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Vegetative Rapid Assessment and Habitat Quality Analysis of Steidtmann Woods

Sarah Mae Bail
Bowling Green State University, sbail@bgsu.edu

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By: Sarah Bail

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Dr. Daniel Mark Pavuk, Primary Advisor

Dr. Holly J. Myers, Secondary Advisor

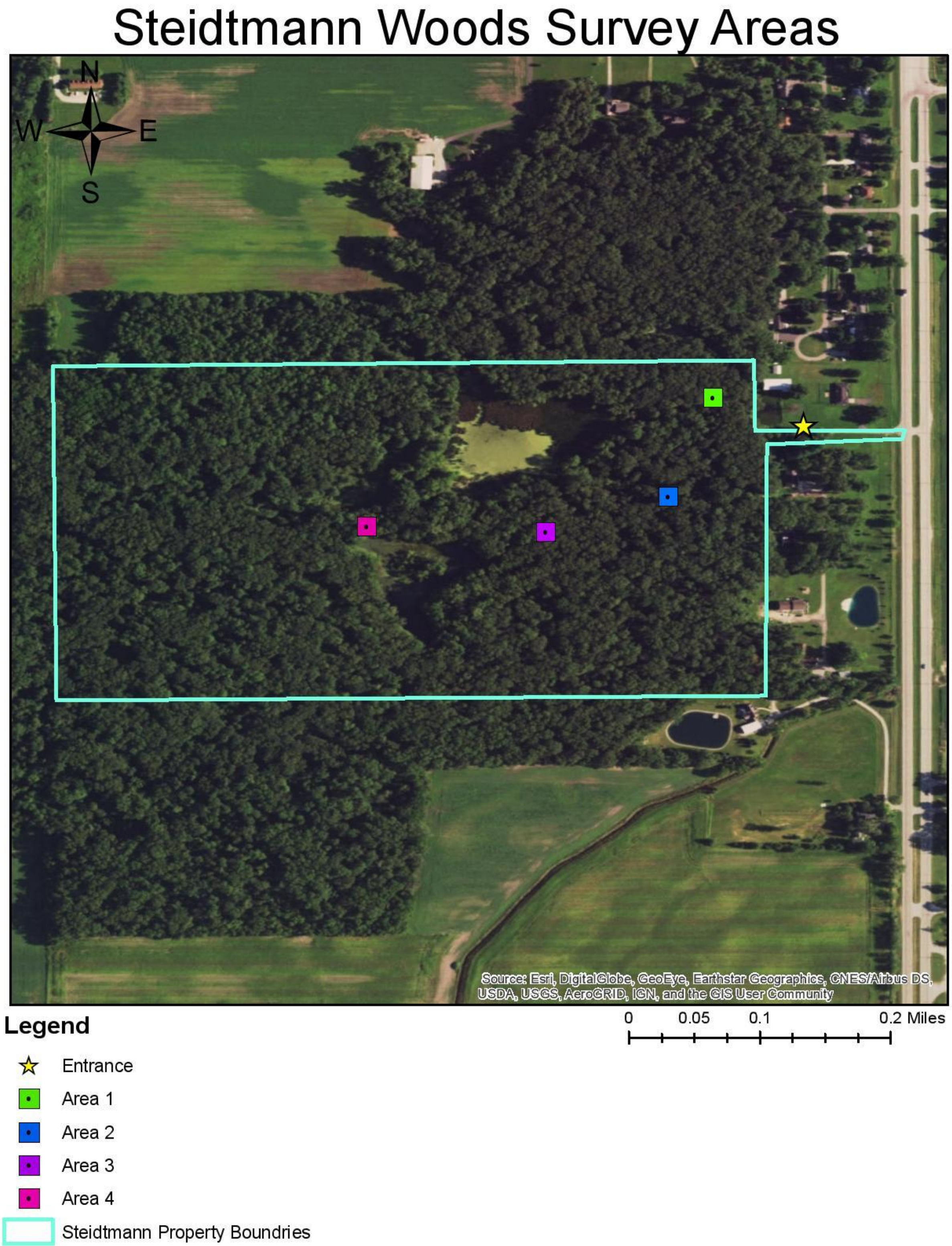

Figure A: Areal Image of Survey Areas in Steidtmann Woods

Abstract

Due to invasive species and the assumption of an unhealthy ecosystem, Steidtmann Woods is an underutilized piece of land owned by Bowling Green State University. However, the property had never been analyzed. The proposed hypothesis was that Steidtmann was indeed in destress and its ecosystem could benefit from intervention—removal of invasive species and supplementation of natives. Through a rapid vegetative analysis, data was collected in several regions of the woods to identify what navies and non-natives were present as well as to identify their proportions. With that data, the species evenness, richness, and diversity was calculated; first, with raw field data and secondly, with data that merged invasive species into one mega-species to see the true effects of invasive populations. The data concluded that Steidtmann needs restoration and that the presence of invasive species reduces the properties overall health.

