Pier Cove Restoration Management Plan

On Behalf of the Pier Cove Ravine Trust

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Acknowledgements

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"A park is not primarily a place for play, but rather to feed one's soul"
-O.C. Simonds, Landscape Gardening, 2000

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Project Overview

The goal of this project is to create a management plan for rejuvenating Pier Cove Ravine. Located in southwest Michigan, this historic property has served its community for over one hundred years as a place for outdoor recreation, reflection, and retreat. Pier Cove's founder, O.C. Simonds, created this property with the intention to connect people with nature. As a result, Pier Cove has become an important local green space home to many species of plants and animals. Through natural processes, and the passage of time, the property faces various challenges like streambank erosion, trail degradation, and invasion by non-native plants.

Although the stream running through the property is small, it is not immune to disturbances (both anthropogenic and natural). All streams are prone to bank erosion from the flow of water. Erosion from the natural flow of a stream over time, plus rapid erosion from large storms, can destabilize banks. This can cause nearby trees to fall into the stream, creating further erosion (Bigham, 2020). Severely eroded stream banks throughout Pier Cove will need to be addressed for both the health of the stream habitat and for stream accessibility.

Many invasive plant species are located throughout the property and have become an issue. Invasive plants are known to outcompete native species and create an unfavorable habitat for wildlife (Fan et al., 2013). Common invasive species in southwestern Michigan include autumn olive, honeysuckle, multiflora rose, and many others (Borland et al., 2009). All of the aforementioned species exhibit rapid growth patterns and are known to overtake a landscape once they have been established. Once again, for the health of the ecosystem on the property and its future accessibility to visitors, there is a crucial need for creating a management plan to manage invasive species on the property.



Figure 1: A bridge that collapsed at Pier Cove due to erosion

The final challenge that needs to be addressed in this management plan is the degradation of the trail running through the property (Figure 1). While this property is a space for nature to exist on its own, it was created with the idea that people could come to the property to reconnect

with nature. Thus, there is a small trail that runs through the property for people to use. Over the years, sections of the trails are no longer used due to the overgrowth of plant species. There are also various boardwalks and bridges that will need to be repaired, or improved, to keep the trail connected and for safe navigation. In addition, the “upper path” of the property was once accessible with vehicles for the enjoyment of older patrons as well as for maintenance and emergencies. This path has been narrowed considerably from overgrowth and will need to be addressed within this management plan.

Pier Cove has immense potential to be restored and preserved for generations to come. Although the property is affected by habitat alteration, invasive species, and trail degradation, these issues are not unsolvable. By successfully rejuvenating Pier Cove, and addressing these concerns, community members and visitors will have improved accessibility to a historic and protected natural area for years to come. To restore and maintain the property for the next several generations, this management plan includes the following:

1. A baseline inventory of Pier Cove’s vegetation
2. Scenarios for restoring and enhancing Pier Cove’s cultural and natural features
3. Possible partnerships and/or strategies for the Trust to expand its property holdings
4. Opportunities for fundraising initiatives for supporting the work of the Trust
5. Interpretive materials/strategies for sharing the history and unique natural features of the ravine with the local community.

To accomplish these goals and objectives the team outlined the project in three phases. In phase one, the group conducted the baseline inventory of Pier Cove’s vegetation using methods which will be outlined in further sections of this management plan. The team also conducted several surveys to understand the impact on steam erosion. In the second phase of the project, the team consolidated and analyzed the data acquired in phase one. During this phase the team also finalized references, identified courses of action, and began preparing the deliverables for distribution. In the final phase, the team will consolidate and finalize all materials to be distributed and presented to the Trust. During this final phase the group will present all materials from the study to the Board of Trustees, SEAS faculty and staff (School for Environment and Sustainability at the University of Michigan), and stakeholders.

History of the Pier Cove Ravine

Formed in 1973, today's Pier Cove Ravine is known as a seventy-acre historic property situated on the shores of Lake Michigan. However it was once the site of an established port town, shipping goods like lumber and fruits to cities, like Chicago (Foster, 2018). Visitors can still catch glimpses into Pier Cove's past just by taking a walk or driving past the property. Restored historic cottages, like the Orchard House, can be seen adjacent to the property and even rented for summer vacations. In recent history, Pier Cove was owned by a man named O.C. Simonds who was a landscape architect and a graduate from the University of Michigan (Simonds, 2000). When Simonds purchased the property in 1889, he designed the property to be an experimental arboretum and planted both native and unique non-native species as a means to reforest the property (Simonds, 2000). As a result, species, like the Great Rhododendron (Figure 2), *Rhododendron maximum*, which are normally native to southeastern states and warmer climates, can be found throughout Pier Cove (Michigan.gov, 2024). Unfortunately, as mentioned previously in this document, many of the species Simonds planted are no longer found on the property due to competition from invasive species. Simonds once envisioned the property to be a place where "all the children of the present day, as well as their fathers and mothers could have some place to go where they could sit quietly and enjoy nature, or where they could romp about and play on the grass, or go in wading or swimming; a place where they could become acquainted with the shapes of all the leaves and their habits of growth" (Simonds, 1909). Generations of families have since inhabited many of the homes surrounding Pier Cove and have created deep connections with the property and its history. Thus, this management plan aims to restore and protect Pier Cove with Simonds' vision in mind, in partnership with Pier Cove's Board of Trustees, and invested community members.



Figure 2: Great Rhododendron (*Rhododendron maximum)* found at Pier Cove

The Pier Cove property has evolved since its inception in 1973. Many environmental and human-made factors have altered the composition of the property. As a result, an updated map, found in Appendix D, has been established so that visitors can easily navigate throughout the property and identify trail terrain, footbridges, etc. For example, Pier Cove Creek, referred to as the stream throughout this document, has kept its shape but looks drastically different than it did even a decade ago. Some foot bridges, and other infrastructure that once existed throughout the property, no longer exist or have been damaged due to erosion and

changes in ecological composition of the property. These footbridges have now been updated on the trail map of the property, which can also be changed easily in its digitized format.

Stream Characterization

Overview of Components

Pier Cove Creek is a small but dynamic meandering stream located in southwestern Michigan. Its headwaters originate in the upland forests and agricultural fields east of Interstate I-196 For reference see Appendix D1. The creek flows westward, passing under I-196 through a recently restored culvert designed to mitigate flooding and improve hydrological connectivity. Despite its relatively short length of 1500m, Pier Cove Creek exhibits significant hydrological capacity, particularly during storm events, which has led to intense stream bank erosion throughout its course. The creek ultimately empties into Lake Michigan, contributing to the broader watershed dynamics of the region.

Due to the combination of natural processes and anthropogenic influences, Pier Cove Creek has experienced substantial erosion and bank destabilization. Sandy soils dominate much of the streambed and banks, leading to increased sediment transport and channel shifting. Large woody debris is prevalent throughout the creek, with fallen trees often exacerbating erosion and altering stream flow patterns [Insert picture]. Understanding these hydrological dynamics is essential for developing an effective restoration and management strategy.

This report outlines a comprehensive restoration and management plan for Pier Cove Creek, focusing on stabilizing eroding banks, mitigating the impacts of excessive large woody debris, and ultimately coming to an understanding of this creek's hydrological tendencies. The following sections will detail the creek’s current hydrological conditions, identify key challenges, propose evidence-based restoration techniques, and recommend long-term management strategies to enhance the ecological integrity of Pier Cove Creek.

Stream Hydrology

Overview of Data Collection Methodologies

Understanding the hydrological behavior of Pier Cove Creek is essential for developing effective restoration and management strategies. To achieve this, a comprehensive hydrological survey was conducted to assess stream morphology, flow dynamics, sediment transport, and the impact of large woody debris (LWD). This section outlines the types of data collected, the rationale behind each dataset, the methodologies employed, a presentation and analysis of the results, and the implications for stream management efforts.

The data collected focused on three primary parameters: stream width and depth, water velocity and discharge, and debris accumulation and clogging risks. These parameters were selected

because they provide crucial insights into stream flow capacity, sediment transport potential, habitat conditions, and erosion dynamics. For instance, understanding bankfull width (the width of the stream at the point where it begins to overflow its banks) is vital for estimating flood risks, while wetted width (the actual width of the stream occupied by water at any given time) indicates available habitat space for aquatic organisms. Similarly, velocity measurements help assess sediment transport and erosion risks, as higher velocities often correlate with greater erosive power. Finally, evaluating LWD presence provides insights into habitat complexity and potential flow obstructions.

