Mapping Invasive Plant Species at Point Defiance Park

By Zach Tingle

Theoretical Foundation

Point Defiance Park, located in Tacoma, is a historical treasure for the surrounding area. At a little over 700 acres, Point Defiance is the second largest urban park in the United States, right after Central Park in New York. Even before it became a city park, back in 1905, Point Defiance was used as military outpost during the mid-19th century and was called "Point Defiance" due to the fact that it "bid defiance to any attack" (TNT 2005). Point Defiance Park is culturally significant to the region, and over the years the natural ecosystem has changed.

Due to the development of the park and urbanization of the Tacoma region, the natural ecosystem of Point Defiance Park has become threatened by invasive species. Unlike non-native species which can coexist with native species harmoniously, invasive species have the potential to outcompete with the native species for resources and result in an overall negative impact upon the ecosystem (Lauren and Whitlow 2012). Invasive species can arrive at a location through various pathways. A significant pathway that invasive plant species inhabit new territory is through road networks. Meunier and Lavoie (2012) state that "roads function as prime habitats and corridors for invasive plant species" and that there is common agreement among other researchers that there is a positive correlation between the existence of roads and invasive plant species. The formation and maintenance of roads create disturbances to the land, and these disturbances result in the propagation of invasive plant species (Joly et al. 2011). According to Mortensen et al. (2009), roads significantly help invasive plants move through forests because the spores of invasive species use vehicles, humans, animals, or physical mechanisms for travel into a disturbed area caused by human development.

Over the past years, the use of Global Positioning System (GPS) devices and Geographic Information systems (GIS) has shown to be crucial tools for environmental research. Masocha and Skidmore (2010) state that “in order to control the spread of invasive species and conserve biodiversity, natural resource managers require accurate maps about the extent and severity of invasions.” Bradley and Marvin (2011) point out that the use of maps can be used to identify “hot spots for priority control” and show trends in the distribution of invasive plant species. The use of digitally stored data through GPS devices and the manipulation of the data through GIS software helps make map production a more accurate and efficient process.

GIS is very useful at modeling the distribution and the potential effects of invasive plant species. Using ArcGIS, Jarnevich et al. (2010) created a model to “determine the biodimatic envelope of a species defined by its known polygonal presence locations.” In other words, a model was created to define areas where a certain species could survive. This model proved very beneficial in predicting locations where the invasive plant species are climatically suited to survive. Kaiser and Burnett (2010) created a model that shows the potential spread, ecological damage, and the economic cost of repair as a result of an invasive species. These examples show the potential that GIS has in monitoring invasive species and predicting future outcomes.

Planning Process

The original intentions for this project were to survey the entire Point Defiance Park for invasive plant species and create optimal routes based on the ease of access (e.g. easy, medium, and hard) for future extraction of the plants using Least Cost Path (LCP) analysis in ArcGIS. There was going to be four routes: 1) A complete route for all the points; 2) A route for only the easy access points; 3) A route for only the medium access points; 4) A route for only the hard access points. For the LCP analysis, the park was going to be rasterized and each cell would have been given a cost. Trails and roads would be given a low cost, while the forested area would be given a high cost. This analysis would have given park management an idea of the most efficient paths to extract the invasive species.

Due to time limitations, the entire Point Defiance Park could not be surveyed in the allotted time frame of this project. The spatial extent of the park proved to be too vast and the forested area too dense to properly survey. So instead of surveying the entire Point Defiance Park the new survey area was determined to be just the northern tip of the park. This reduction in survey area also affected the analysis that would be done in this project. Instead of conducting LCP analysis for the optimal routes, the analysis switched to finding which invasive patches are in walking distance of parking lots using network analysis.

After the data was collected, network analysis proved not to be the most efficient analysis to use for this project. Instead, the use of buffers was used to show areas within the surveyed area that are within a certain walk time of a parking lot. Buffers were also used to show the spatial area for each invasive patch.

The methodology has changed since the beginning of the planning process for this project, but the overall intention of mapping out invasive plant species in Point Defiance Park has remained the same throughout the project. Furthermore, the method for collecting data has also remained the same during the project. Even though the methods for this project have adapted since the initial planning process, the desired goal for this project has been achieved.

Methods

For this project, the survey area was the northern tip of Point Defiance (Figure 1), which is roughly 116 acres or 16% of the entire park.