Introduction

Steidtmann woods is a small wooded area off South Dixy Highway that is owned by Bowling Green State University. The rectangular shaped parcel is surrounded by rural residential properties and agricultural activities with a small buffer, on all but one side (the entrance side, see Figure A), of wooded area. This section of land is set aside as a reserve as well as a research area for students and faculty of the college. Regrettably, few individuals utilize the property because, historically, the area has been infested with invasive species— which, in this case, references plants that are not original inhabitance of this area. Invasive species often have no true predators and therefore no checks and balances. This enables invasive inhabitance to grown in an exponential and uninhibited fashion which smothers the native species and creates a monoculture ecosystem; drastically reducing the ecosystem's value and services (i.e. the ability to provide clean water, decompose waste, or provide adequate food and habitat for natives). This issue tends to steer biologists and ecologists away from Steidtmann and to areas which have more biologically significant ecosystems to conduct their research.

"Biological significance" is equivalent to the quality of the habitat and thus its ability to provide ecosystem services and habitat for plants and animals. There are many factors that determine the quality of a habitat including, but not limited to, connectedness of the property, size, species richness, species diversity, access to tributaries, and invasive abundance. Many natural areas are under increased pressure as pollution, invasive species, human development and expansion destroy ever-growing amounts of land. To combat this trend, remaining ecosystems must be analyzed for their health (biological significance) and, if it is found that the ecosystem is in distress, restored to an improved state.

However, no such investigation of Steidtmann had ever been conducted to assess the biological significance of the area nor had a restoration plan ever been constructed. Is Steidtmann woods as degraded as some predict? Is the ecosystem viable? Is it feasible to restore the area? The proposed hypothesis is that the Steidtmann Woods ecosystem has been degraded by invasive species and that a restoration plan focused on the removal of those species and the introduction of native species will greatly increase the properties biological significance.

Materials and Methods

To determining the biological significance of Steidtmann woods a two-part study was conducted. First, a vegetative rapid assessment as outlined by the California National Plant Society was completed. The California National Plans Society defines a vegetative rapid assessment as a process that determines the quantities and species of plants within an area to be cataloged and referenced to determine the overall ecosystem health and function. These rapid assessments are utilized to encourage restoration and species preservation at an ecosystem level—focusing not on individuals but the area as a whole in order to create more inclusive and practical restoration policies and practices. The CNPS dictates that vegetation must be analyzed (counted and identified) via quadrant and transect line methods.

Thus, for the data collection portion, four locations within Steidtmann woods were selected as collection sites. Each test area consisted of 25 square feet (a five-foot by five-foot square), totaling 100 square feet of identified and quantified plants (See Figure A). They were chosen due to their approximate location, one on the exterior of the property and then the remaining three were spaced evenly to the center of the property, to obtain data that would be inclusive of the entire area. This method considers the effects of edge habitat and sheltered interior habitat. The exterior of a natural area is often less diverse, contains more invasive species, and displays negative side effects of exposure to human development such as pollution—in the form of runoff, sound and light. Many plant and animal species avoid the edge habitat, living in the interior sheltered habitat, to avoid these disturbances. Even though Steidtmann has a small wooded buffer on most sides one can consider this buffer as “edge” because it is privately owned and known for constant human presence.

The in-field analysis was followed by a breakdown of that data to determine species abundance (the number of individuals of each species within a community), species evenness (the quantity of each species in relation to each other within an environment), species diversity (the number of different species dwelling within an ecosystem), and ratio of native to non-native plant species. It is important to note that the data for each test area was assumed to be inclusive of the entire plot and therefore was compounded and computed as if there had only been one test cite. This was done so that the complete health Steidtmann could be determined versus the health of independent regions within the woods.