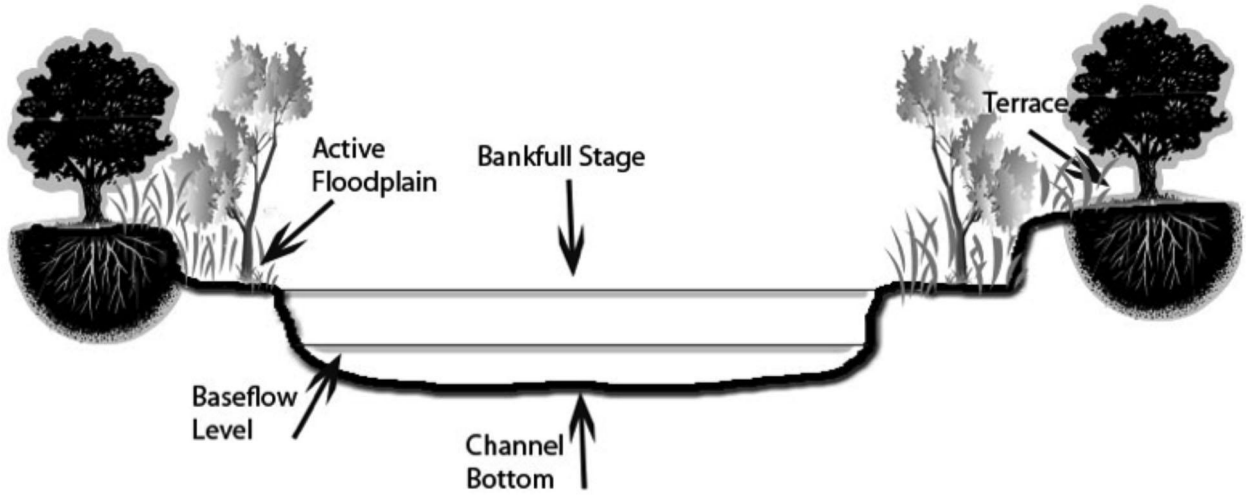

Figure 3: Cross-section of stream corridor with major components labeled. (“Natural Stream Restoration and Enhancement - Oklahoma State University,” 2017)

Site Selection and Mapping: Monitoring points were selected along the approximately 1500m length of Pier Cove Creek, ensuring representation of diverse hydrological sections, including riffles (shallow areas with fast-moving water), runs (deeper areas with moderate flow), and pools (deepest areas with slow-moving water). Points were also chosen based on soil composition (sandy, gravelly, or clayey) and ecological variation. GPS mapping was used to record each transect, facilitating precise, repeatable measurements. For reference see Appendix D3.

Stream Velocity and Discharge: Velocity measurements were taken using a flow meter, a device that calculates the speed of water flow at multiple depths and cross-sectional points. Discharge (Q), which represents the volume of water flowing through a cross-section per unit time, was calculated using the velocity-area method: $Q=A\times VQ$. This method provides insight into the stream's ability to transport water and sediment, especially during storm events.

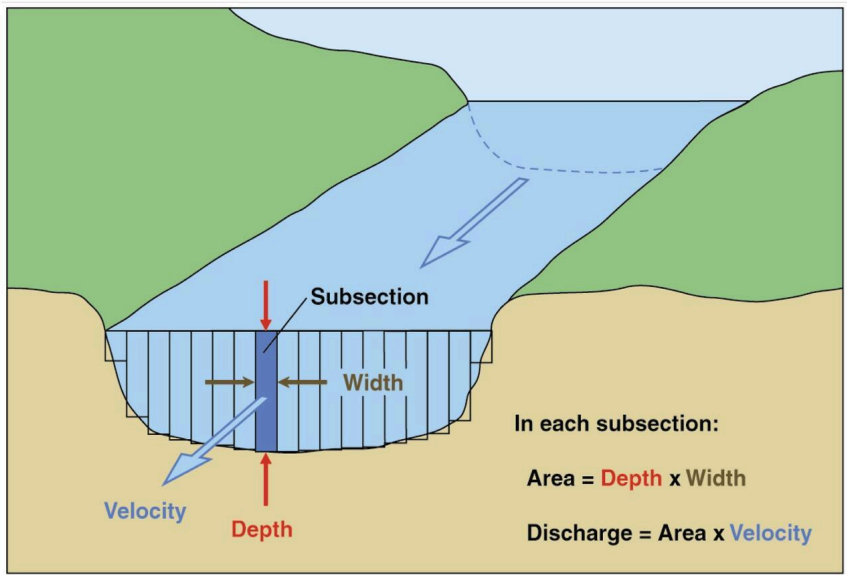

Figure 4: Diagram showing a cross section of a stream visualizing how the stream discharge is calculated. (“How Streamflow Is Measured | U.S. Geological Survey,” n.d.)

Stream Morphology and Flow Characteristics

Measurements revealed that bankfull width ranged from 4.11m to 14.7m, averaging 5.9m. The wetted width varied between 2.08m and 4.62m, with an average of 2.8m. These variations reflect seasonal fluctuations in stream discharge.

Velocity measurements across transects ranged from 0.05 m/s to 0.23 m/s, with an average of 0.12 m/s. Higher velocities were observed in narrower sections with steeper gradients, indicating areas with elevated erosion potential. Depth measurements varied from 1.0 cm to 12.0 cm, with deeper sections typically found in pools, providing critical habitat for aquatic species.

Erosion and Soils

Debris and Clogging Assessment
LWD surveys involved documenting the presence, abundance, and impact of woody debris across transects. The volume of debris was estimated to assess flow obstructions, while impact evaluations identified areas where debris contributed to erosion or sediment buildup.

Erosion and Sediment Trends - Sandy areas showed the most significant erosion, particularly where LWD altered flow paths. The presence of iron-rich deposits at certain transects suggested groundwater interactions, potentially influencing sediment composition and stream chemistry. Gravel-rich sections were identified as key macroinvertebrate habitats, highlighting the

importance of maintaining substrate diversity. Table 1 highlights the substrate observations across the stream from left to right bank at all transects.

Table 1: Substrate observations at five points across the stream at each transect. Substrate was determined by visual observations as well as tactile observations to confirm size or texture of substrate granules. Left versus right bank was determined by facing downstream at each transect and working left to right across the stream from bank to bank.

Transect	Left	Left Center	Center	Right Center	Right
A	Sand	Sand	Sand	Coarse gravel	Sand
B	Sand	Sand	Fine gravel	Sand	Sand
C	Sand	Sand	Coarse gravel	Coarse gravel	Fine gravel
D	Sand	Sand	Sand	Sand	Sand
E	Fine gravel	Fine gravel	Sand	Fine gravel	Fine gravel
F	Coarse gravel	Coarse gravel	Cobble	Cobble	Coarse gravel
G	Sand	Sand	Sand	Sand	Sand
H	Sand	Sand	Sand	Fine gravel	Fine gravel
I	Wood	Wood	Sand	Sand	Sand
J	Sand	Coarse gravel	Coarse gravel	Fine gravel	Fine gravel
K	Sand	Fine gravel	Fine gravel	Cobble	Sand
Most Common Substrate	Sand	Sand	Sand	Sand	Sand

Debris and Clogging Risks -

LWD accumulation was observed at multiple locations, with some transects showing severe clogging that contributed to localized bank undercutting. Heavy debris loads were linked to altered flow patterns and increased erosion risks. Selective debris management will be essential to balance habitat benefits with hydrological function.

Implications for Stream Management

The hydrological data collected from Pier Cove Creek highlights key restoration priorities. Streambank stabilization efforts should focus on areas with high erosion rates, particularly those with sandy soils and significant LWD accumulation. Managing LWD through selective removal and strategic anchoring can reduce erosion while preserving habitat complexity.

Additionally, continued monitoring of velocity, discharge, and sediment transport is recommended to refine hydrological models. These models will help predict storm and flood surges, enabling proactive management strategies. The findings from this section will directly inform the restoration and management practices outlined in the following section, ensuring that interventions are data-driven and site-specific.

Restoration and Management Plan for Pier Cove Creek

The observations from the Pier Cove Creek stream survey highlight critical areas requiring management intervention. Recommended management practices include stabilizing stream banks through strategic vegetation planting and bioengineering solutions, selective management of large woody debris to balance ecological benefits and hydrological function, implementing hydrological monitoring programs, and developing a predictive hydrological model to inform proactive management. Detailed explanations, figures, and citations for these strategies are provided in the **Management Recommendations** section.

Riparian Zone

Methods

The stream characterization was conducted at eleven transects along the Pier Cove Stream, starting with Transect A on the western end of the property and ending with Transect K on the eastern end (Figure 5). Methods for the physical habitat collection were modified from the wadeable stream methods for the EPA National Rivers & Streams Assessment (National Rivers and Streams Assessment Field Operations Manual - Wadeable 2023).

For vegetation observations, both sides of the stream were inspected with the left and right banks being determined by facing downstream at each transect. The area for observation on each bank at each transect included looking five meters upstream, five meters downstream, and ten meters from the edge of the bank (10m x 10m total riparian zone area). On each side, the team member would inspect the canopy (>5m), understory (0.5m-5m), and ground cover (ground-0.5m). For the canopy, the team member would determine the dominant woody vegetation type and estimate the percentage cover of large (DBH > 0.3 m) and small trees (DBH < 0.3 m). For the understory, woody vegetation type was determined as well as the percentage of woody shrubs/saplings and non-woody vegetation. For ground cover, the percentages of non-woody vegetation, bare soil (forest floor with no live vegetation present), and woody shrubs/saplings were estimated. These methods were repeated for each side of the stream at all eleven transects.

It is worth noting that, for the sake of time, the stream characterization was completed over two days. Transects A-H were completed on August 12, 2024 and transects I, J, and K were completed on August 13, 2024. It should also be noted that the terrestrial vegetation

characterization and stream characterization were completed as separate components - although both characterizations use letters to denote the transects, transect A of the stream and transect A of the vegetation characterization are spatially separate from each other and should not be reviewed as one entity. All stream characterization transects should be considered separate from any terrestrial vegetation characterization that share the same transect label.