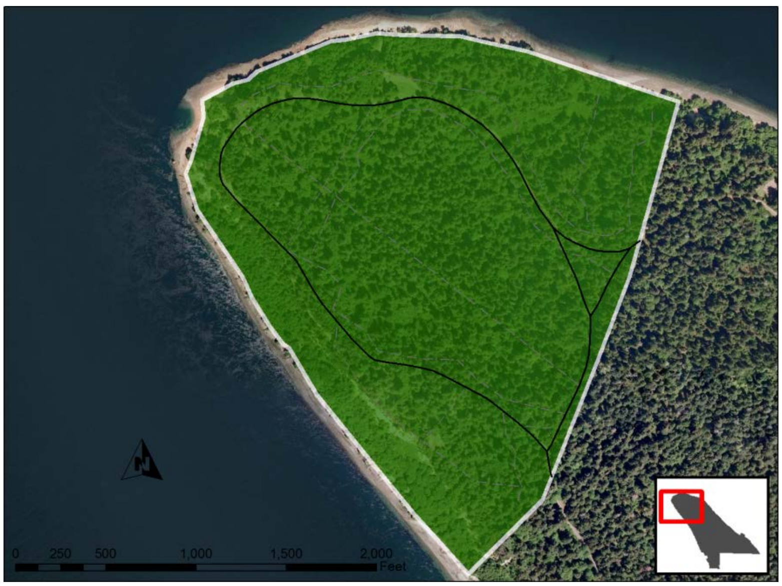

Fig. 1 Survey area: Northern tip of Point Defiance Park.

There were 20 different invasive species (Table 1) that were used for this project. These species were declared to be the most common invasive plants that inhabit Point Defiance Park. Locations for the invasive species were collected using a Trimble® GPS device.

Table 1

Invasive Plant Species			
1) Common Bugloss	6) Field Bindweed	11) Japanese Knotweed	16) Poison Hemlock
2) Daphne Laurel	7) Gorse	12) Mountain Ash	17) Portuguese Laurel
3) English Holly	8) Herb Robert	13) Norway Maple	18) Scotch Broom
4) English Ivy	9) Himalayan Blackberry	14) Old Man's Beard	19) Sycamore Maple
5) English Laurel	10) Horse Chestnut	15) One seeded hawthorne	20) Tansy ragwort

Before going out into the field, the Trimble® GPS device was loaded with a basemap of the survey area and a roads layer so that a relative location could be established out in the field when collecting data. The Trimble® was also set up with quick data entry fields, so that data entry was more efficient. The three fields used were species name, access level, and area.

While out in the field, when a patch of an invasive plant species was located the geographic location of the center of the patch was recorded along with the invasive species name, the difficulty of accessing the patch, and the area that the patch inhabited. For purposes of this project, the access level was determined to be classified as: easy if the invasive patch was located within 15 feet of a trail or road and did not require climbing over obstacles; medium if the invasive patch was further than 15 feet from a trail or road and also did not have obstacles blocking the path or was within 15 feet of a trail or road and required climbing over obstacles; hard if the invasive patch was further than 15 feet from a trail or road and had several obstacles blocking the path or was potentially dangerous.

After the data was collected, the points were entered into a geodatabase and then into a feature dataset using the “NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet” projection. A point layer was created for each invasive plant species and for each access level for the purpose of showing each of the criteria on a map. Parking lots and trails were digitized using images and aerial photos.

For the main GIS analysis for this project, 3 buffers were placed around parking lots; the buffers divided the surveyed area into areas that are within a 3 minute walk from a parking lot, within a 5 minute walk from a parking lot, and within a 10 minute walk from a parking lot. For the intentions of this project, walking speed was established as 3 mph.

As an additional analysis, buffers were put around invasive patches in relation to their area. ArcGIS uses the radius to create buffers, so for each point the radius was calculated from the measure area. This analysis provides a proximal size of the invasive patch in relation to the surveyed area.

Results

A total of 113 points were collected and 4 out of the 20 invasive plant species were identified in the surveyed area (Figure 2).The points are broken down into the following: 60 points are classified as English Holly; 29 points are classified as Scotch Broom; 21 points are classified as Himalayan Blackberry; 3 points are classified as Portuguese Laurel.

