Analyzing the Treatment of Invasive Liana *Hedra helix* in Arlington Virginia

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ABSTRACT

Invasive species are an exorbitant problem, which is being seen all over the world and is enveloping local ecosystems in a shroud of death and extinction. While some argue semantics over the anthropocene, the planet has without a doubt entered an era of mass extinction as a result of human action in climate, species displacement, and introduction of invasive species into fragile ecosystems (Kolbert 2014). In this paper, researchers analyzed the effectiveness of local invasive species management by researching a specific particularly destructive and deeply embedded invasive liana colloquially known as English Ivy (binomial nomenclature *Hedra helix)*. Researchers consulted local experts, and compared a percentage cover map of invasives from 2007 to a newly created map. Furthermore, researchers collected accounts of management methods and practices from workers, volunteers, and experts. This paper found that management methods in Arlington Virginia have been marginally effective, with an 11% decrease in percentage cover of *Hedra helix* in Arlington parks when compared to the map in 2007 (Appendix A; Appendix B)

Introduction

Invasive species have been a massive and widely known issue world wide, changing soil chemistry, causing disease, outcompeting local species and causing extinction (Kolbert 2014). Earth is currently undergoing a 6th mass extinction, and there is little scientific debate as to whether or not it is happening as a result of human action (Ceballos, 2017; CWHL, 2018; Kolbert, 2014;Wagler, 2012) . In Elizabeth Kolbert's book *The 6th Extinction* Kolbert talks about a few invasive fungi such as Chytridiomycosis which have wiped out over 200 species of frogs and other amphibians (CWHL, 2018). The spread of invasive species is a relatively normal result of human action, and has happened countless times due human expansion and exploration, however an increased rate of transportation as a result of globalization has caused thousands of invasive species to move across the planet at a rate that was completely impossible prior to human technological advancement and proliferation.

Invasive species have been proven to cause many ecological issues in environments and some have been shown to present a "snowballing effect" when added to a fragile ecosystem (CWHL, 2018; Kolbert, 2014). For example, the invasion of feral hogs in Hawaii have proven to significantly change the bioturbation (or the disturbance of geological settlement by biological entities) rates during their rooting activities, which creates conditions favorable for other, similarly destructive, and invasive species (Fei et al. 2014). Invasive species have even been proved to cause issues with long term implications such as issues associated with nutrient cycling (Hickman 2013). While in initial stages of invasion nutrient cycling is relatively unaffected, after invasive species have overrun native leaf litter, biogeochemical changes will be more irreversible and problematic (Hickman 2013). This all demonstrates the pressing issues that invasive species present for the larger ecoscape. These issues don't only present problems in hyperural environments, but also in suburban and small park areas.

Researchers from this project have been dealing with *Hedra helix* for several years. In 2019 in a middle school science class researchers spent time pulling weeds in the forests within walking distance from school.

As a rowdy middle school student who loved being outside, science, and most importantly missing class this was a dream come true. Naturally when the research process started, *Hedra helix* removal and even invasive species management as a whole were always considered as possible topics that needed more research. This led researchers to consult local wildlife experts concerning the invasive liana, where they were provided with an outdated map (Appendix A). Invasives are a problem ever evolving, and researchers were eager to help solve this world wide issue which had been so personal to them.

This is where a gap in research was found. There is a monolith of research on invasive species, and mass extinction. Some experts even point to invasive species as being one of "the most devastating and far-reaching anthropogenic direct drivers affecting global biodiversity [is the] spread of invasive species and genes" (Wagler 2012). Invasive species work is so prevalent it made its way onto last year's AP Seminar exam, with Eric Bender discussing effects of the invasive tiger mosquitos growing larger as a result of climate change. Along with their adaptation to low income, and/or abandoned Baltimore housing areas (Bender, 2022). After reaching out to experts such as Jennifer Soles, the Natural Resource Specialist Arlington County Department of Parks and Recreation in search of data, no new data was available on the effectiveness of treatment against local invasive species such as *Hedera helix A* (English Ivy) (Personal Communication; Appendix A). Researchers were however able to receive maps from Soles, making the decision on what to research was more clear.

