no new growth as it is possible we may have missed some small trees and it can take several years to eradicate invasive plant species. We were unable to identify many of the species within the pond because of the lack of foliage during the time of the study. Once there is foliage on the flora in the Ocean Pond, the species should be identified again. There are likely other non-native tree species as well as non-native bushes and aquatic plant species that we did not identify. Overall, our project was just the start of revitalizing the pond and efforts will need to be made for years to come in order to return the pond to a native Acadian forest environment.

Acknowledgments

First, we would like to recognize that Dalhousie University and the Ocean Pond reside on Mi'kma'ki, which is the traditional ancestral territory of the Mi'kmaq people and we aimed to consider this when making recommendations for the transformation of the Ocean Pond.

We would like to thank the professionals at Dalhousie University who offered their expertise, knowledge, opinions, and time to help us achieve success in beginning the revitalization of the Ocean Pond. These individuals were James Steenburg, Kendra Marshman, Roechelle Owen, Susan Gass, and Peter Dunkirk. Without the guidance from these members of the Dalhousie community we would not have been able to complete our project.

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References

Carr, D., Duinker, P., Morton, J., Ratcliffe, G., Rapaport, E., Vollick, C., & Wilkinson, M. (2014, April). Dalhousie University Natural Environment Plan (S. Cushing, Comp.). Dalhousie University, Halifax.

Clarke, Amelia. (2006). The Campus Environmental Management System Cycle in Practice: 15 Years of Environmental Management, Education and Research at Dalhousie University. International Journal of Sustainability in Higher Education, 7(4), 374-389.

Dalhousie University. (2014, April). *Dalhousie University Natural Environment Plan*.

Farrar, J. L. (2017). *Trees in Canada*. Ottawa: Natural Resources Canada, Canadian Forest Service.

Flannigan, M. D., Bergeron, Y., Engelmark, O., & Wotton, B. M. (1998). Future wildfire incircumboreal forests in relation to global warming. Journal of Vegetation Science, 9(4), 469-476.

Forest Invasives . (2015). *Hemlock Woolly Adelgid*. Retrieved April 3, 2018, from Forest Invasives: http://forestinvasives.ca/Meet-the-Species/Insects/Hemlock-Wooly-Adelgid

Galbraith-Kent, S. L., & Handel, S. N. (2011). Acer rubrum (red maple) growth is negatively affected by soil from forest stands dominated by its invasive congener (Acer platanoides, Norway maple). *Plant Ecology, 213*(1), 77-88. doi:10.1007/s11258-011-0008

Halifax Regional Municipality. (2013). *Urban Forest Master Plan.* Dalhousie University, Halifax.

Master, T. (2010, August). OOS 2-4: *Responses of eastern hemlock dependent songbirds to hemlock woolly adelgid infestation in Appalachian riparian forests*. In The 95th ESA Annual Meeting.

Mosseler, A., Lynds, J., & Major , J. (2003). Old-growth Forests of the Acadian Forest Region. *Environmental Review, 11*, 47-77.

National Wildlife Federation. (n.d.). Invasive Species. Retrieved March 31, 2018, from https://www.nwf.org/Educational-Resources/Wildlife-Guide/Threats-to-Wildlife/Invasive-Species

Owen, Rochelle. (2018, April 2). Personal Communication.

Sanders, J. N. (2005). Towards a model policy for implementing ecoregional conservation in the Northern Appalachian/Acadian forest ecoregion (Doctoral dissertation, Concordia University).

Simpson, J. (2008). Restoring the Acadian Forest. Nova Scotia, Canada: Res Telluris.

Steenberg, J. (2018, March 21). Personal Communication.

Steenberg, J. W., Duinker , P. N., & Bush, P. G. (2011). Exploring Adaptation to Climate Change in the Forests of Central Nova Scotia, Canada. *Forest Ecology and Management*, 2316-2327.

