An abundance of invasive trees in Toronto and a lack of trees in the streets of Toronto's core.*

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Tree- lined streets are an exceptional way to add nature to urban envirnoments. Using the Street Tree data from OpenData Toronto, this paper examines the patterns and trends in Toronto's street trees. Tree species count, count of trees by ward, and distribution of tree-diameters were analysed. Uncovered was a abundance of a non-native tree species, and a lack of trees on the streets of Toronto's core

1 Introduction

Urban spaces can be void of vast expanses of nature, whether it be grass fields, blooming flowers, or teaming and diverse natural wildlife. One simple way to tackle this is to incorporate nature within the urban landscape, such as with trees. Trees are a vital plant in the world, they take in carbon dioxide and provide oxygen, a key component in the air we breath. Urban areas are known for the excess in carbon dioxide, which only makes it seem natural that trees can live and perhaps thrive in such environments. One way cities have incorporated trees into the city are roadside trees. Trees line many of the cities highways, arterials, collectors, and small roads. Lines of trees lined alongside highways can act as a natural sound barrier by reflecting, scattering and absorbing nearby noises (Dobson and Ryan (2000)). Tree-lined streets can also alter the way wind affects pedestrians below them, creating a more hospitable environment to promote active transportation such as walking or biking (Krayenhoff et al. (2020)). It should be no surprise then, that many cities around the world, including Toronto, have incorporated trees into their landscape, in busy downtown centres, to sleepy suburbs, and everywhere in between.

In this paper we look at street tree data from Toronto's roadside trees, and discern any patterns or observations to suggest further investigation. We first look at the most populous tree

*Code and data are available at: https://github.com/Veyasan1/STA3014-Paper1 species in Toronto, an the ward with the most trees. We will also look at tree diameter, which can indicate the approximate age of trees in the city, and look for anomalies and interesting summaries there. Finally we look at the least populous tree species and figure out where Toronto's native trees stack up.

Section 2 will outline the source of this data, and highlight key varaibles to be used in the model. Section 3 covers the construction and rationale of the model. Section 4 is where the model results will be outlined. Finally, section 5 discusses key takeaways from the data and the model, and addresses weaknesses and limitations that can be considered for another report.

2 Data

All collection and analysis of data was done using R, a free programming language designed for data scientists (R Core Team (2023)). Additionally, tidycerse (Wickham et al. (2019)), dplyr (Wickham et al. (2023)), and janitor (Firke (2023)) have been used as packages to read, clean, and present data. Finally OpenData Toronto is an online database containing thousands of datasets pertaining to the City of Toronto, which is where the data for this paper was initially accessed (Gelfand (2022)).

Rohan Alexander's book, *Telling Stories with Data* was referenced for troubleshooting and general ideas for data analysis (Alexander (2023))

The data comes from Urban Forestry, an organization dedicated to Toronto's urban forests. They work towards planting more trees, and protecting existing trees from damage due to individuals, private entities, and public entities ("Donate to Urban Forestry" (2024)). This particular dataset is called Street Tree Data, and focuses on city-owned trees located on roads. This information would be most likely used by city planners and road maintenance, ensuring snow plows and street dusters don't impede on any trees that line the roads. It is important to note that there may be some privately owned trees listed among the municipal trees, as they may be of interest with regards to road maintenance or other city services.

Street Tree Data contains around 32000 observations, each observation being an individual tree. Each observation has a general id for data analysis, as well as an structure id, telling us if the tree is part of an existing structure or building. Location is covered in 4 ways: first the address number (address) and streetname (streetname) of nearest postal delivery address, next is the street name and the nearest 2 cross streets (crosstreet1 and crossstreet2), third being the ward number (ward), and finally geometry containain a tuple of general latitude and longitude. Street Tree contains both the species name (botanical_name) and the common English name common_name), however we have decided to use only the species name to avoid confusion between similar sounding trees. Common English names will be provided for species of key interest. There is also measurement called dbh_trunk. This is the standard method forestry experts use to measure the diameter of a tree. Depending on where the measurement is taking placce, the breast height changes. For example, in Canada it is 1.3 meters, while the US uses 4.5 feet. This methodology is comprised of old conventions used to measure trees used throughout the world (Snyder (2006)). The result is a complicated mess where breast_height is a vague term that changes by location. Additionally, the convention breaks down when the tree is anything but vertically upright and straight. As a result, the DBH is more of an estimate rather than a sturdy measurement.