This led to the research question: To what extent have *Hedera Helix* treatment methods over the last 17 years been effective? (RQ1). This data is not only personally interesting but valuable to Arlington County as well, with a few experts requesting a presentation of the data (Personal Communication, Appendix A). Following the conclusion of this paper it was sent to Arlington county representatives, in an attempt to aid in research and development. Additionally, the last graph assessing percent cover of *Hedra helix* in Arlington was conducted in 2007, which means that new data is productive and helpful to local invasive species management companies. This all demonstrates a gap in local research, in addition to a necessity for more local research to be conducted, as researchers were actively requesting further investigation.

There were some hardships in choosing a research subject, as there is so little data on local invasives. One of the most proliferant problems to address was how to spot and quantify species. This significantly ruled out any mammals, reptiles, fish, or insects as they would be nearly impossible to quantify with the limited time and resources that researchers on this project had. This left the list to exclusively plants, however during the winter time, many of the invasive plants in Virginia, would be significantly more difficult to spot and count. An example of this is *Ailanthus altissima* known colloquially as the *Tree of Heaven* which is currently rated as the most problematic invasive species in the state of Virginia (Hefferman, 2014). *Ailanthus altissima* is ranked as highly invasive, however as the research had to be conducted during the winter time, it would be very difficult to spot and quantify this species. This fact narrowed down options more so to 3 or 4 options, and then being able to quantify and analyze data became an issue. With ground covering, (and therefore suffocating) Flora such as grasses, and liana, finding and quantifying percent cover is as simple as calculating area of coverage, and then subtracting it from maintained area of the parks, as opposed to Tree studies in which one needs to count each individual tree, which leaves room for error due to human imperfection and fatigue.

Some of the most popular, and prevalent ground covering ivy in Virginia are the Honeysuckle, Kudzu, Algerian Ivy, and English Ivy. While all of these species were appealing for study, there had been direct efforts towards the elimination of English Ivy in Arlington Virginia (Personal Communication, Appendix A). Additionally, when winter comes data might become skewed by shrinking and shriveling due to the cold climate. Original data was collected by researchers during spring months, meaning the growth may have been different. However, *Hedra helix is* specifically chosen due to its similar size and growth during summer and winter months. Few other Liana, plant, and even animal species maintain size in the same way that *Hedra helix* does (Personal Communication 1). After some thought, and some requests from local experts, the importance of English Ivy research became clear.

Around the world, the effects of English Ivy are much more thoroughly researched than the ecological issues surrounding the Liana. English Ivy is known to be toxic and have an irritating effect on both people and livestock, causing severe vomiting when consumed by livestock (CDFW 2012). Furthermore, a paper written by Rounsaville and their associates discusses the Allee effect and whether or not the Liana is affected by this effect. The Allee effect is defined in the paper as "positive density dependence" (Rounsaville et al. 2018). Through the naturalistic observation of the Liana, it was learned that dense congregating Liana can affect soil chemistry. This study also determined that their sample held an increased concentration of carbon, nitrogen, calcium, magnesium, and phosphorus (Bautista, 2018; Rounsaville et al., 2018 p. 871). This can cause chemical imbalances which can become extremely problematic in the long term Biosphere (Rounsaville et al., 2018). In another paper, provided by Jennifer Soles, Bautista and their colleagues came up with some clever ways to measure percent cover, in comparison to different areas in a stream basin. Discovering that there is no different percent cover between the select invasive species (including English Ivy), however it did find that in forested areas, vs riverbeds, there was less percent cover of all of the select invasive species (Bautista, 2018).

Methods

Planning data collection is possibly the most difficult part of conducting a research project. After being provided with Maps of Arlington Parks (Appendix A), being able to recreate these maps after over 15 years of invasive species management. By recreating these maps on the GPS and topographic mapping software *ArcGIS* it will be easy to analyze the effectiveness of certain forms of invasive species management such as chemical treatment, uprooting, and landscaping. Using *ArcGIS* allows for flexibility and accuracy in comparison to measuring from other less precise and perhaps untrue mapping services such as *Google Maps* or even paper maps, though researchers made good use of topographic maps when planning grid search patterns.. *ArcGIS* is a critical part of a lot of environmental science research, so much so that at a local university, environmental science majors are required to take an *ArcGIS* class, in which they are taught the in's and out's of the software.