Thompson, C.W. & Silveirinha de Oliveira, E. (2016). *Urban Green Spaces and Health; A Review of Evidence.* Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0005/321971/Urban-green-spaces-and-health-review-evidence.pdf?ua=1

Tree Canada. (n.d.). Tree Killers: Norway Maple. Retrieved March 31, 2018, from https://treecanada.ca/resources/tree-killers/norway-maple

Trees and Shrubs. (n.d.). Retrieved April 10, 2018, from https://www.dal.ca/dept/sustainability/programs/Natural_Environment/trees-and-shrubs.html

Unama'ki Institute of Natural Resources. (2005). *Black Ash* . Retrieved from Unama'ki Institute of Natural Resources: http://www.uinr.ca/black-ash/

Vermeer, L.A., Shaw, J.A. and Aatre, R. (1994), “Preliminary draft proposal on the development and implementation of an ecological garden around the Life Sciences Center”, Dalhousie University, Halifax

Appendix

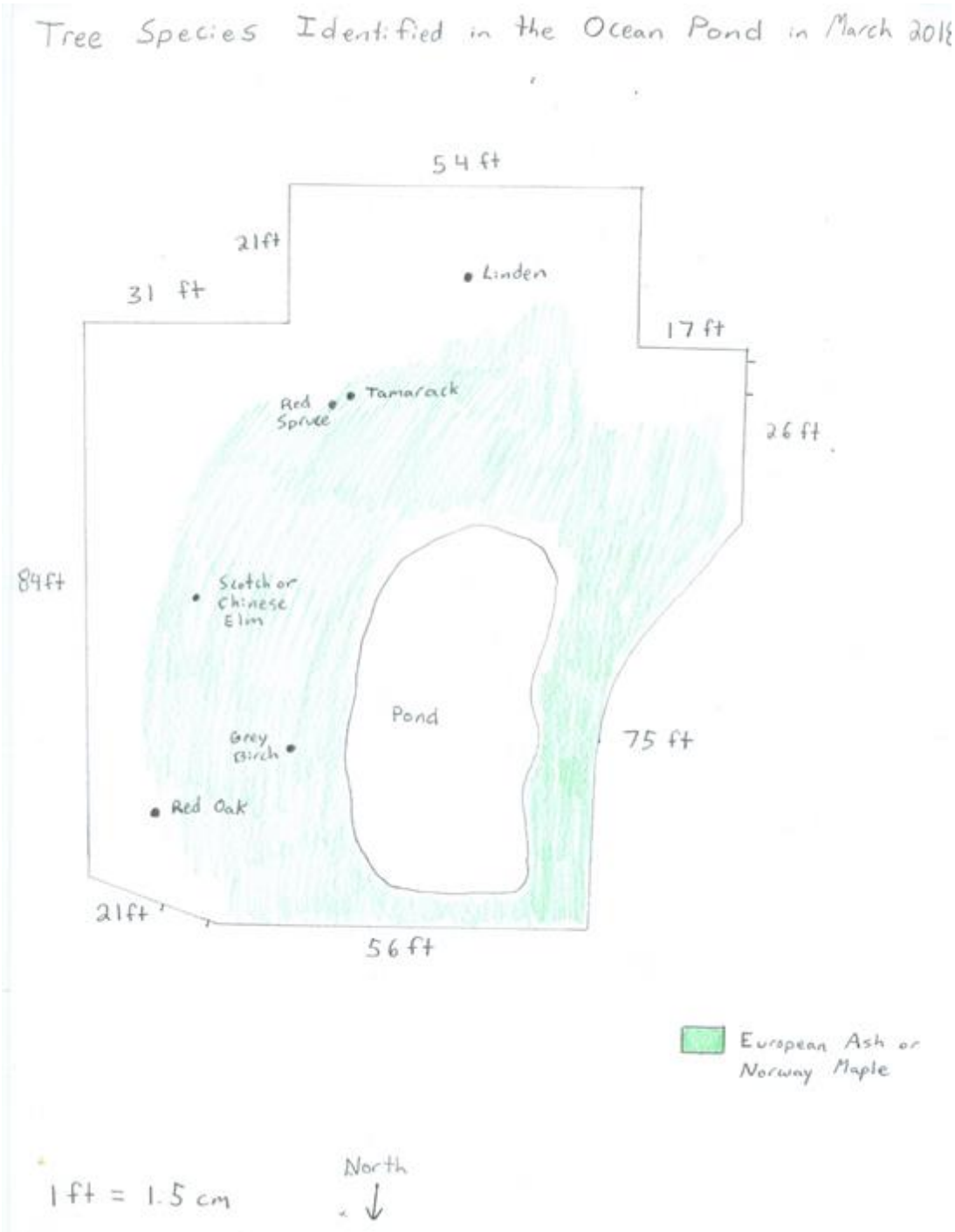

