St. Olaf College

Local Ecology Research Papers

The Effect of Established Trees on Succession Patterns

Henry Scott

2021

Henry Scott
Field Ecology
12/15/21

The Effect of Established Trees on Succession Patterns

Abstract

Forests are vital to life for both humans and many other organisms around the world. Due to this vitality, forest management is becoming an important field as we try to mitigate the many problems that forests are facing due to human induced impacts. One factor that has not been well studied among forest managers is how established trees affect seedling and sapling density. This study looked at the impact these parent trees had on both total seedling and sapling density as well as species specific effects. Likely due to the small sample size no significant effects were seen, but potentially promising trends did occur. Specifically, we saw high levels of seedlings near established trees of the same species as well as higher levels of seedlings near smaller trees. However, to find more concrete evidence a higher level of sampling must be done.

Introduction

Forests are one of the most important ecosystems on the planet. Forests have been known to provide a variety of different ecosystem services including climate change mitigation, prevention of soil erosion, natural resources such as lumber, oxygen and medicines and habitat for many organisms. Due to many anthropogenic factors such as deforestation and climate change, forests are being increasingly threatened. Because of this forest management is becoming a more and more important field. One factor that has not been well studied or really studied at all is the effect of parent trees on seedling and sapling density. This study attempts to combat this lack of research by looking at how seedling and sapling density is affected by parent tree species in the Big Woods ecosystem in southern Minnesota. I looked at six species: *Acer saccharum* (Sugar Maple), *Tilia americana* (American Basswood), *Ulmus americana* (American Elm), *Fraxinus pennsylvanica* (Green Ash), *Carya cordiformis* (Bitternut Hickory) and *Quercus alba* (White Oak). I selected these species due to their variability in seed

dispersal method, growth time and shade tolerances as well as because of their abundance in Heath Creek, the forest I studied. Heath Creek is a forest located in southeastern Minnesota, it is fairly small and highly fragmented and is largely dominated by sugar maple and basswood trees. Elm has been noted as the most common species in the Big Woods ecosystem (Grimm, 1983) but recent studies in Heath Creek have found that sugar maples are more common at all stages of development.

I expected to see a lower seedling density in close proximity to larger trees and a higher density of seedlings adjacent to parent trees of the same species. This study had the following objectives: 1) to measure how seedling density changes with proximity to parent tree species, and 2) to determine if parent tree species has any effect on seedling species distribution.

Methods

I began by laying out a transect at the base of a parent tree in a direction that avoided paths or other unnatural disturbances. I then set out one square meter plots at 5, 10, 20 and 30 meter from the parent tree on the transect. Once the meter by meter plots had been laid out I counted and identified the seedling and sapling densities in each plot. I defined seedlings as trees that were less than a half a meter tall while saplings were defined as trees over half a meter tall and with less than a 13 cm diameter at breast height. This process was repeated at every plot I sampled. I ended up taking data at 5 sugar maple parent trees, 5 basswood trees, 3 American elms, 3 green ashes, 2 bitternut hickories and 2 white oaks. The variability of parent tree numbers was simply due to abundance as sugar maples dominate the Big Woods

ecosystem and it was difficult to find mature bitternut hickories or white oaks in particular.

Results

Figure 1 shows that we generally see higher concentrations of green ashes and sugar maples close to parent trees while other trees have no clear relationship. It's worth noting that none of the seen results were significant, however the two mentioned above were the closest. In addition, seedling populations were so dominated by green ashes and sugar maples that the other species did not have a large enough abundance to see any trends.

Figure 2 shows that green ash and sugar maple parent trees were most likely to have high seedling densities close to them regardless of species while other species had no significant results.

Figure 3 shows us that all trees in general had a higher seedling density the closer they were to a parent tree of the same species. Unfortunately, similar to the other figures I did not find any significant results.