3 Results

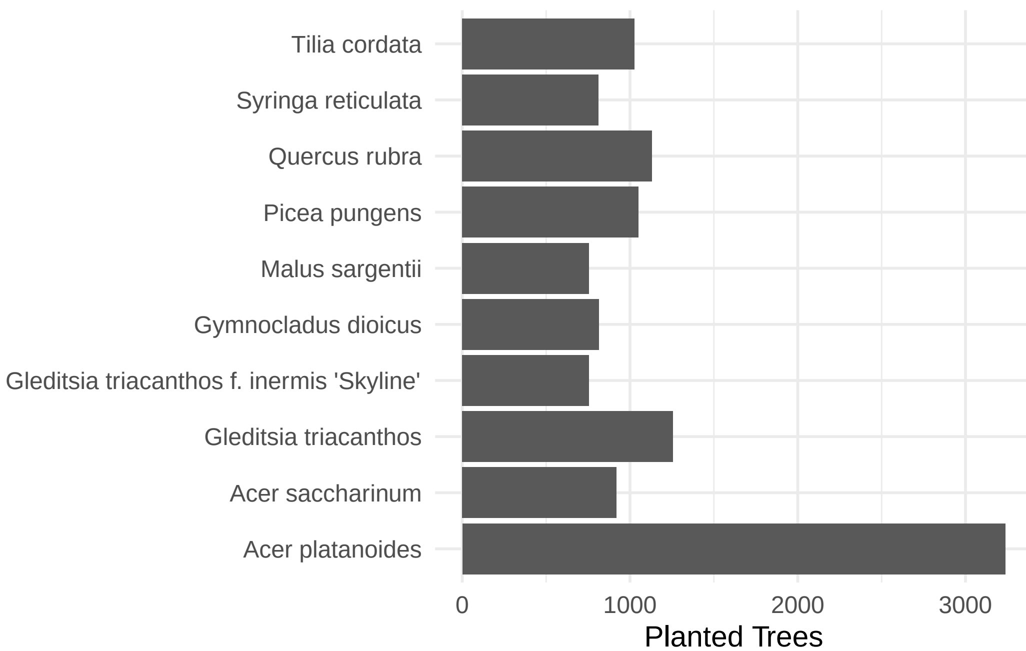

Figure 1: Street tree count of 10 most popoulus tree species in Toronto up to September 2024

Looking at Figure 1, the most populous species by far is the Acer platanoides, commonly known as the Norwegian Maple. It is interesting how much more prevalent it is compared to any of the other top 10 tree species, at over 3000 recorded individuals. Also note the similarity of the names Gleditsia triacanthos and Gleditsia triacanthos f. inermis 'Skyline'. The latter is an example of a hybrid tree, which is why it's botanical name contains the botanical name of another tree.

Figure 2 shows the count of trees over each ward in Toronto. Toronto has 25 wards, each with varying land sizes and populations. Ward 2 takes the top spot for tree count, with Ward 3 trailing behind it. These wards are both in Toronto's west end, Etobicoke Centre, and Etobicoke- Lakeshore. Ward 13 and Ward 10 have the least amount of trees, being Spadina-Fort York and Toronto Centre.