Figure 1 Map of the trees we identified in the Ocean Pond on Dalhousie University Studley Campus in March 2018 with James Steenburg and Kendra Marshman.

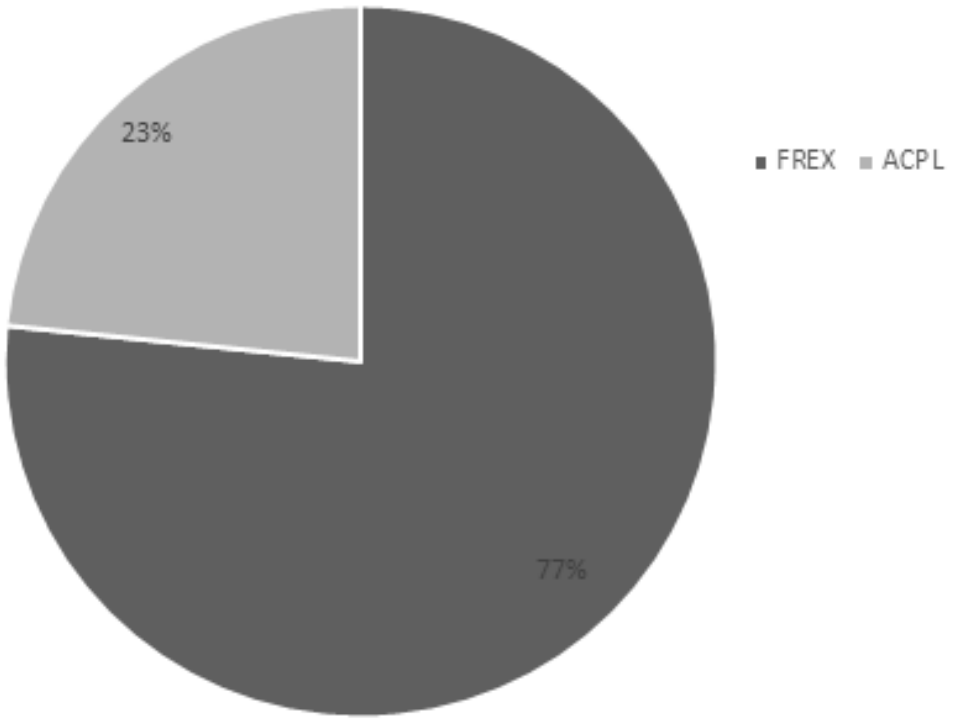

Figure 2 The proportion of the 372 trees that we measured in March 2018 within the Ocean Pond on Dalhousie University Studely Campus that were European Ash (FREX) and Norway Maple (ACPL).

Table 1 The diameter at breast height (cm) for each tree that we tagged for removal from the Ocean Pond on Dalhousie Studley Campus in March 2018. FREX is the code for European Ash and ACPL is the code for Norway Maple.

Species	DBH (cm)
FREX	3
FREX	6.1
FREX	1.9
FREX	1.5
FREX	1.5
FREX	1.5
FREX	0.9
FREX	0.8
FREX	0.9
FREX	1.5
FREX	2
FREX	0.9
FREX	0.6
FREX	2.2
FREX	1.5
FREX	1.9
FREX	3.3
ACPL	1.5
FREX	2.8
FREX	3
FREX	1
ACPL	5
ACPL	3.6
ACPL	0.8
FREX	0.5
ACPL	0.9
FREX	1.9
ACPL	1.6
FREX	0.7
FREX	1.2
FREX	2.7
ACPL	3.4
FREX	2.7
FREX	1.9
FREX	2.9
FREX	2
FREX	1.6