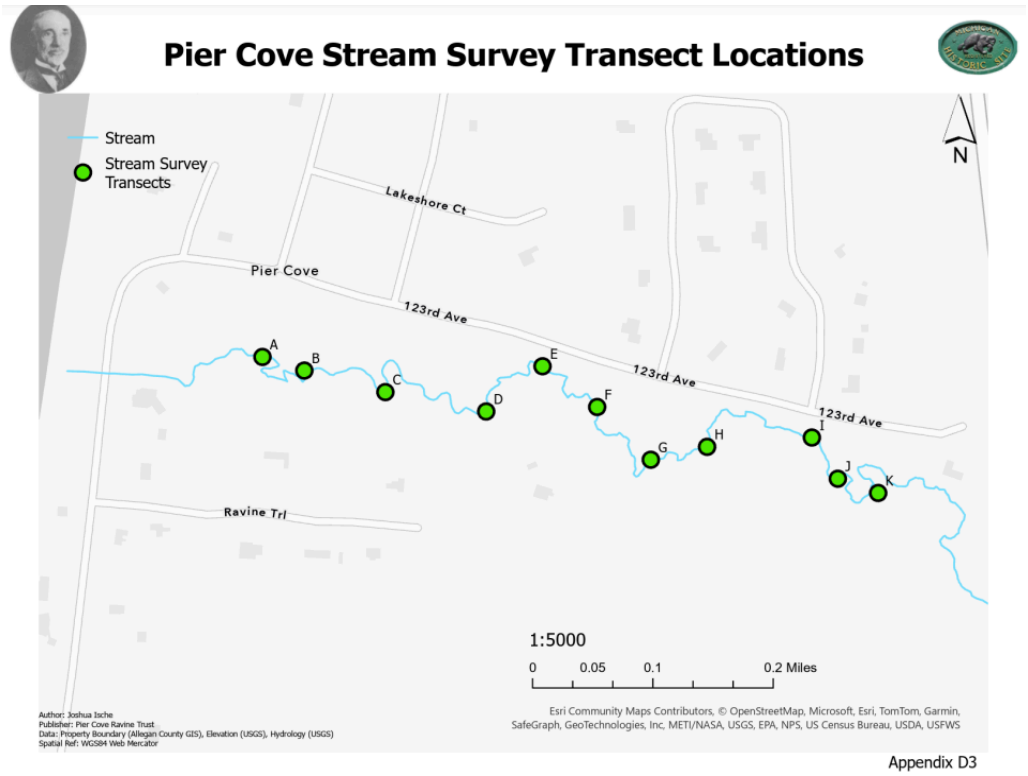

Figure 5: Map of Pier Cove Stream sampling locations.

Results

The dominant woody vegetation type for both sides of the stream at all transects is deciduous, with a few spots of mixed woody vegetation types. This is true of both the canopy and the understory. In the canopy, small trees tended to dominate over large trees. The understory is dominated by woody shrubs and/or saplings, with little non-woody vegetation present. Ground cover for all transects on both sides of the stream is dominated by bare soil, or in other words, open forest floor that does not contain live vegetation. Tables 2 and 3 show the full observations for right and left banks, respectively.

Table 2: Right bank observations of the riparian zone. WV = woody vegetation, WS = woody shrubs/saplings, NW = non-woody vegetation, and BS = bare soil (forest floor with no live vegetation present). For woody vegetation type, D = deciduous and M = mixed (i.e., multiple woody vegetation types present).

Transect	Canopy: Dom WV	Canopy: % large trees	Canopy: % small trees	Understory: Dom WV	Understory: % WS	Understory: % NW	Ground: % NW	Ground: % WS	Ground: % BS
A	D	45	55	D	80	20	10	65	25
B	D	10	90	D	80	20	10	40	50
C	D	10	90	D	60	40	40	20	40
D	D	10	90	D	20	80	12.5	12.5	75

E	D	10	90	D	20	80	10	10	80
F	M	15	85	D	50	50	5	5	90
G	D	5	95	D	70	30	10	10	80
H	M	10	90	D	75	25	10	10	80
I	D	60	40	D	70	30	10	10	80
J	D	10	90	D	95	5	5	5	90
K	D	70	30	D	90	10	20	20	60
Average % or Most Common	D	23.2	76.8	D	64.5	35.5	13.0	18.9	68.2

Table 3: Left bank observations of the riparian zone. WV = woody vegetation, WS = woody shrubs/saplings, NW = non-woody vegetation, and BS = bare soil (i.e., forest floor with no live vegetation present). For woody vegetation type, D = deciduous and M = mixed (i.e., multiple woody vegetation types present).

Transect	Canopy: Dom WV	Canopy: % large trees	Canopy: % small trees	Understory: Dom WV	Understory: % WS	Understory: % NW	Ground: % NW	Ground: % WS	Ground: % BS
A	D	10	90	D	80	20	10	60	30
B	D	15	85	D	90	10	10	15	75
C	M	30	70	D	25	75	30	20	50
D	D	20	80	D	20	80	30	10	60
E	D	20	80	D	75	25	30	10	60
F	D	5	95	D	40	60	10	10	80
G	D	5	95	D	75	25	10	10	80
H	M	25	75	D	75	25	10	30	60
I	D	60	40	D	70	30	10	10	80
J	D	10	90	D	95	5	5	5	90
K	D	60	40	D	70	30	20	20	60
Average % or Most Common	D	23.6	76.4	D	65	35	15.9	18.2	65.9

Discussion

The riparian zone of the Pier Cove stream is dominated by deciduous vegetation with minimal ground cover that is not bare soil/open forest floor. Although small trees (DBH < 0.3 m) were dominant on both sides of the stream in the riparian zone, these trees were relatively tall with

full canopies. The height combined with full canopy cover is likely the reason that there is little ground cover that is not open forest floor, as it prevents adequate sunlight from reaching the forest floor to allow non-woody vegetation to flourish.

Most of the woody shrubs that were observed in the riparian zone were invasive Japanese barberry, which were likely descended from plants that O.C. Simonds planted when he founded the property. These invasive plants could be another contributing factor to the lack of significant woody vegetation.

Benthos

Methods

Macroinvertebrates were collected at the same time as riparian zone observations were being made. Macroinvertebrates were collected at each transect with a D-frame net (Figure 6), pictured below. The stream section in which the invertebrates were collected was categorized as left, center, or right, using the same determination method of facing downstream to determine where the right and left bank was. Sampling section started on the left bank at Transect A, and continued on in a repeating pattern of “left → center → right” throughout the rest of the transects. Team members determined the dominant substrate type at each transect and did their best to sample this substrate. Streamflow type was also recorded at each transect, with a choice between riffle or run.

1-2 team members collected invertebrates by placing the net into the stream on the substrate and pointing it upstream so that water flowed into the net, and kicking the substrate in front of the net for three minutes until a sufficient amount of substrate was collected. The nets were then dumped into sampling trays where the collectors picked out as many invertebrates as possible and deposited them into bottles of ethanol to be preserved for later identification in the lab, which took place in October 2024.



Figure 6: D-net used for sampling benthic macroinvertebrates.

Results

Macroinvertebrate assemblage was dominated by order *Amphipoda*, which includes scuds, shrimp, and sideswimmers. *Diptera* and *Trichoptera*, flies and caddisflies respectively, were also dominant orders throughout the assemblage. Table 4 shows the invertebrate assemblage across all transects along with the associated pollution index for that order. An individual assemblage graph for each transect can be found following Table 4 (Figures 7-17). Amphipods were observed at all stream transects in high numbers.

Table 5 shows the most common order observed at each transect, along with the substrate type sampled and channel flow type. Amphipods were the most common at nearly every transect, with only Transect B and Transect K being dominated by *Diptera* and *Trichoptera*, respectively (Table 5).

Table 4: Counts of each taxonomic order of aquatic macroinvertebrates found across all transects. Pollution index is listed on a scale of 0 (least tolerant) to 10 (most tolerant).

Order	**Total Count (all transects)**	**Pollution Index**
Amphipoda	246	4
Diptera	52	6-8
Oligochaeta (class)	2	8
Trichoptera	59	4
Ephemeroptera	30	4
Coleoptera	11	5
Hemiptera	8	6
Isopoda	3	8
Odonata	2	5
Collembola	2	10
Corydalidae	8	0
Total Count	**423**	

Table 5: Dominant order, substrate, and channel flow at each transect. Channel flow was either run (smooth, unbroken water surface) or riffle (gently broken water surface with audible rippling sound). Substrate was either: sand/fines, coarse (cobble or other larger substrate), gravel (small to medium sized rocks), or other if none of the previous categories were fitting.