First, Species evenness was calculated in excel using the EVAR formula[1]. This is done to determine how the numbers of each species in the environment compared to each other which goes hand in hand with determining biodiversity. The output number is going to be on a scale from 0-1; 0 being that there is no evenness and 1 being that the species are distributed completely evenly. The closer the output is to one the better the health is of the ecosystem.

Secondarily, species diversity was calculated using the Shannon index[2]. The Shannon index is used as a tool to determine biodiversity since the output will be higher as both species richness and evenness in the community increases. Typically, this number falls between 1.5 and 4 where the higher value displays a higher overall ecosystem health.

Lastly, complete ecosystem health was determined. To do this, data on all invasive species was compiled—forming one invasive "mega-species". This "meg-species" (referred to as invasive species in Table 2) was then added to the native species data and the evenness and diversity indexes were recomputed. This served to display the negative impacts of invasives by removing their ability to increase ecosystem diversity. Essentially, the total biomass remined the same however, the tree invasive species (honeysuckle, multiflora rose, and garlic mustard) that previously contributed to the diversity of the ecosystem are removed and made into one species that has larger footprint (uses more resources and room). This is done to show the negative impacts of the invasive on the ecosystem health.

[1] E_{var}=1-2/π arctan{∑(ln(x)-∑ln(x)/S)^2/S}

[2] H= -∑PilogPi

Results

Overall, the species diversity was 13 for the base data and that fell to 11 after adjusting for invasive species. The total biomass (plants analyzed) was 508 with abundances ranging from 8 to 136 plants per species. As for the calculations, species evenness for the base data was equal to .658 and the Shannon Diversity Index was equal to 2.26. This was contrasted by the aggregated data readout that equated at .56 for evenness and a 1.98 for diversity. This equated a 14% reduction in diversity and a 17.5% reduction in the areas evenness when data was adjusted for invasive species and their effects. It was also computed that for every one invasive there is 2.5 native plants—meaning that about 40% (39.9%) of the total biomass of Steidtmann woods consists of invasive species.

Plant Species	Area 1	Area 2	Area 3	Area 4	Total (Species Abundance)
Oak Trees	17	5	0	8	30
Honey Suckle	0	10	60	8	78
Multifloral Rose	8	9	18	12	47
Strawberry (Fragaria Rosales)	0	2	0	6	8
Violet	0	0	12	0	12
Carolina springbeauty (Claytonia car	0	3	4	6	13
Mayapple	0	38	18	0	56
Garlic Mustard	0	12	0	8	20
Fern	7	0	8	6	21
Speacies 1 (mid-range shrub)	21	7	3	0	31
Species 2 (leafy ground cover)	60	28	16	32	136
Species 3 (Leafy ground cover)	10	12	11	6	39
Species 4 (singular leaf-- late spring f	8	2	4	3	17
Totals	131	128	154	95	
Species Richness (S)	13				
Total Biomass	508				

Table 1: Raw Data: Unprocessed Field Data

Plant Species	Total Spec
Oak Trees	30
Strawberry (Fragaria Rosales)	8
Violet	12
Carolina springbeauty (Claytonia car	13
Mayapple	56
Fern	21
Speacies 1 (mid-range shrub)	31
Species 2 (leafy ground cover)	136
Species 3 (Leafy ground cover)	39
Species 4 (singular leaf-- late spring f	17
Invasie Species	145
Species Richness (S)	11
Total Biomass	508

Table 2: Computed Data: Invasive Species Combined into "Mega-Species"

Ln (x)	Ln(x) /S	(A-sum(B))^2/S	Pi	Pi*(LN(pi))
3.401197382	0.30919976	4.05734E-08	0.059055118	-0.167083705
2.079441542	0.18904014	0.158982271	0.015748031	-0.065370707
2.48490665	0.2259006	0.076437585	0.023622047	-0.088478145
2.564949357	0.23317721	0.063675321	0.025590551	-0.093802987
4.025351691	0.36594106	0.035339555	0.11023622	-0.24308517
3.044522438	0.27677477	0.011608548	0.041338583	-0.13170303
3.433987204	0.31218065	9.38007E-05	0.061023622	-0.170652208
4.912654886	0.44660499	0.207498613	0.267716535	-0.352803961
3.663561646	0.33305106	0.0062259	0.076771654	-0.197066678
2.833213344	0.25756485	0.029396837	0.033464567	-0.113688106
4.976733742	0.45243034	0.225473651	0.285433071	-0.357861058
	3.40186544	0.814732121		
Species Eveness	0.56476877		SW Diversity	1.981595753