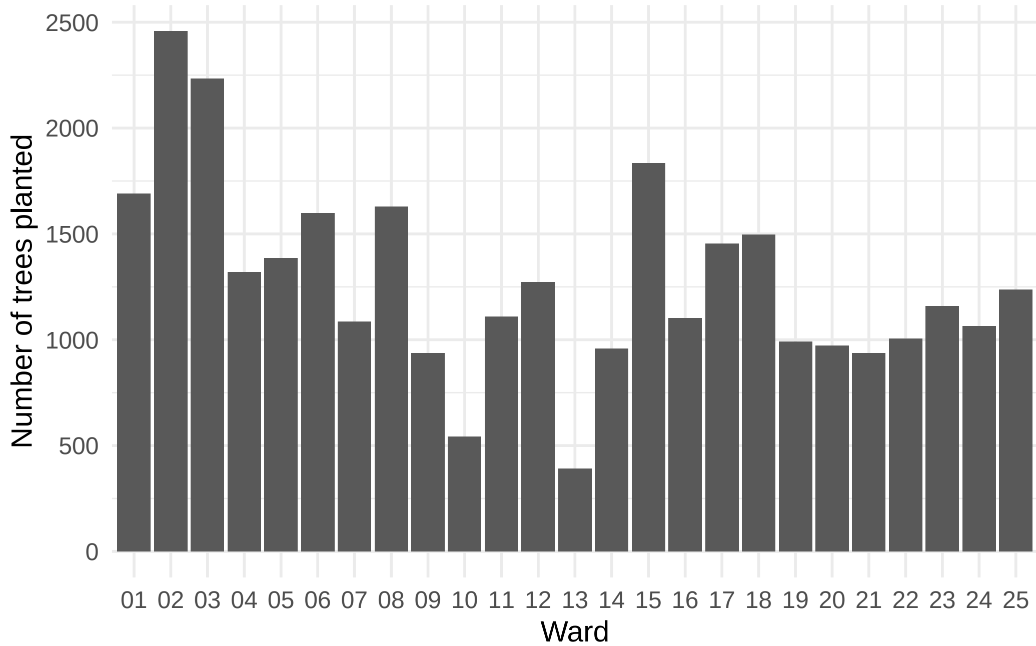

Figure 2: Street tree count by Toronto wards up to September 2024

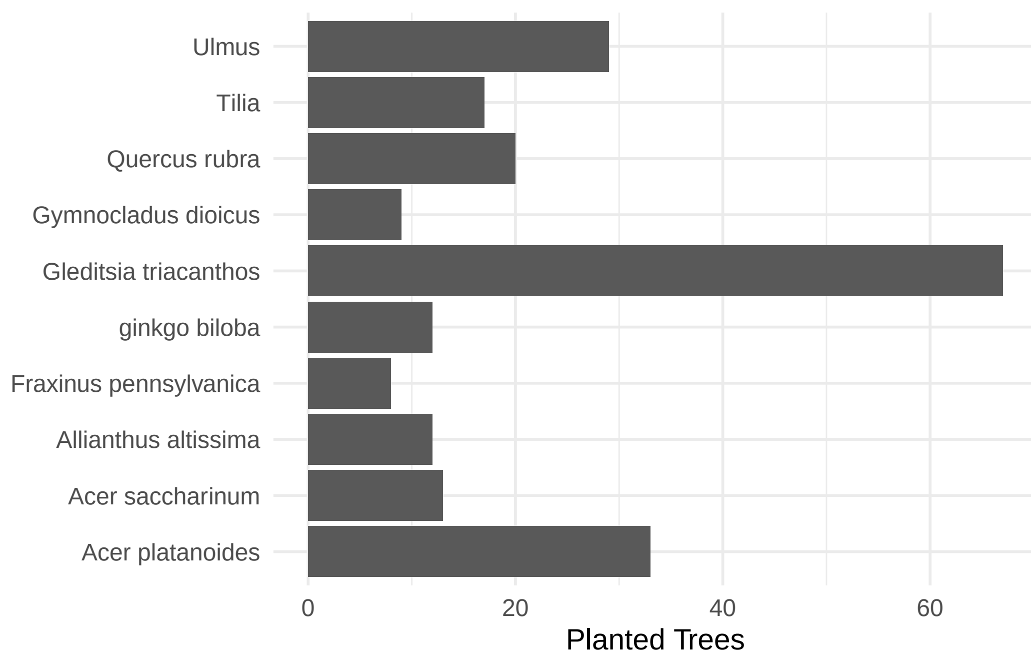

Figure 3: 10 most populous tree species in Ward 13 of Toronto, Ontario

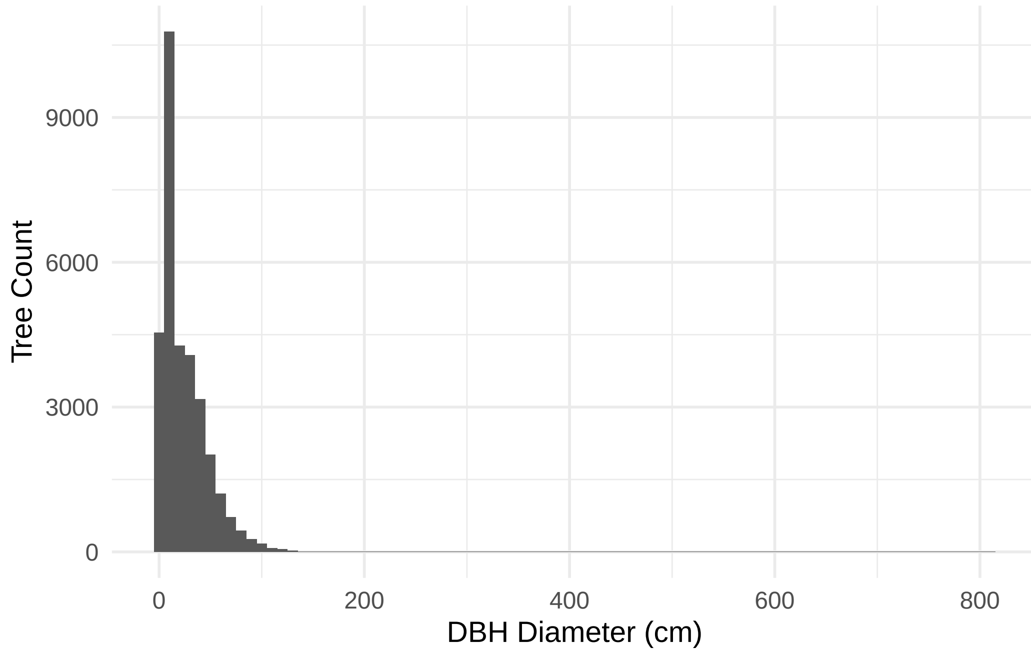

Figure 4: Distribution of Distance-at-Breast-Height diameter of all trees in Toronto up to September 2024

Figure 4 is a histogram of the frequency of certain tree-diameters across Toronto. The histogram has a very long tail to the left, indicating one or two trees having upwards of 815 cm of diameter.