Transect	Dominant Order	Substrate	Channel Flow Type
A	Amphipoda	Sand/fines	Riffle
B	Diptera	Sand/fines	Riffle
C	Amphipoda	Coarse	Riffle

D	Amphipoda	Sand/fines	Riffle
E	Amphipoda	Coarse	Riffle
F	Amphipoda	Coarse	Riffle
G	Amphipoda	Sand/fines	Riffle
H	Amphipoda	Sand/fines	Riffle
I	Amphipoda	Sand/fines	Run
J	Amphipoda	Gravel	Riffle
K	Trichoptera	Coarse	Riffle

Transect A:

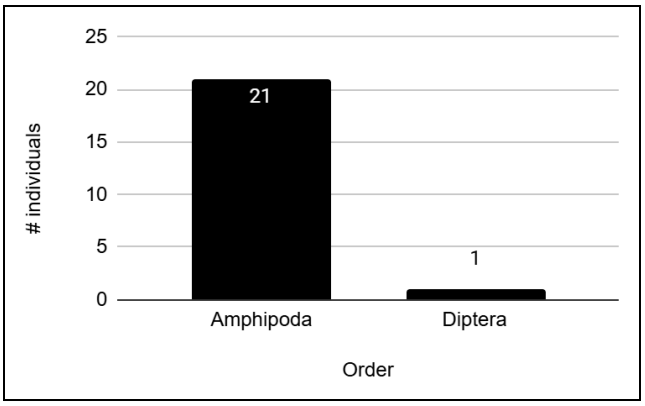

Figure 7: Invertebrate assemblage by order for stream transect A.

Transect B:

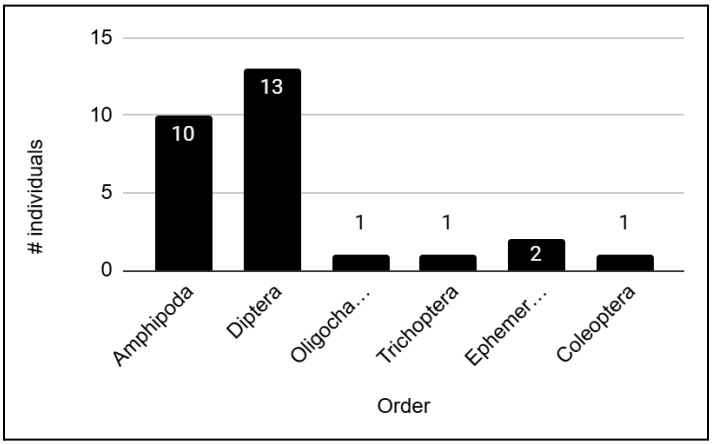

Figure 8: Invertebrate assemblage by order for stream transect B. Note that only *Oligochaeta* is a class and not an order.

Transect C:

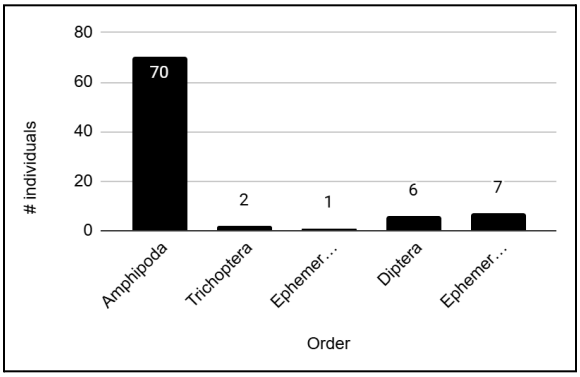

Figure 9: Invertebrate assemblage by order for stream transect C.

Transect D:

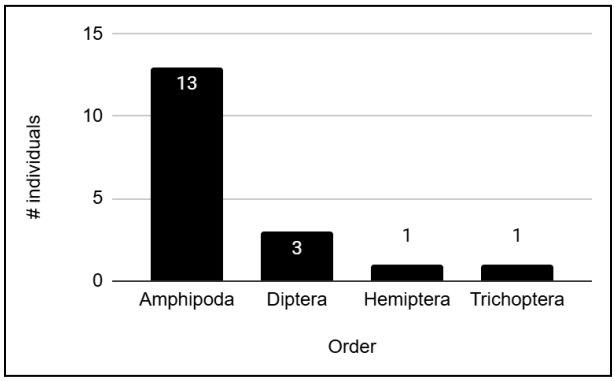

Figure 10: Invertebrate assemblage by order for stream transect D.

Transect E:

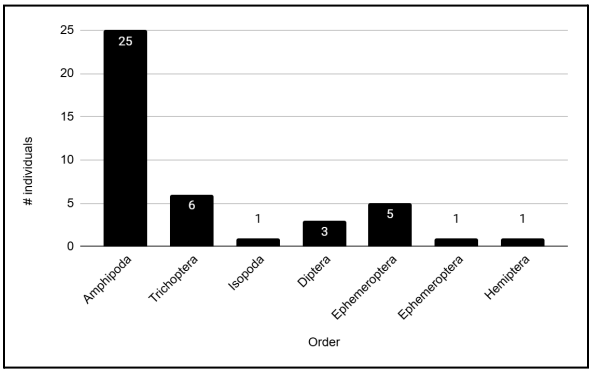

Figure 11: Invertebrate assemblage by order for stream transect E.

Transect F:

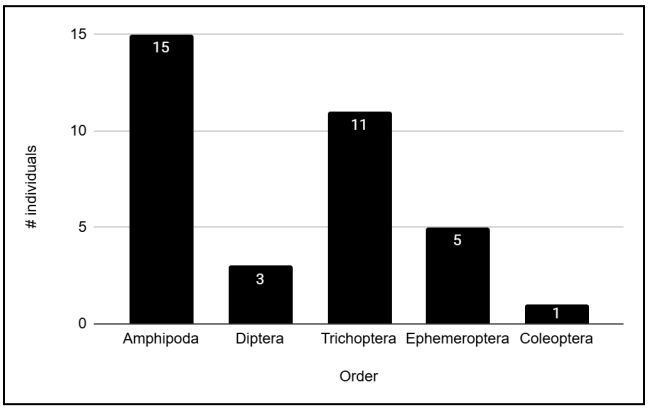

Figure 12: Invertebrate assemblage by order for stream transect F.

Transect G:

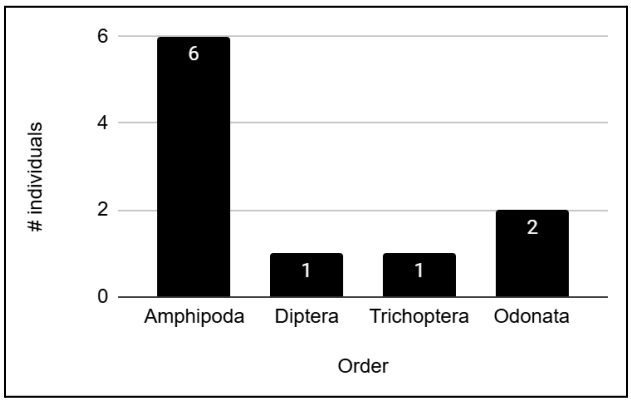

Figure 13: Invertebrate assemblage by order for stream transect G.

Transcect H:

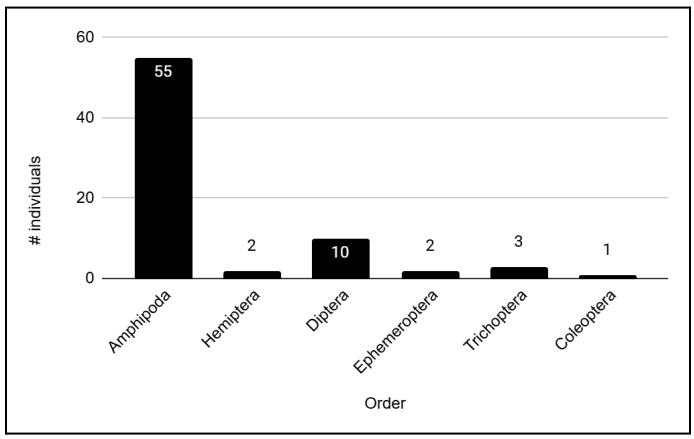

Figure 14: Invertebrate assemblage by order for stream transect H.

Transect I:

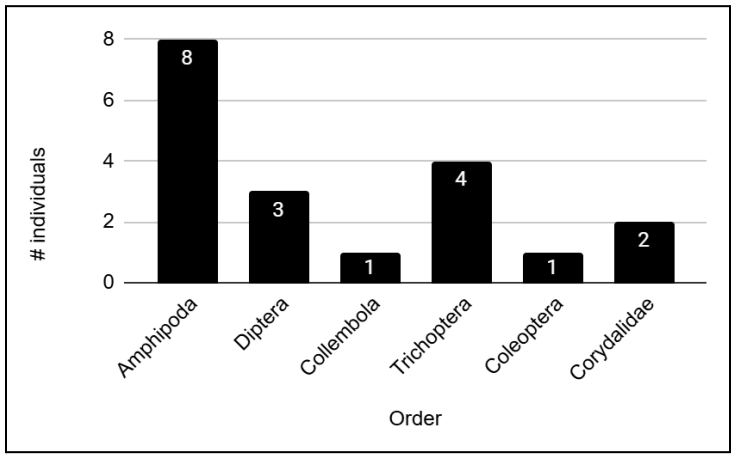

Figure 15: Invertebrate assemblage by order for stream transect I.