ACPL	2.1
FREX	1.8
FREX	1.8
FREX	2
FREX	1.7
FREX	2.8
FREX	1.9
FREX	1.6
FREX	1.4
ACPL	2.3
FREX	3.4
ACPL	2
FREX	3.2
FREX	2
FREX	0.6
ACPL	0.7
FREX	0.6
FREX	0.7
FREX	0.5
FREX	0.6
FREX	0.7
FREX	0.7
FREX	1.4
FREX	1.1
FREX	2.4
FREX	1.8
FREX	2.9
FREX	1.6
FREX	0.8
FREX	0.7
FREX	0.9
FREX	2
FREX	1.2
FREX	1.1
FREX	1.2
FREX	2.8
FREX	1.9
FREX	0.7
FREX	2.3
FREX	1
ACPL	4.5
FREX	2.9
FREX	0.9

FREX	0.8
FREX	1.6
FREX	0.7
FREX	0.7
FREX	0.8
FREX	0.5
FREX	1.2
FREX	1
FREX	1.1
FREX	0.5
FREX	0.8
FREX	2.7
FREX	4.3
FREX	0.6
FREX	3.9
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ACPL	0.7
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FREX	1.5
FREX	1.6
FREX	0.5
FREX	3.3
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FREX	1.5
FREX	0.6
FREX	0.5
FREX	1
FREX	0.6
FREX	0.9
FREX	1.5
ACPL	3.2
FREX	0.6
FREX	0.9
FREX	0.8
FREX	0.7
ACPL	1.2
ACPL	2.1
FREX	1.4
ACPL	1.9
ACPL	1.8
FREX	2.2
FREX	1.7

ACPL	3.3
ACPL	3.1
FREX	1.7
ACPL	1.6
FREX	1.1
FREX	1.5
FREX	3
FREX	1.1
FREX	2.7
FREX	0.9
FREX	1.7
FREX	2.5
FREX	2.4
FREX	1.5
FREX	1.8
FREX	1.5
FREX	2.6
FREX	2.2
FREX	1.4
FREX	2.7
FREX	1.2
FREX	1.1
FREX	2.9
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FREX	2.5
FREX	1.4
FREX	3
FREX	2
FREX	1
FREX	1.5
FREX	2.5
FREX	1.2
FREX	1
FREX	1.2
FREX	1.3
FREX	1.9
FREX	2.9
ACPL	1.9
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FREX	1.3
FREX	2
FREX	3.3
FREX	2.1

FREX	2
FREX	1.3
FREX	0.8
FREX	1.3
FREX	3.6
FREX	2
FREX	1.2
FREX	2.9
ACPL	2.9
FREX	1.2
FREX	4.2
ACPL	10.2
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FREX	1.4
FREX	2.1
ACPL	2.5
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FREX	4.4
FREX	0.6
FREX	0.6
FREX	1.1
FREX	0.8
FREX	0.9
FREX	1.1
FREX	0.7
ACPL	3.9
FREX	0.9
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FREX	0.7
FREX	1.1
FREX	1
FREX	0.7
FREX	1.7
FREX	1
FREX	1.3
FREX	0.9
FREX	0.7
FREX	0.9
FREX	0.6
FREX	0.8
FREX	1.1

FREX	1.5
FREX	1
ACPL	2.5
FREX	1.3
FREX	2.8
ACPL	2.7
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FREX	1.2
FREX	1
ACPL	4.3
ACPL	2.7
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FREX	1.2
FREX	0.8
FREX	0.6
FREX	0.7
FREX	1
FREX	1
FREX	1.1
FREX	11.3
FREX	10.2
FREX	7
FREX	4.4
FREX	2.9
FREX	2
ACPL	9.9
FREX	2.1
ACPL	5.4
FREX	4.4
FREX	4
FREX	2.7
ACPL	4.2
ACPL	5
ACPL	2.7
ACPL	10
FREX	3.6
ACPL	11
FREX	2.4
FREX	2.1
FREX	2.5
FREX	1.7
FREX	2.4