Figure 5 is the result of trimming large dbh_trunk observations from Figure 4. This gives us a better idea of where the average dbh is, which is around 8-12 cm. However, this average would have been made without the large DBH values mentioned earlier, which would skew this average to a higher number.

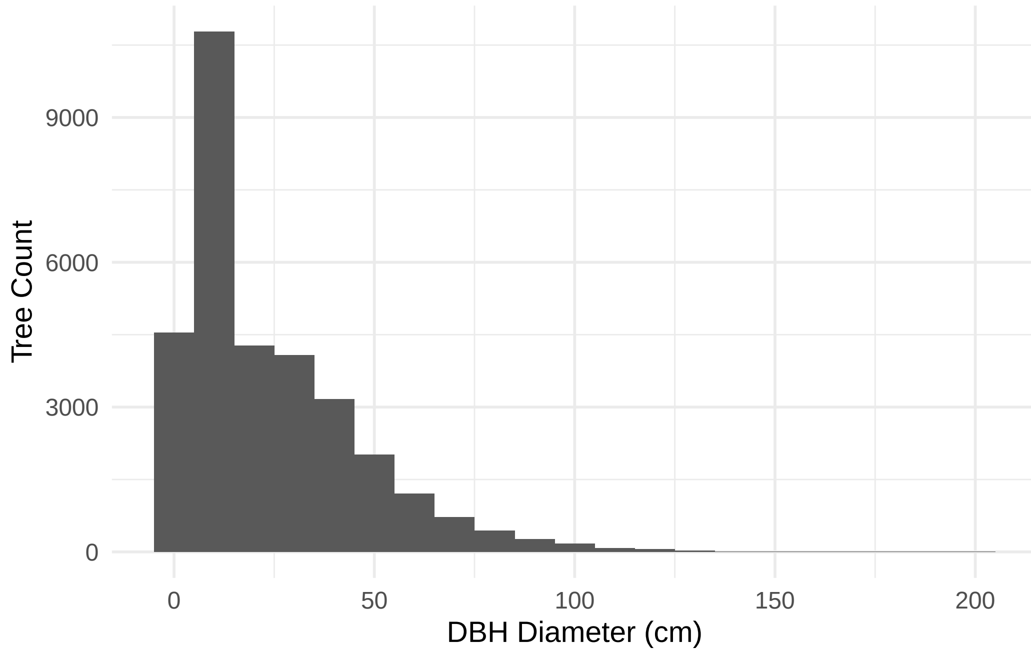

Figure 5: Distribution of Distance-at-Breast-Height diameter of all trees at or under 200 cm DBH in Toronto up to September 2024