In this study, researchers explored the affected areas described in the maps provided by Jennifer Soles. After locating groves of *Hedra helix,* researchers dropped pins using the mapping software *ArcGIS* creating a new perimeter of these areas. After establishing a perimeter around these areas researchers calculated the area of coverage, subtracted this from the park's manicured or constructed area, such as playgrounds or football fields and repeated this process on separate areas. After doing this researchers compared the area of coverage from the 2007 maps provided by Arlington county. Additionally, ArcGIS included an area calculation software that the researchers used to check and aid in the area cover calculation process. Doing this provided an effective before and after map which aids in comparing and contrasting the effectiveness of Arlington Counties methods of conservation.

Beyond quantitative data, researchers also conducted several interviews with excerpts in invasive species management and spent time volunteering and getting involved in the fight against *Hedra Helix.* This provided researchers with a more personal understanding of the problems associated with management in local parks. Having hands on experience also allowed researchers to provide a newly formed expert opinion on this prevalent issue.

Results and Data Analysis

Collection of data was enjoyable and in depth. Researchers followed the protocols highlighted in the methods and replicated data at each park at least twice, but in most 3 times. Weather proved to be a difficult factor to navigate with several instances of Snow making collection of data completely impossible. Lack of coordination between researchers and school administration also proved difficult, with dates dedicated to data collection

being wasted due to political gridlock in the schools attendance office. The data collected demonstrates that Arlingtons model of invasive species mitigation has been effective in the majority of the parks analyzed.

Researchers found that when scaled to the amount of data collected using only English Ivy polygons in Appendix A, there has been an 11% decrease in polygons labeled as "high" which is defined as being greater than 10% of the forrest space subtracted by area of trails/manicured fields. This demonstrates that current methods of invasive species management in Arlington are slowly but surely working. 11% is a significant figure, however it must be taken with a grain of salt, and reanalyzed as the speed in which *Hedra helix* grows is astonishing, meaning that if management techniques and ecological legislation aren't considered that decrease can quickly turn into an increase.
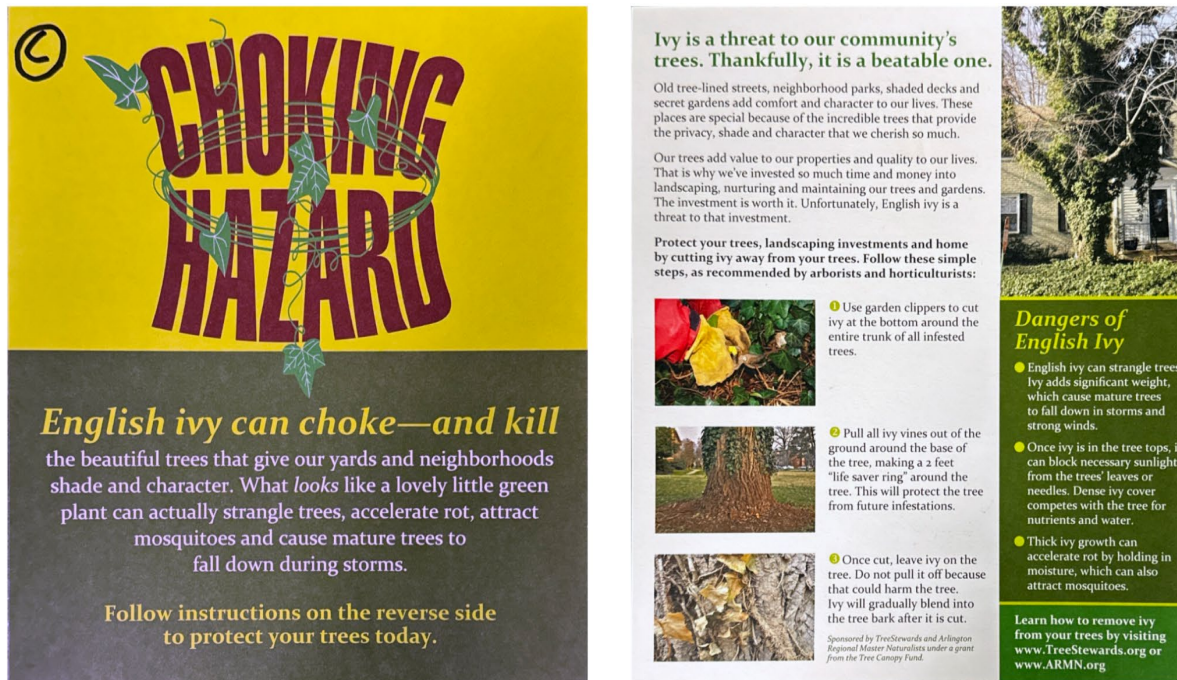
Figure C. Pamphlet collected from Zachary Taylor Nature center concerning Invasive Liana Education.