Discussion

I'd like to begin by briefly discussing certain topics of interest that were disregarded due to a lack of data. While I previously mentioned that I took sapling data in each of my plots due to such low overall numbers I decided to exclude any data from my results. While an ANOVA test on sapling mean differences did obtain a confidence level of a little higher than .1 which is higher than most of my confidence levels it was still insignificant and any more niche data on sapling was simply too limited to be relevant. In addition, data looking on specific parent tree species to specific seedling

species other than the same species to the same species was also excluded. This is largely due to the fact that seedling distributions were so dominated by sugar maples and green ash that the other seedling species did not have high enough populations to obtain relevant data.

One relevant result I found is that green ash and sugar maple seedlings do well in close proximity to mature trees. One explanation for this is due to their high shade tolerance. Sugar maple trees have an extremely high shade tolerance while Green Ashes have a decent tolerance (Baker, 1949). This would enable them to thrive in shady areas caused by the looming canopies of mature trees. In a similar vein I also found that mature Sugar Maple and Green Ash trees were more likely to have seedlings in close proximity to them. Looking at Table 1 we can see that both the aforementioned trees had a relatively small diameter class. While these diameter classes are not necessarily reflective of overall trends in tree size and that should be noted if studies are to continue in other forests this is relevant in this particular study. These species are likely younger than species such as basswoods which are generally older due to their ability to thrive once they have established themselves (Shea and Helgeson, 2018). Because these trees are smaller they are likely taking less resources and therefore enabling seedlings to grow nearby.

One other result I found is that we see high seedling groupings next to mature trees. This could be due to a variety of reasons. The first is that dispersal methods cause said trees to drop seeds in nearby locations. This would especially make sense with wind dispersed trees such as Green Ash, Sugar Maple and American Basswood (Forest Service) and we do see this trend exacerbated in these species. American

Basswood species in particular are known for seeds to not fall far from the parent tree (DNR). Another possible reason is simply biome preference. For example we would expect to see high mature tree and seedling densities in a swampy area for a species that prefers a moist environment.

This study did have some limitations. The biggest of these is that a lack of data contributed to an inability to find significant results. More data particularly in the form of species other than green ash and sugar maple would be greatly beneficial towards looking at trends. In addition this would enable us to look at differences between animal and wind dispersed seeds, growth rate and other factors between the multiple species. In addition it would be interesting to see whether these trends continue in forests other than Heath Creek which would determine whether these trends are unique to the Heath Creek ecosystem or also occur in other Big Woods ecosystems.

Acknowledgements

I would first like to thank the Field Ecology class of 2021/22, their findings of the diameter classes of mature trees was helpful for me to try and explain my results. In addition I would like to thank professor Shea for her guidance, support and wisdom on this project. It would not have been possible without her.

Literature Cited

Baker, F.S. 1949. A revised tolerance table. Journal of Forestry 47: 179–181.

Grimm, E. 1983. Chronology and Dynamics of Vegetation Change in the Prairie-Woodland Region of Southern Minnesota, USA. New Phytologist 93-2

Minnesota's native trees. (n.d.). . https://www.dnr.state.mn.us/trees/native-

trees.html.

N.d https://www.fs.fed.us/database/feis/plants/tree/acesac/all.html.

Shea, K.L. and S.R. Helgeson. 2018. Tree growth patterns, mortality and colonization in a restored maple-basswood forest. Ecological Restoration 36: 295-305.

Tables and Figures:

Table 1. Shows size distributions of trees in a previous study of this forest

Diameter Classes	13.0-22.9	23.0-32.9	33.0-42.9	>43.0cm
Bitternut Hickory	2	1	0	0
White Oak	0	0	1	6
Sugar Maple	35	24	32	44
Basswood	4	5	1	13
American Elm	12	4	2	3
Green Ash	11	12	3	0