4 Discussion

4.1 The worrying prominence of Acer platanoides

Figure 1 shows that Acer platanoides, otherwise known as the Norway Maple, is clearly the most populous tree in the city of Toronto, beating out any of 9 other contenders by 200 individuals. Acer platanoides is a well known tree used in urban environments, especially after the demise of elm trees in the 1970s (Sandberg, Bardekjian, and Butt (2014)). These trees are know for ‘a vigorous early growth rate, desirable form and size, the capacity to withstand many urban impacts (e.g. pavement, moderate levels of pollution, dusts, and dry soils) and the abilities to transplant well, grow on a wide variety of soils, and withstand ice and snow damage better than other maples’ (Nowak and Rowntree (1990)). Being planted in cities, it’s seeds can travel by wind across to more wooded suburbs, where the seeds can tolerate shade for extended periods of time (Sandberg, Bardekjian, and Butt (2014)). However, as it’s common name suggests, it is not a native species to Canada, instead brought here by European explorers and settlers. While not a very invasive species, taking over just 9% of Southern Ontario’s forests, it does so by harming other native plants and trees ((**urbanforests?**)). More attention should be cast on the spread of this tree, as it has the potential to devastate Toronto’s and Southern Ontario’s forests in the years to come.

While Figure 3 demonstrates that Acer platanoides isn't the most popoulous tree everywhere in Toronto, it also shows the potential dangers having non-native species have on places with little natural wildlife. Ward 13 has the fewest street trees in Toronto, and ther are still over 30 trees of a species known to be invasive and hamper the survival of native plants and trees. Additionally, since the downtown core is full of tall buildings which carry wind currents, the dispersal of Acer platanoides seeds seems inevitable, and will only exacerbate the troubling increasing in population of this invasive species, across Toronto and Southern Ontario. More care should be put into the planning of street trees, putting more empahsis on native trees in spaces with minial room for any trees to begin with.

4.2 The lack of trees in Toronto-Centre

Figure 2 shows the distribution of trees across the 25 wards of Toronto. Wards 2 and 3 top the rankings, at over 2000 individuals. This isn't a surprise as those wards are located in Etobicoke Centre and Etobicoke-Lakeshore, consisting mainly of suburbs and small pockets of woodland. On the other hand, Wards 10 and 13, Spadina-Fort York, and Toronto Centre, display a shocking lack of trees, at 500 or less. These wards make up a majority of Toronto's downtown core, which would explain the lack of trees. However, this could be a call to invest in more roadside and path side greenery. Implementing more trees either along big avenues such as university, or small roads servicing townhouses and condos, can help liven up what is considered by many to be a dull, drab section of the city, with endless rows of concrete and glass interspersed with concrete and brick and little else.

Knowing that Ward 13 has the lowest amount of street trees across all of Toronto's wards, Figure 3 was made to investigate the tree species count in this ward. Unlike the city-wide trend of Acer platanoides being the most popoulous, the most popoulous tree in this ward is Gleditsia triacanthos, otherwise known as the Honey Locust. The honey Locust. The HOney Locust is a tree that grows moderately fast and resiliant against dry and salty- climates. This makes it ideal for windbreaking (Blair (1990)). Windbreaking, as mentioned earlier, helps create inviting spaces in urban enviroments, especially for pedestrians. Using a tree such as Honey Locut makes sense therefore, in a crowded downtore core with large skyscrapers and condos, which funnel air and wind around them. The species is native to North America, but it's reach just barely makes into the southernmost areas of Ontario, making it technically a non-native species in Toronto (Blair (1990)).

4.3 Anomalies in DBH diameters and potential causes

The spread of DBH diameters as seen in Figure 4 indicates that a small number of trees have extremely high DBH values. A DBH value of 800 for instance, means that the measured diameter of the tree is 8 meters! This is most likely an error on the part of the person in charge of inputting data at the time. There may have been a decimal missing from the entry, which would divide the offending dbh by 10. Figure 5 was made excluding any dbh_trunk values over 200 cm, to get a better look at the majority of all trees in Toronto. It shows a much clearer distribution of the vast majority of all dbh_trunk values in the data. The largest bin is located somewhere between 8 cm and 12 cm, indicating that the averaege diameter of Toronto's street trees is around that value as well. This suggests that most street trees are actually very young, and have not had much time to develop their trunks. This can be explained by initiatives to plant saplings along new or existing roads, potentially replacing older trees that had been cut down to make way for urban development. Larger trees are more rare either because they have been removed for urban developemnt, mentioned before, or as a result of storms and natural disasters.