Transect J:

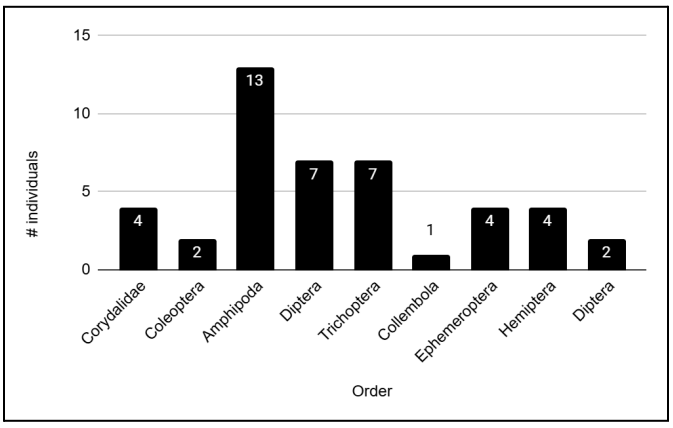

Figure 16: Invertebrate assemblage by order for stream transect J.

Transect K:

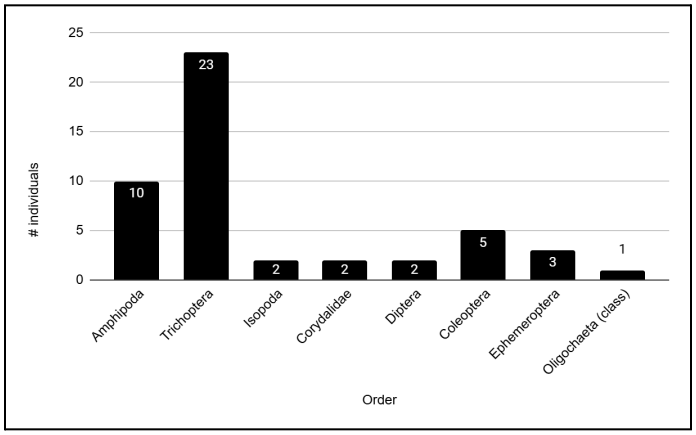

Figure 17: Invertebrate assemblage by order for stream transect K.

Discussion

Dominated by sand and gravel, Pier Cove Stream provides sufficient habitat for benthic macroinvertebrates. The areas of gravel combined with the numerous fallen trees in the stream provides possible habitat for fish as well as the benthos. The team did not have the means to sample for fish, however, members of the Trust have personally observed fish in the stream and the US Fish & Wildlife Service found evidence of native lamprey (Personal comm., J. Gooch).

The most commonly observed order of invertebrates throughout all transects was *Amphipoda,* followed by *Diptera* and *Trichoptera.* While *Diptera* are more tolerant of pollution (ranging from tolerance level 6-8), *Amphipoda* and *Trichoptera* are slightly less tolerant, both scoring at tolerance level 4 (Table 4). Having amphipods and caddisflies at high numbers throughout the stream is an indication of moderately healthy water quality and does not raise major concern for stream health. However, the consistent presence of *Diptera* throughout all transects is

something to bear in mind, as this indicates there is possibly more pollution entering the stream than desired.

Interstate-196 runs north and south on the eastern end of the property, which is a possible source of pollution entering the stream due to the high volume of traffic that the interstate sees daily. Runoff from the interstate during rain events could be contributing to the dominance of pollution-tolerant invertebrates such as *Diptera.* Bordering the property to the north and the west is 123rd Avenue, a small two-way street that could also contribute to runoff. While 123rd Avenue is not a major highway, it is worth noting that its presence causes the stream to be bordered on three sides by roadway, which can present a possibility for contamination by storm runoff, tire particles, or leakage from vehicles (i.e., oil, coolant, etc.). Macroinvertebrate assemblage can give informal indication of stream health, but more comprehensive water quality testing is worth considering for future management practices.

Terrestrial Vegetation Characterization

Overview Of Methods

The 76-acre property was surveyed in August 2024 using the point-centered quarter method (Mitchell 2023). Six-100 meter transects were laid west to east with two on the northern portion of the property along the stream and four spread across the remainder of the property. Along each transect, ten randomly generated points were used to conduct the point-centered quarter method. Each point was then divided into four quadrants using sticks to mark the quadrant boundaries. Diameter at breast height (DBH), species name, and distance from the center of the plant to the transect point, was collected at each quarter for the nearest mature and sapling species. Species name, and distance from the transect point, was collected for any invasive plant species within 25 meters of the transect point. A limit of 25 meters from the center of the point was enforced to reduce the chance of counting the same tree twice. Land cover data was collected using the Line-point Intercept Method (NRCS). A flag was then dropped vertically every two meters along the 100 meter transects. Everything the flag pin interacted with while dropping was recorded. To account for the areas that were not included in the transects, a visual survey was conducted to confirm or deny the presence of historically planted species. The list of historically planted species was provided to us by the Trust using a hand-drawn historical map in appendix C1. The list of historical species extrapolated from the map can be found in appendix C2. The list of all species found during our point-centered quarter survey can be found in appendix C3.

Overall Results

The most abundant mature tree species recorded across all transects were Red Pines (*Pinus resinosa*), Eastern White Pines (*Pinus strobus*), Norway Spruce (*Picea abies*), and Sugar Maples (*Acer saccharum*). The dominant seedling species recorded in our survey were

Serviceberry (*Amelanchier canadensis*), American Beech (*Fagus grandifolia*), and Sugar Maples (*Acer saccharum*). Ground cover across all terrestrial transects surveyed was 78.3% leaf litter, as shown in Table 1.

Table 1: Total land cover percentages of all 6 transects

Land Cover	Leaf Litter	Wood	Saplings/ Seedlings	Artificial	Bare Soil	Moss	Forbs
Percentage	78.3%	9.1%	8.2%	2.0%	1.1%	1.1%	0.2%

The data gathered for each transect was used to calculate the absolute/relative density, absolute/relative frequency, absolute/relative basal area, and importance values of each woody plant species recorded. Absolute density refers to the expected number of trees per hectare, while relative density refers to the expected percentage of how many individuals were observed compared to other species. Absolute frequency refers to the percentage of points that contain a species, and relative frequency refers to the proportion of trees present at the sampling point compared to the total number of plants. Relative basal area refers to the amount of space a species occupies compared to the entire stand. The last metric calculated was importance value, which combines the relative density, relative frequency, and relative basal area to measure which species is most important within the forest community. More detailed results of the absolute density and importance values for mature and sapling species can be found in the following sections, broken down by each transect.

Transect A:

Transect A was located on the northern side of the Upper Loop of the property. The absolute density and importance value of the mature species observed are shown in Chart 1 and Chart 2. For the mature species, Red Pine, *Pinus resinosa*, was the most observed species along the transect, with a total of 14 recorded. The absolute density for Red Pine was 264.9, which means that there should be a total of approximately 265 Red Pines within the transect area. Mature Red Pines also had the highest importance value of all species observed. This means that Red Pines are the dominant species in the stand and serve the most important role in the community. Mature Northern Red Oak was the second most abundant in the stand.

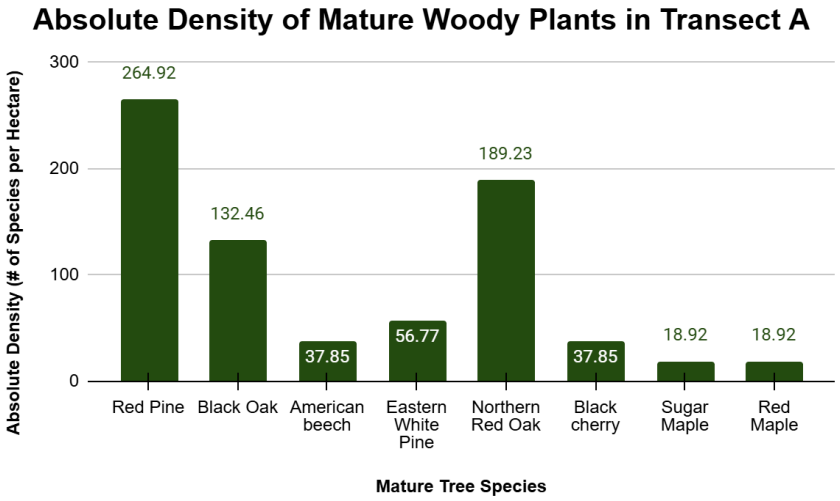

Chart 1: Distribution of Absolute Density, in numbers of species per hectare, of the Mature Tree Species observed in Transect A

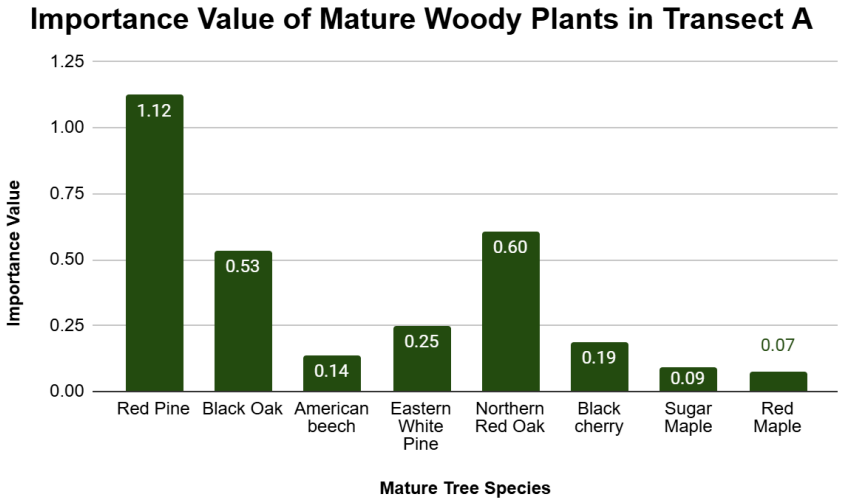

Chart 2: Importance values of mature tree species observed in Transect A.