FREX	1.5
FREX	1.6
FREX	1.5
FREX	1
FREX	2
FREX	1.3
FREX	3.7
FREX	2.8
FREX	3.6
FREX	2.3
FREX	2.1
FREX	1.9
FREX	1.1
ACPL	1.6
FREX	2.5
FREX	1.4
ACPL	2.6
ACPL	1.5
ACPL	1.3
ACPL	6.5
ACPL	6.4
ACPL	1.7
ACPL	5
ACPL	3.3
ACPL	3.2
ACPL	2.6
ACPL	2.6
ACPL	0.8
ACPL	3.8
ACPL	3.5
ACPL	7.3
ACPL	1.3
FREX	4.8
FREX	4.5
FREX	9.8
FREX	3.6
ACPL	4
ACPL	9.4
ACPL	4.5
ACPL	7.1
ACPL	8.6
FREX	0.5
FREX	8.8

FREX	2.7
FREX	5.6
FREX	4.8
ACPL	5.7
FREX	1.8
ACPL	2.7
ACPL	2.8
FREX	4.4
FREX	2.1
FREX	3.1
FREX	0.2
FREX	5.4
FREX	0.9
FREX	6.9
FREX	1.8
FREX	2.1
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FREX	0.7
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FREX	2.2
FREX	1.4
FREX	1.7
FREX	7
FREX	5.3
FREX	1.8
FREX	1.9
FREX	1
FREX	1.6
FREX	1
FREX	0.8
FREX	1.5
FREX	2.4
FREX	2.7
FREX	1.7
FREX	1.9
FREX	0.5
FREX	0.6
FREX	1.9
FREX	3.1
FREX	2.8
FREX	2.2
FREX	2.7
FREX	1.3

FREX	2.2
FREX	3.1
FREX	5.3
FREX	0.8
FREX	1.6
FREX	2.2
FREX	2.7
FREX	4.4
FREX	5.8
ACPL	6
ACPL	2.7
ACPL	0.8
ACPL	1.6
ACPL	1.2
ACPL	1.5
ACPL	2.3
ACPL	1.4
ACPL	4.3
ACPL	6.5
ACPL	7.7
ACPL	7.4
ACPL	3
ACPL	9.5
ACPL	13.7
ACPL	7.9
ACPL	1.9
ACPL	5.6
ACPL	1.3
ACPL	4
ACPL	4.8
ACPL	5.9
ACPL	4.5
ACPL	5.9
ACPL	1

Table 2 Dalhousie Classes in the 2018/19 academic year that could incorporate the Ocean Pond into their syllabi and lab work and why.

Faculty	Class	Name	Reasoning
Biology	2004	Diversity of Plants and Microorganisms	Class focus on ecology and diversity and has a lab component.
	2020	Cell Biology	Could incorporate plant cells in addition to mammalian.
	2060	Introductory Ecology	Could use Ocean Pond as a lab space.
Environmental Science	1200	Environmental Challenges	Includes urbanization and city gardens and green spaces.
	2500	Field Methods in Environmental Science	Pond could be a lab site for sampling, identification, etc.
	3225	Plants in the Human Landscapes	Good example of plants in urban area and pond planning etc.
	3226	Economic Botany, Plants & Civilization	Not very fitting but could study the social impacts.
Environmental Studies	5041	Environmental Education	Pond could be used as educational program.
	5047	Conservation System Design	Course could redesign the Pond for active learning module.
	5051	Special Topics - Sust Urban	Laboratory project space.
Geography	1035	Intro to Human Geography	Example of an altered landscape and organization.
	3001	Landscape Ecology	Good for a landscape project.
	3006	Reading the Landscape	Black Ash planting in the Ocean Pond.
Physics	2800	Climate Change	Available as a way to study long term changes to species.
Planning	3053	Transp. & Land Use Planning	Community design example.
	3001	Landscape Ecology	Good for a landscape analysis project.
	3002	Reading the City	Local, urban analysis.
Sustainability	3701	Community as a Living Lab	Halifax community as a lab, Ocean Pond problem solving.