4.4 Weaknesses and next steps

Street Tree data is cumulative, meaning Urban Forestry has to manually update the status of each tree, which is an arduous task for over 30000 trees. As a result the data may be mismatched, with some trees having only been checked months or even years prior. This may be why Figure 4 is so skewed. There may have been errors in the way the data was inputted for certain trees, leading to misplaced decimals. A similar occurrence happened when observing the raw data, which can be seen in the Appendix. No additional information was provided by OpenData Toronto when viewing the dataset on their database, apart from who provided the data, Urban Forestry. Perhaps more detail on their part, including units of measurement for dbh_trunk, would have helped make this analysis much easier.Another limitation mentioned earlier is the inclusion of some privately-owned trees.

Next steps would be augmenting this data with other data from Toronto's roads, or other trees, to see if any comparisions or correlations can be drawn there. Does vehicle traffic impact the trees lining a certain road, and if so, how long would it take for the effects to be noticeable? Does the distribution of street trees tell us anything about income disparity, fire risk, or quality of life within Toronto? This report can be used as a launching pad for further investigations, using key takeways from this report as drivers for further questions.

With newer report, pressure will be put upon Urban Forestry to better curtail the data they have collected thus far. It is imperative that their hard work be recognized and any feedback on the data they have collected be sent to them as well, ensuring better datasets for analysts, leading to more informative conlusions for all.

5 Appendix

5.1 Data Cleaning

While cleaning that dataset, some inconsisten values were discovered. A particular species of tree, Salix x sepulcralis, had it's name misspelled in the dataset. This may have come from using special characters that could not be saved onto the dataset, resulting in a garbled name. An additional step was taken to restore the correct botanical name, using the common name as reference. Similarly, one observation did not have a ward location allocated. This was remedied by reading the globval coordinates from geometry, a varaible in the raw data file that shares the latitude and longtitude of the tree individual. Using these coordinates, and the address number, the general location for this tree was determined, along with its ward location. The ward entry for this observataion was updated accordingly.

References

Alexander, Rohan. 2023. *Telling Stories with Data*. Chapman; Hall/CRC. https://tellingstorieswithdata.com.

Blair, Robert M. 1990. "Gleditsia Triacanthos l. Honeylocust." *Silvics of North American Trees* 2: 358–64.

Dobson, Martin, and Jo Ryan. 2000. *Trees and Shrubs for Noise Control*. Arboricultural Advisory; Information Service.

"Donate to Urban Forestry." 2024. City of Toronto.

Firke, Sam. 2023. *Janitor: Simple Tools for Examining and Cleaning Dirty Data*. https://CRAN.R-project.org/package=janitor.

Gelfand, Sharla. 2022. *Opendatatoronto: Access the City of Toronto Open Data Portal*. https://CRAN.R-project.org/package=opendatatoronto.

Krayenhoff, E. Scott, Timothy Jiang, Andreas Christen, Alberto Martilli, Timothy R. Oke, Brian N. Bailey, Negin Nazarian, et al. 2020. "A Multi-Layer Urban Canopy Meteorological Model with Trees (BEP-Tree): Street Tree Impacts on Pedestrian-Level Climate." *Urban Climate* 32: 100590. https://doi.org/10.1016/j.uclim.2020.100590.

Nowak, David J, and Rowan A Rowntree. 1990. "History and Range of Norway Maple." *Arboriculture & Urban Forestry (AUF)* 16 (11): 291–96.

R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Sandberg, L Anders, Adrina Bardekjian, and Sadia Butt. 2014. *Urban Forests, Trees, and Greenspace: A Political Ecology Perspective*. Routledge.

Snyder, Michael. 2006. "What Is DBH?" *Northern Woodlands*.

Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Grolemund, et al. 2019. "Welcome to the tidyverse." *Journal of Open Source Software* 4 (43): 1686. https://doi.org/10.21105/joss.01686.

Wickham, Hadley, Romain François, Lionel Henry, Kirill Müller, and Davis Vaughan. 2023. *Dplyr: A Grammar of Data Manipulation*. https://CRAN.R-project.org/package=dplyr.