Table 3: Field Data: Shannon Diversity Index Calculations and Species Evenness Data Calculations

Ln (x)	Lnx/S	(A-sum(B))^2/S	Pi	Pi*(LN(Pi))
3.401197382	0.261630568	0.000147464	0.0590551	-0.1670837
4.356708827	0.335131448	0.076814712	0.1535433	-0.28770524
3.850147602	0.2961652	0.018675919	0.0925197	-0.22022774
2.079441542	0.159957042	0.125631707	0.015748	-0.06537071
2.48490665	0.191146665	0.058559086	0.023622	-0.08847814
2.564949357	0.197303797	0.048307641	0.0255906	-0.09380299
4.025351691	0.309642438	0.034318576	0.1102362	-0.24308517
2.995732274	0.230440944	0.010062559	0.0393701	-0.12735233
3.044522438	0.234194034	0.00753083	0.0413386	-0.13170303
3.433987204	0.264152862	0.000451042	0.0610236	-0.17065221
4.912654886	0.37789653	0.186059687	0.2677165	-0.35280396
3.663561646	0.281812434	0.007209748	0.0767717	-0.19706668
2.833213344	0.217939488	0.021137365	0.0334646	-0.11368811
	3.357413449	0.594906336		
			SW diversity	2.259020008
Species Evenness	0.658347978			

Table 4: Computed Data: Shannon Diversity Index Calculations and Species Evenness Data Calculations

Discussion

It was found that the evenness of the initial survey of Steidtmann woods was equal to about .658 and the Shannon Diversity Index was equal to about 2.26. (see Table 3). Neither of these two values point to a significantly healthy ecosystem. However, the species evenness is above .5 which means the diversity is more evenly spread than not and the Shannon diversity was neither the highest nor lowest but at about a mid-range. This data points to an ecosystem that is functioning and valuable but that could benefit from assistance. However, when considering that some of the diversity is brought from invasive species, this may point to an ecosystem that could be beginning its downward trend to a monoculture.

This possible downward trend is boldly highlighted when the invasive species were conglomerated into one “mega-species”. This action caused the evenness to drop to .56 and the Shannon diversity to shrink to 1.98 (as seen in Table 4). These numbers more accurately reflect the overall health of Steidtmann Woods. As invasive species grow in biomass they use more ecosystem resources and push out the balanced native species. Therefore, invasive species should not be considered to add to the overall species richness of the area—with time they will devastate the natives and create a monoculture. With the above-mentioned output data, Steidtmann can be considered in need of remediation as the evenness has dropped to nearly .5 (which means there is no significantly even distribution of species) and the Shannon Diversity Index is under 2 which means it is .5 away from the lowest end of the spectrum. Not to mention that nearly 40% of the plants contains within Steidtmann are identified as non-native plants. This poses a huge threat on the ecosystem health.

Overall, this analysis proves that Steidtmann Woods is a suffering ecosystem that needs both the removal of invasive species and the supplementation of native species. Further studies and analysis of the area may prove helpful to determine the rate at which the invasive population is growing. However, caution on postponing restoration should be stressed as invasives multiply exponentially and could make up half the Steidtmann vegetative population within a few years or less.

This study was conducted during the winter and spring months. It is important to realize that though this data is lending one to agree with the proposed hypothesis that there is a challenge posed with the data collection due to time of year. This study, to be proven as viable, must be recreated during the summer months when all viable native species are no longer in hibernation. This could greatly affect the overall richness, diversity, and evenness of the property. Likewise, it is important to note that the survey sites were not large which could harm the validity of the data.

If this experiment was to be recreated the seasons would need to be accounted for and the survey areas would need to be larger than the ones previously analyzed. Likewise, data should be collected from each side of the area (along each property boundary) which would eliminate the assumptions of equal edge effects and provide more accurate data. The most logical proposal would consist of nine areas, 10 feet by 10 feet, comprising of one on each boundary, one midway between each boundary and the center of the woods, and one in the center of the woods. This would provide the most complete coverage and accurate data. Also, this experiment should be done once each season (sans winter months) to include seasonal species and ensure comprehensive data.

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