Overall, researchers were extremely surprised over the prevalence of certain methods such as education (see figure C) being favored alongside traditional methods such as continuous pulling, and professional chemical/physical removal of English Ivy in parks. When visiting Zachary Taylor nature center, researchers were treated to not only a pamphlet but also, a course, and an opportunity to volunteer, which was extremely enlightening and eye opening to one of the most unique methods of management. According to an interview with a parks management official, park management personnel are cleaning up invasive weeds, and trimming back native species in order to promote the growth of native plants, while simultaneously limiting the growth of invasives (Personal Communication). Beyond the paid professional management, Zachary Taylor park hosts volunteers that search for invasives and pull them from the ground. Researchers joined these volunteers and were astonished as to how many invasives grew in only a few days, as areas that were originally hardly visible grew to be heavily crowded with *Hedra helix* after only some weeks with a lack of care.

Researchers were extremely perplexed as to the low levels of invasives found in several parks. Upon driving home from one research operation at Gulf Branch (one of the worst parks recorded) researchers were surprised to find relatively low levels of invasives in the designated park area. Researchers then noticed that on Spout Run Parkway, there was complete infestation on both sides of the highway. Researchers quickly realized

the value of the park management systems, as the Arlington parks, under the authority of the Arlington county natural resource department were intensely clean, with relatively few groves of *Hedra helix*. In contrast, Spout Run Parkway, under the authority of the Virginia Department of Transportation, is completely covered and infested with *Hedra helix*. This infestation explains a part of the destruction of trees, watersheds, and native plant life often seen near highways, roads, and parkways in Arlington Virginia.

Additionally, *Hedra helix* is often sold and planted in personal lawns and gardens, due to its extremely quick growth and ground cover. This explains why in many maps, around the edges near homes the level of *Hedra helix* growth is extremely high, as it often spills from people's yards, like a pandora's box. An easy way to expunge a good deal of the *Hedra helix* is to simply ban the sale and planting of *Hedra helix*. This has been conducted with several different species such as Pythons in Florida (DOI 2017). This can be conducted in Virginia, but is often unpopular among the conservative, and laissez faire government of Virginia.

Community was found to be extremely important in this research project. Community members in Arlington Virginia care significantly about keeping the parks in Arlington clean, so they volunteer and clean out the invasives and the garbage in the parks. Without community values and care for the environment and natural beauty, there would be complete overrun in every park, just like there is on Spout Run Parkway. Researchers believe that park officials see this value, and try to push education, volunteerism, and knowledge onto the public in order to further aid in the crisis of conservation. This can be seen in the pamphlets, as well as environmental education centers that are funded by Arlington County.

Additionally, researchers have collected more specified data, from more parks than the originally collected 17, further extended to areas not controlled by the Arlington country natural resources department, such as spout run parkway. More data is almost always helpful in enhancing knowledge and understanding of a subject, so this collection has been important, and overall helpful in investigating invasive species management in Arlington Virginia.

As an analytical summary, researchers found a considerable decrease in percentage cover of the invasive Liana *Hedra helix* in and around Arlington Virginia parks since the original data was collected in 2007. This shows that Arlington methods of invasive control and management have been at least marginally effective, and may be used as a model for other counties, municipalities, states, and organizations that have similar issues with *Hedra helix* or other invasive liana. This means that when considering the research question To what extent have *Hedera Helix* treatment methods over the last 17 years been effective? Researchers can conclude that it has been marginally effective, with the 11% decrease in percentage cover. With that said there is significant work to be done surrounding invasive species management. Researchers were surprised at the importance that was placed on invasive species education and community involvement. When joining volunteers at several parks, it was surprising to see how many people share similar niche values and views on conservation and invasive management. Beyond this, *Hedra helix* is still being planted in several gardens and yards, and is even sold at home depot. The easiest way to prevent the spread of this horrible invasive, is to not allow its sale or planting on a large scale by corporations or individuals.

Discussion

In preliminary research the lack of specific and localized data provided researchers with a serious problem in finding recent, relevant, and useful data. Even the extremely localized and unique map provided to researchers by Expert Jennifer Soles only provided researchers with data on 18 out of over 130 parks in Arlington. While this may have not seemed as such in the beginning, the lack of data on parks, ended up being an unanticipated blessing for researchers due to the relative lack of time dedicated to the collection of data.