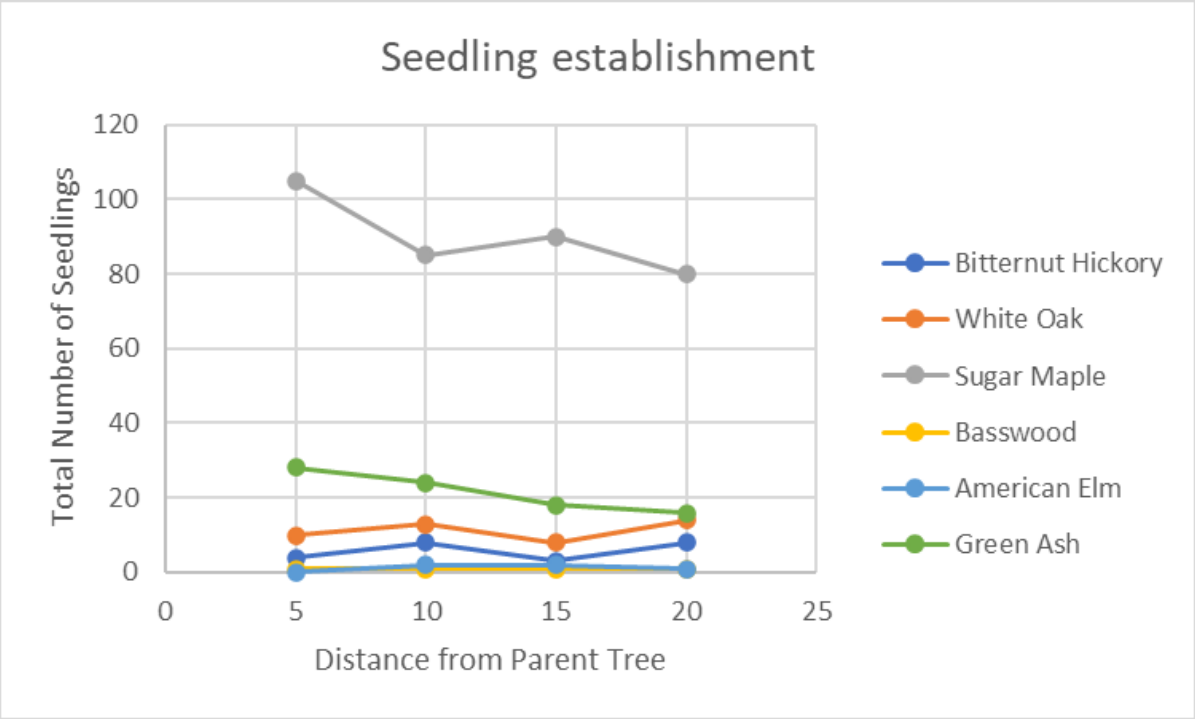

Figure 1. Variation in total seedling density with varying distance from

parent trees of different species.