The absolute density and importance value of the sapling species observed are shown in Chart 3 and Chart 4. Downy Serviceberry, *Amelanchier arborea*, was the most common species with a total of 13 recorded. The absolute density of Downy Serviceberry was 247.09 but the importance value was only 0.6. This means that although it was the most recorded species along the transect, it did not have a wide enough distribution to be considered dominant. The Eastern White Pine, *Pinus strobus*, was considered the dominant sapling in the transect because it was widely distributed and recorded often. No invasive species were found in this transect within 25 feet.

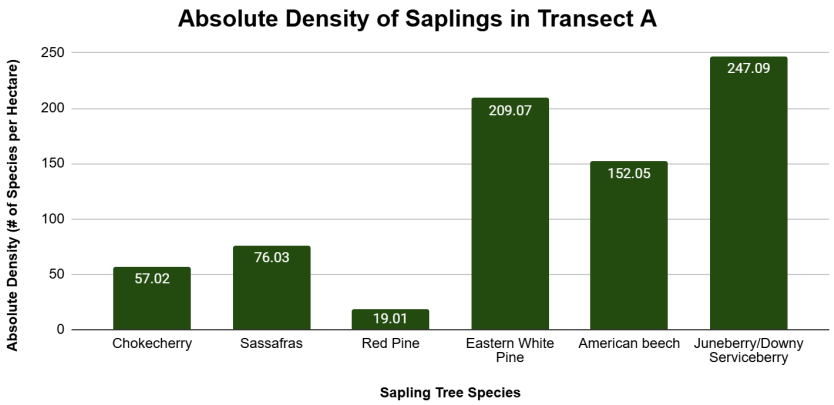

Chart 3: Distribution of Absolute Density, in numbers of species per hectare, of the Sapling Tree Species observed in Transect A

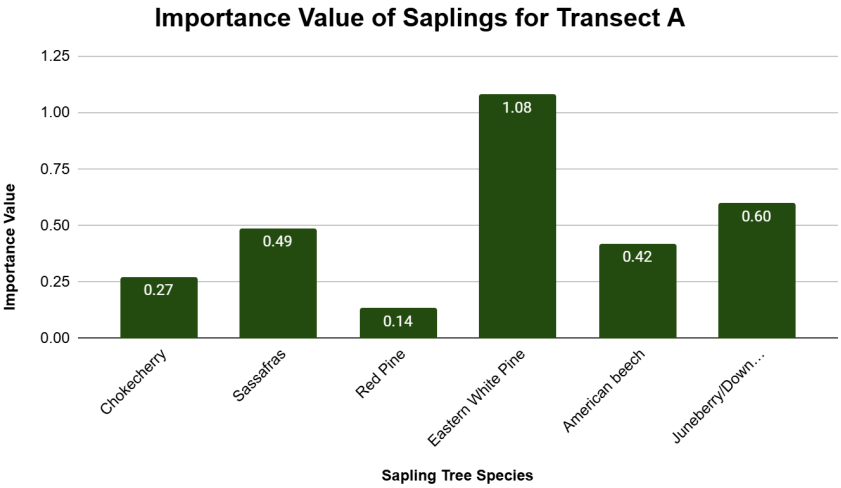

Chart 4: Importance value of sapling tree species observed in Transect A.

Transect B:

Transect B was located on the northern side of the Upper Loop of the property and south of Transect A. The absolute density and importance value of the mature species observed are shown in Chart 5 and Chart 6. Eastern White Pines, *Pinus strobus*, were the most observed mature tree species, with a total of 18 recorded. The absolute density for Eastern White Pine was 146.3, which means that there should be a total of approximately 146 Eastern White Pines within the transect area. Mature Eastern White Pines also had the highest importance value of all species observed. This means that Eastern White Pines are the dominant species in the stand and serve the most important role in the community around this transect. Mature Northern Red Oak was the second most abundant and second most important in the community.

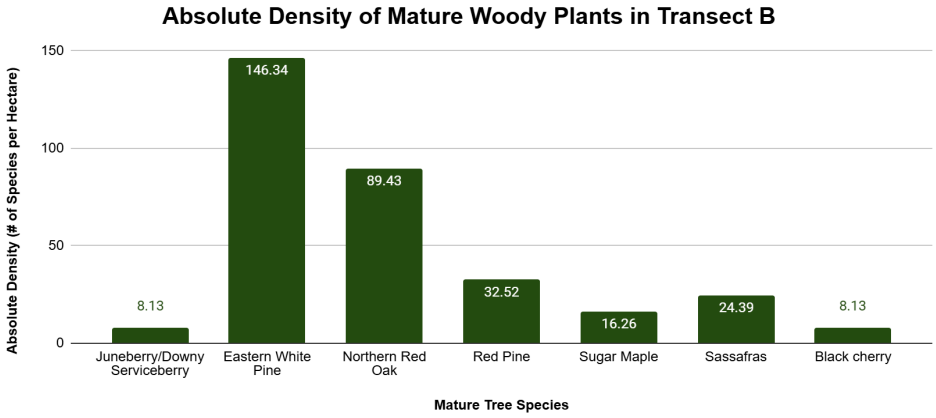

Chart 5: Distribution of Absolute Density, in numbers of species per hectare, of the Mature Tree Species observed in Transect B

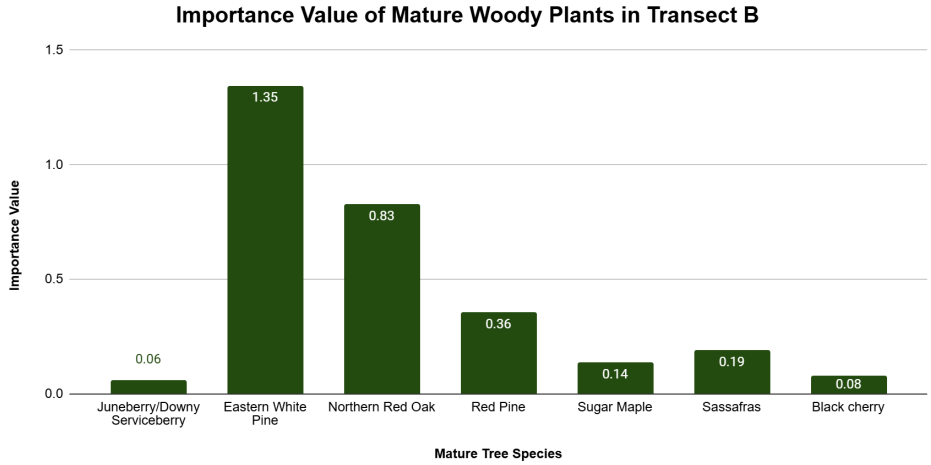

Chart 6: Importance values of mature tree species observed in Transect B.

The absolute density and importance value of the sapling species observed are shown in Chart 7 and Chart 8. American Beech, *Fagus grandifolia*, was the most common species observed with a total of 23 recorded. The absolute density of American Beech saplings was 177.9 and had the highest importance value of 1.2. This suggests that American Beech dominates the understory in this area of the property. Japanese Barberry, *Berberis thunbergii*, was recorded 9 times along the transect at 3 sampling points.

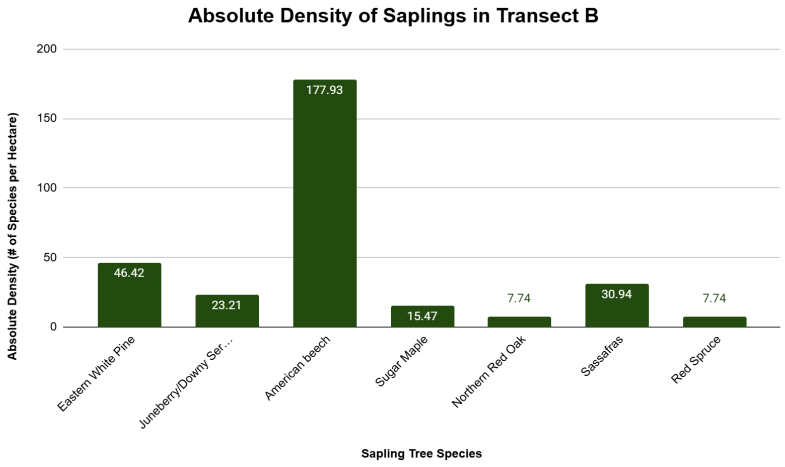

Chart 7: Distribution of Absolute Density, in numbers of species per hectare, of the Sapling Tree Species observed in Transect B

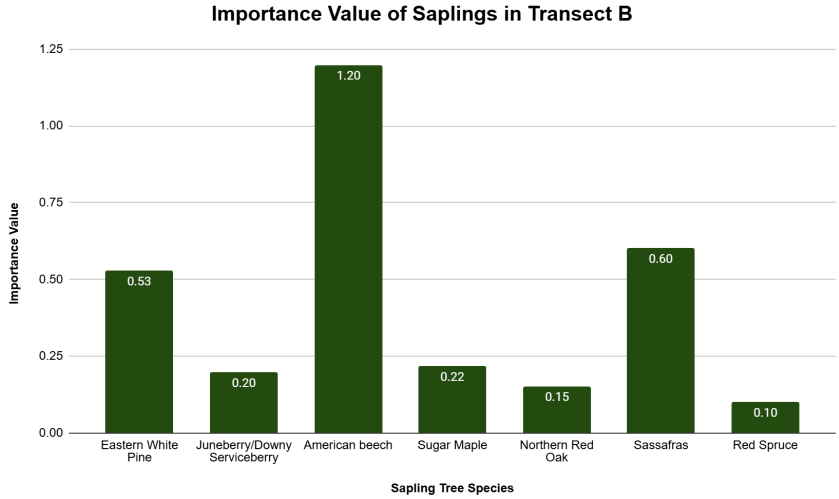

Chart 8: Importance value of sapling tree species observed in Transect B.