Beyond the collection of data, invasive Liana present unique challenges to conservation experts as their devastating effects often are not realized for several seasons (Hickman 2013). Challenges are presented over a few seasons of nutrient cycling, when combating the species is significantly more difficult than in earlier

stages of invasion. (Hickman 2013)(Biggerstaff and Beck 2007). There is little local research on the topics of invasive liana, as it has presented itself as more of a prevalent issue in more wet areas such as British Colombia, and the Pacific northwest, however many of these papers are still applicable. The negative effects of English Ivy are highlighted in Seed Bank germination, and the stealing of key soil nutrients, which effectively starves the trees they form around (Biggerstaff 2007)(CDFW 2012). The management of invasives is a crucial step in repairing the near irreparable damage caused by human expansion and disregard.

Conclusion

Researchers were inspired by the works of Kolbert, Cabellos, and personal communications with local Wildlife Conservation expert Jennifer Soles. There was a massive gap in research found in maps of invasive Liana in the local area, with the last map being created in 2007. Local experts were delighted to receive this research, and it provides valuable data for those who are assessing and analyzing effective methods of management and conservation. By recreating these maps with more modern data, and more thorough percent cover researchers bridged this gap and gave some more thorough and current data.

Researchers have seen the devastation caused by invasives in their own backyards. Following correspondence with Soles, the problem became more apparent and more available to research than ever before. It is known that human action is responsible for unforeseen destruction and ecological terrors (Ceballos, 2017; CWHL, 2018; Kolbert, 2014;Wagler, 2012). Beyond this, invasives and extinction have a cascading effect which leads to and pushes more extinction, and more depopulation, therefore leading to and fostering an environment which is suitable for more invasives and more extinction (CWHL, 2018; Kolbert, 2014). If the public doesn't hold the threat of invasives more seriously, it will continue to destroy the native ecosphere. It ends with education, funding and people caring about their local environment.

Biases and Limitations

Unfortunately, and as stated previously, data from this study may be skewed by a few percentages due to human error, mathematical error, as well as the time of year, and the time allotted to conduct this research. Being able to conduct several trials over multiple seasons gave the most accurate and useful results available. It is difficult, especially with limited time and equipment, to perfectly find where the perimeter of a patch of *Hedera helix* begins, and where the patch of a similar but native species such as *Euonymus Fortunei* (Fortune's Spindle) begins. If given a larger span of time, and more funding, the research conducted as well as methodology would likely be slightly different and more in depth, leading to more precise, but similar results. With that said, precision in this experiment is not overwhelmingly important, as a noticeable difference in the growth and development of Liana following treatment, is the only truly important value. If the difference in percentage cover were found to only be 1 percent following treatment, the effectiveness of the treatment will be so insignificant that the few inches missed on the perimeter of a few polygons, or a few values calculated improperly don't really matter.

There are few risks associated with collecting this data. When being in a local forest there are direct threats of exposure, as well as being harmed by local flora and fauna. Locally, *Amblyomma americanum*, also known as the Lone Star Tick, can create problems for anyone walking through the forest in Northern Virginia. This parasite can spread pathogens, as well as cause infection in bitten areas (Fairfax County Department of Health and Human Services 2023). In order to prevent being affected by this parasite a few measures were taken as a form of risk mitigation. For one, researchers collected data wearing clothing that covered the entire body, which limited areas available for the parasites to latch. Additionally, researchers used EPA registered insect repellents containing DEET, OLE, PMD, or 2-undecanone (CDC 2020). However, with all of that said, as this

trial was conducted during the winter, the threat of parasitic infection from *Amblyomma Americanum* as well as other parasites that might spread disease such as *Aedes albopictus*, also known as the Asian Tiger Mosquito, was significantly decreased as these species are largely dormant during the winter (Fairfax County Department of Health and Human Services 2023).

Due to unforeseen circumstances, and a lack of coordination between administration and the student body, times dedicated to research and work were unable to be utilized for students conducting projects that involved leaving the designated school grounds. Because of this researchers were forced to work during limited personal hours on physically arduous and time consuming research. After some complaints and loopholes, researchers were able to properly utilize designated class time to conduct their research, allowing for a more efficient and therefore less time consuming collection of data.

Acknowledgments

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