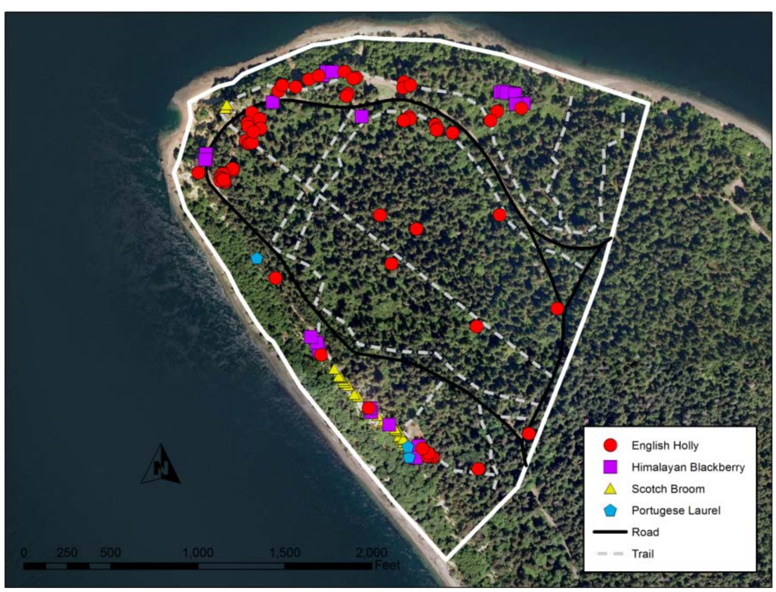

Fig. 2 Locations of invasive plant patches within the surveyed area.

Easy, Medium, and Hard Access points were determined. 85 points are classified as "Easy Access," 21 points are classified as "Medium Access," and 7 points are classified as "Hard Access."

The area for each invasive patch was mapped out, and the largest patch is 900 ft^2 and the smallest is 1 ft^2 (Figure 3). The invasive plants cover roughly 0.15 acres of the 116 acre surveyed area.

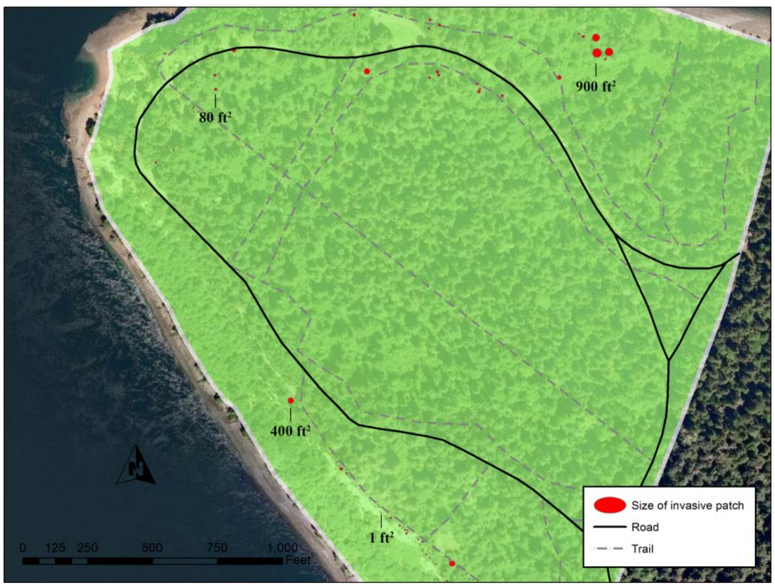

Fig. 3 The area for each invasive patch in comparison to the surveyed area.

The surveyed area was divided into areas that are within a 1 minute walk, within a 5 minute walk, and within a 10 minute walk from a parking lot (Figure 4). Excluding points that are classified as hard access, it was determined that 24 invasive patches are within a 1 minute walk from a parking lot, 64 invasive patches are within a 5 minute walk from a parking lot, and all 106 of the easy and medium access invasive patches are within a 10 minute walk from a parking lot.