Transect C:

Transect C was located towards the center of the Upper Loop of the property and south of Transect B. The absolute density and importance value of the mature species observed are shown in Chart 9 and Chart 10. Norway Spruce, *Picea abies*, were the most observed mature tree species, with a total of 14 recorded. The absolute density for Norway Spruce was 122.6, which means that there should be a total of approximately 123 Norway Spruce within the transect area. Mature Norway Spruce also had the highest importance value of all species observed. Eastern White Pine had a similar importance value, with only a 0.02 difference to Norway Spruce. This suggests that Norway Spruce and Eastern White Pine both dominate in the community around the transect.

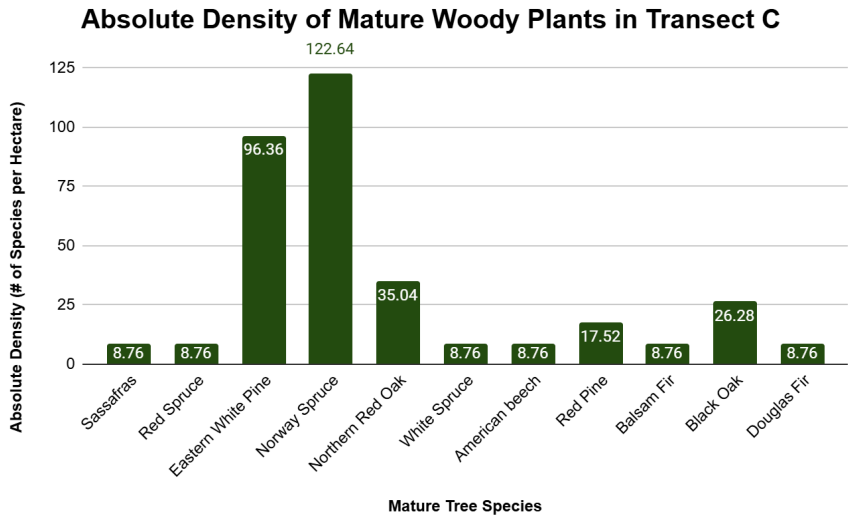

Chart 9: Distribution of Absolute Density, in numbers of species per hectare, of the Mature Tree Species observed in Transect C

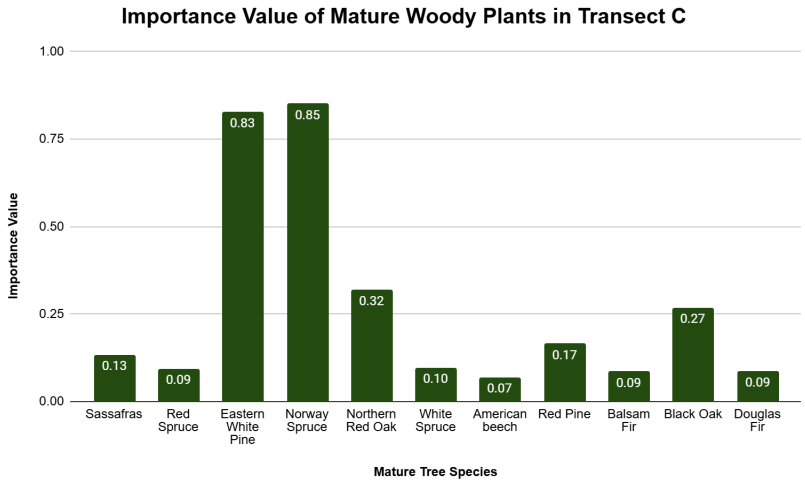

Chart 10: Importance values of mature tree species observed in Transect C

The absolute density and importance value of the sapling species observed are shown in Chart 11 and Chart 12. American Beech, *Fagus grandifolia*, was the most common species observed with a total of 17 recorded. The absolute density of American Beech saplings was 92.2 and had the second highest importance value of 0.99. Sassafras, *Sassafras albidum*, had the highest importance value of 1.23. This suggests that Sassafras is more widely distributed and therefore dominates the understory around this transect. Japanese Barberry, *Berberis thunbergii*, was recorded 16 times along the transect at 6 sampling points. Out of all the transects located in the Upper loop of the property (transects A-D), transect C had the highest occurrence of the invasive Japanese Barberry.

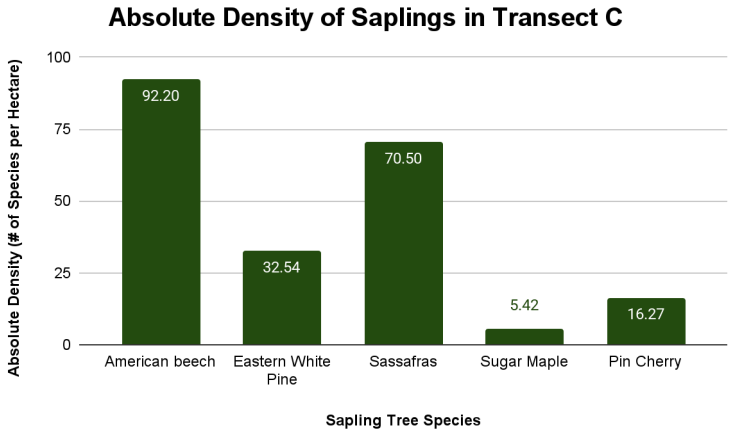

Chart 11: Distribution of Absolute Density, in numbers of species per hectare, of the Sapling Tree Species observed in Transect C

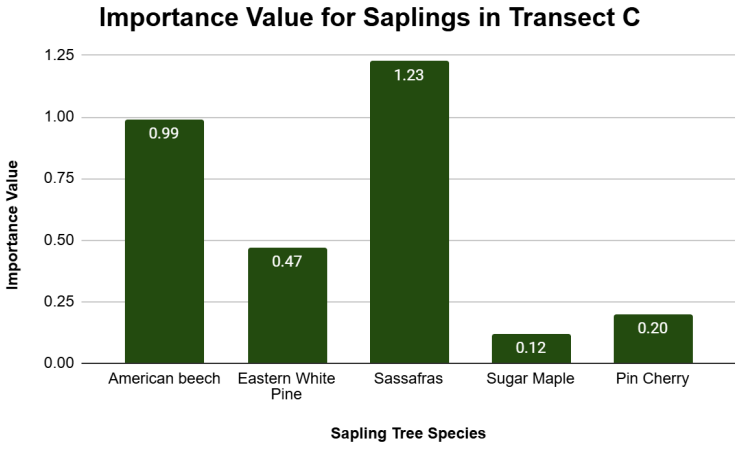

Chart 12: Importance value of sapling tree species observed in Transect C.

Transect D:

Transect D was located towards the southern side of the Upper Loop of the property and south of Transect C. The absolute density and importance value of the mature species observed are shown in Chart 13 and Chart 14. The most observed mature tree species, with a total of 13 recorded, was Norway Spruce, *Picea abies*. The absolute density for Norway Spruce was 159.6, which means that there should be a total of approximately 160 Norway Spruce trees within the transect area. Mature Norway Spruce also had the highest importance value of all species observed. This means that Norway Spruce trees are the dominant species in the stand and serve the most important role in the community around this transect. Mature Red Pine was the second most abundant and second most important in the community.