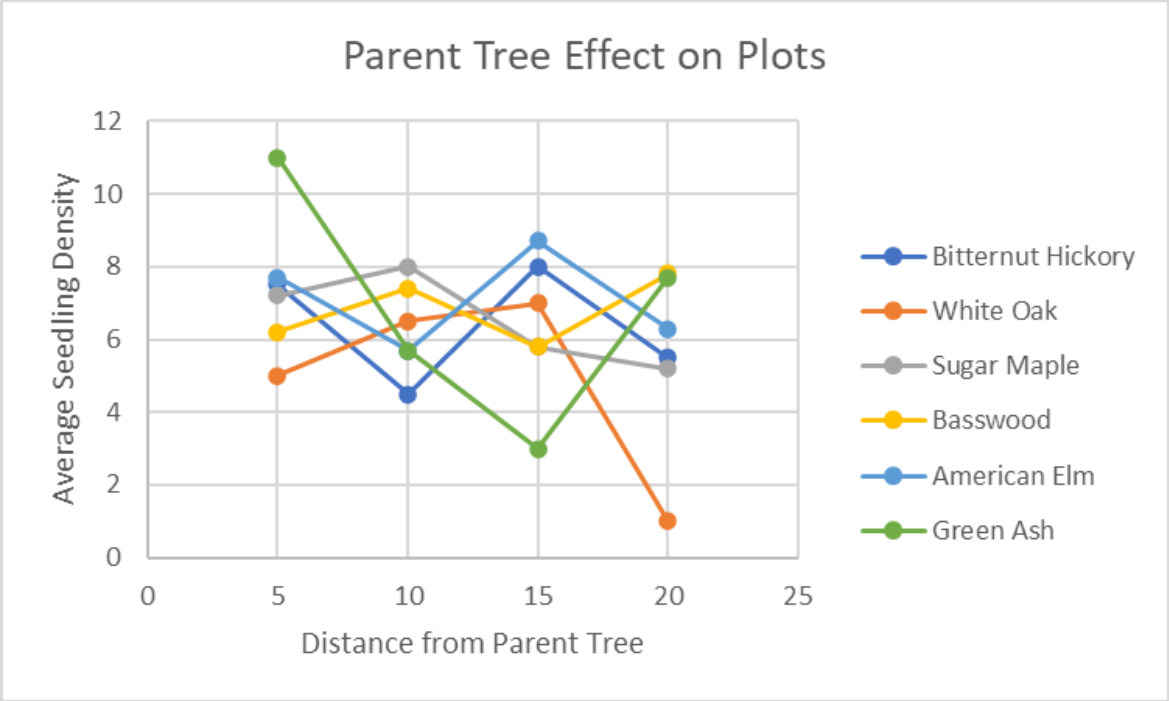

Figure 2. Shows how different seedling species fared under different distance from parent tree

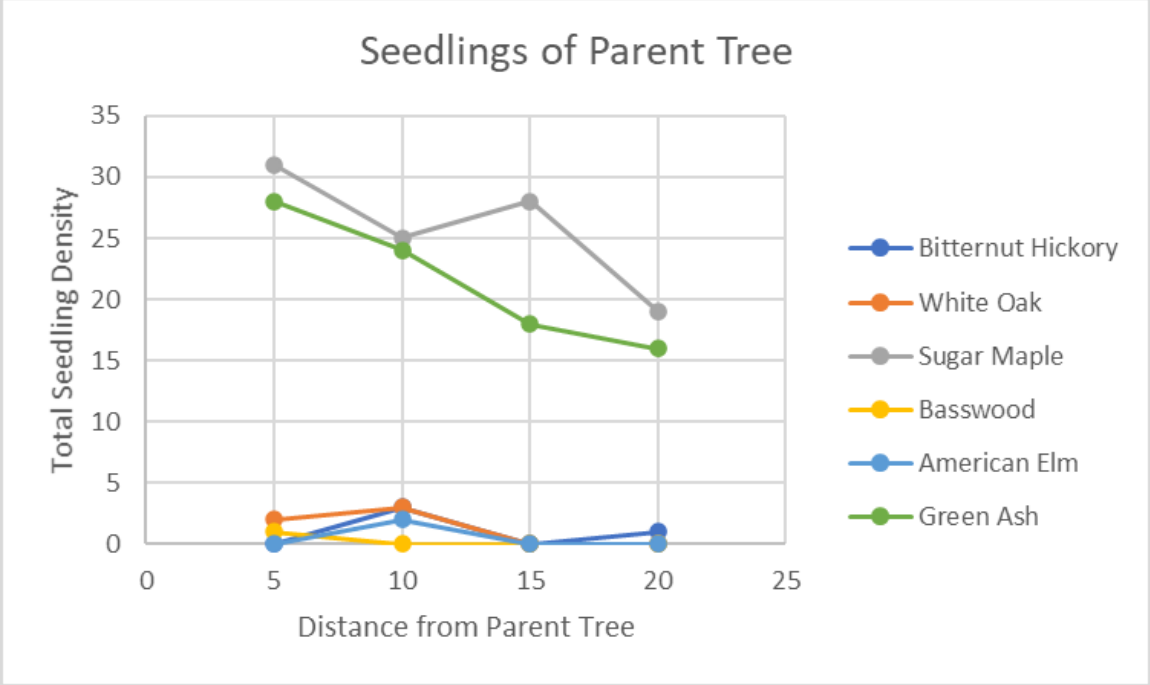

Figure 3. Shows how seedlings fared with parent trees of the same species at different distances