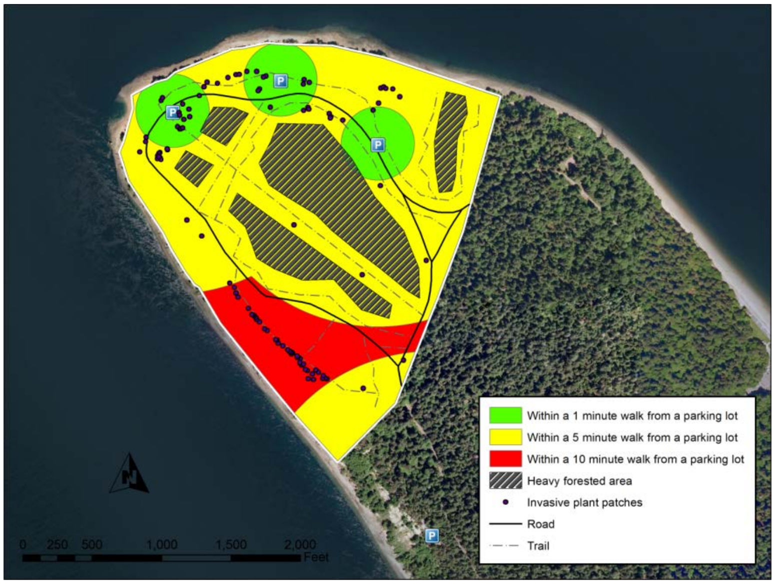

Fig. 4 Survey area categorized by walk time from a parking lot.

Discussion

The results show a common trend that the invasive species are more frequently located near roads and trails. This supports the findings from previously mentioned articles (Meunier and Lavoie 2012; Joly et al. 2011; Mortensen et al. 2009) that roads and other pathways are primary corridors for invasive species inhabiting an area. These invasive plant species take advantage of the ecological disturbances that result from park maintenance and human recreational activities.

Even though only 4 out of the 20 invasive species were discovered in the surveyed area, the other invasive species are most likely scattered throughout the areas of the park that were not surveyed. It was interesting to note that both the Scotch Broom and Portuguese Laurel inhabited only the western side of the surveyed area, while the English Holly and the Himalayan Blackberry were found throughout the area. A possible reason for this is that the western cliff edge seemed to provide more sunlight than the rest of the surveyed area, which would create better growing conditions for the Scotch Broom and the Portuguese Laurel.

The total area that the invasive species inhabited seemed miniscule to the total surveyed area. At 0.15 acres, the invasive species only inhabit 0.13% of the surveyed area. Even though this seems like the invasive species pose a small threat to the natural ecosystem of Point Defiance Park, if these invasive species are left unchecked, their threat upon the park could greatly increase. The dense vegetation of the old growth forest slows down the spread of invasive species, but each new disturbance to the forest increases the odds of invasive species spreading deeper into the forest.

The buffer analysis around the parking lots shows that the majority of the surveyed area is within a 5 minute walk of a parking lot. The parking lot buffer map was created with the intention that an average person could park their car at one of the parking lots and use this map to help extract invasive species from the park. The “Hard Access” points were excluded from the layout and the “Heavy Forested” polygons were included because the points that are classified as “Hard Access” would be too hard or dangerous for the average park enthusiast to travel to and the “Heavy Forested” areas were created to show that areas that were virtually impassable.

In the end, the primary goal for this project was achieved. Invasive plant species locations were identified in the park and mapped out using GIS methods. Even though the whole park was not surveyed, this project opens the door for further analysis of invasive plant species at Point Defiance Park.

Critical Analysis

This project relates to course material and discussions. Drawing upon Mark Monmonier's book *How to Lie With Maps*, this project portrays "little white lies" to get the main point across to the reader (1996, p. 25). For instance, the map that shows the area for each invasive species patch (Figure 3) only shows the representation of the area and not the true area that the patch inhabits. Even though the map might be visually inaccurate, it still gets the point across of the size of the invasive species in relation to the surveyed area. Furthermore, Monmonier states that the information contained in maps is "perishable" (1996, p. 54). Since this project deals with living organisms, the locations of the invasive species is constantly changing and the information contained in this project will decrease in accuracy over time.

As Marianna Pavlovskaya (2006) mentions, GIS is more than a quantitative tool for analyzing data; GIS has huge potential for qualitative analysis. This project was more qualitative than quantitative. The goal for this project was to visually represent the data in a way that the reader could see the distribution of invasive species at Point Defiance Park and provide a method for eradicating the plants. In all, this project has built upon ideologies learned through the GIS program.

Acknowledgements

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