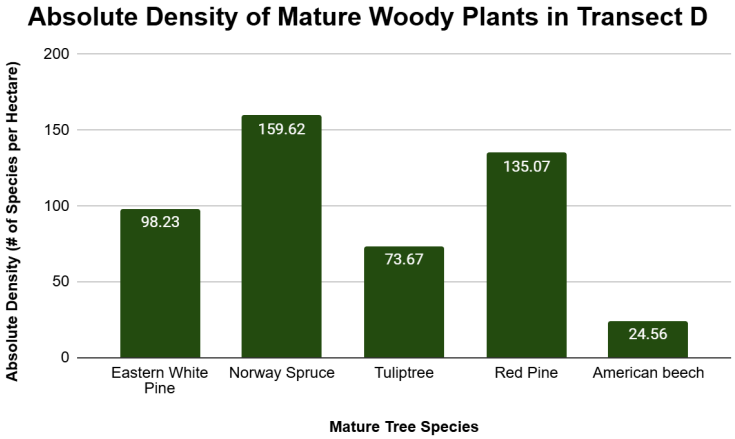

Chart 13: Distribution of Absolute Density, in numbers of species per hectare, of the Mature Tree Species observed in Transect D

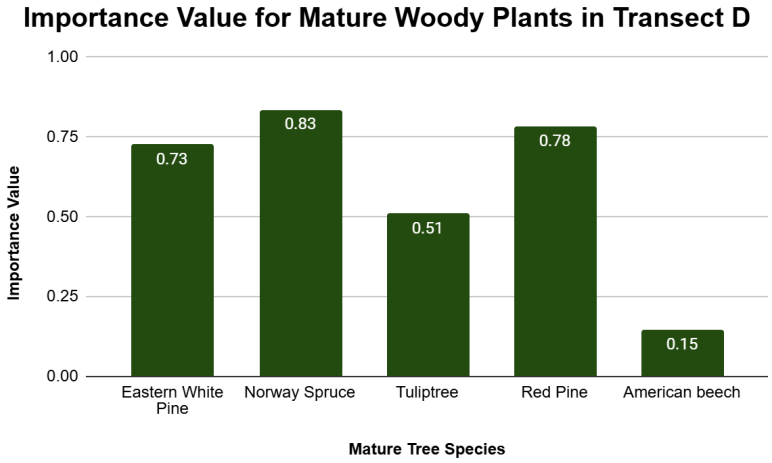

Chart 14: Importance values of mature tree species observed in Transect D

The absolute density and importance value of the sapling species observed are shown in Chart 15 and Chart 16. American Beech, *Fagus grandifolia*, was the most common species observed with a total of 13 recorded. The absolute density of American Beech saplings was 42.5 and had the highest importance value of 0.86. Eastern White Pine, *Pinus strobus*, had the second highest absolute density and importance value. Japanese Barberry, *Berberis thunbergii*, was recorded only one time along the transect.

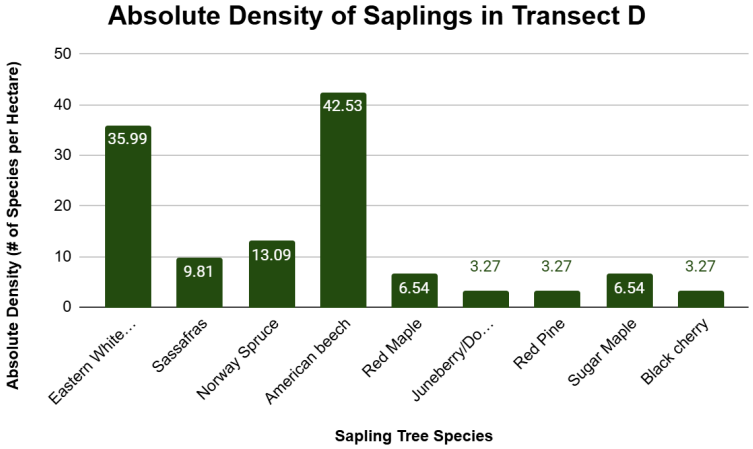

Chart 15: Distribution of Absolute Density, in numbers of species per hectare, of the Sapling Tree Species observed in Transect D

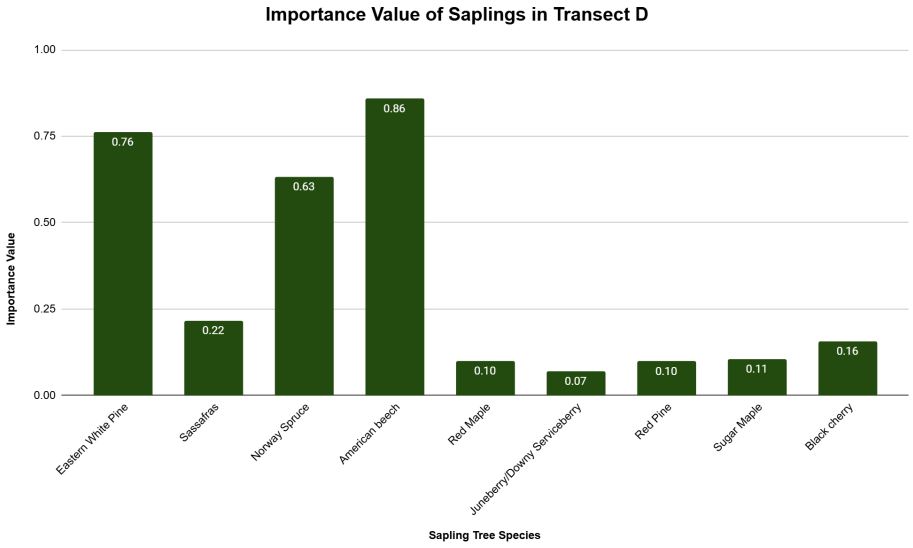

Chart 16: Importance value of sapling tree species observed in Transect D.

Transect E:

Transect E was located on the northwestern side of the property, just north of the stream. The absolute density and importance value of the mature species observed are shown in Chart 17 and Chart 18. The most observed mature tree species, with a total of 32 recorded, was Sugar Maple, *Acer saccharum*. The absolute density for Sugar Maples was 256, which means that there should be a total of approximately 256 Sugar Maples within the transect area. Mature Sugar Maples also had the highest importance value of all species observed. This means that Sugar Maples are the dominant species in the stand and serve the most important role in the

community around this transect. Mature Black Locust, *Robinia pseudoacacia*, was the second most abundant and second most important in the community.

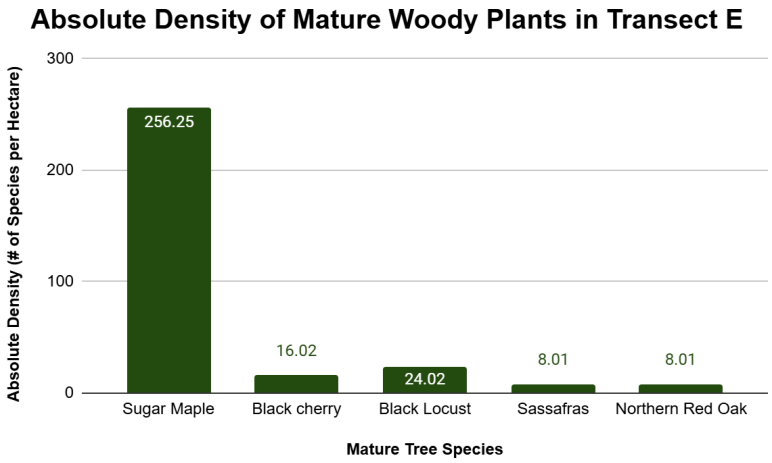

Chart 17: Distribution of Absolute Density, in numbers of species per hectare, of the Mature Tree Species observed in Transect E

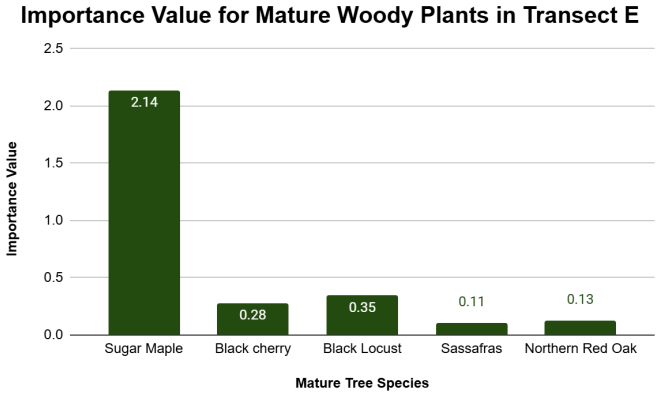

Chart 18: Importance values of mature tree species observed in Transect E

The absolute density and importance value of the sapling species observed are shown in Chart 19 and Chart 20. Sugar Maple, *Acer saccharum*, was the most common species observed with a total of 37 recorded. The absolute density of Sugar Maple saplings was 121.2 and had the highest importance value of 2.78. American beech and Sassafras are tied for the second most abundant and important species in the transect area. Japanese Barberry, *Berberis thunbergii*, was recorded 23 times across 8 sampling points along the transect.

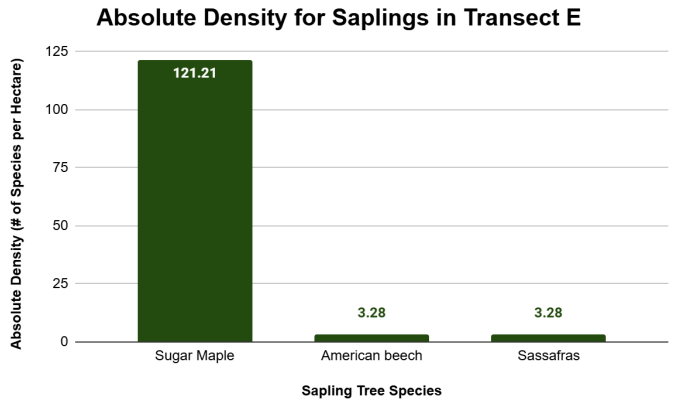

Chart 19: Distribution of Absolute Density, in numbers of species per hectare, of the Sapling Tree Species observed in Transect E

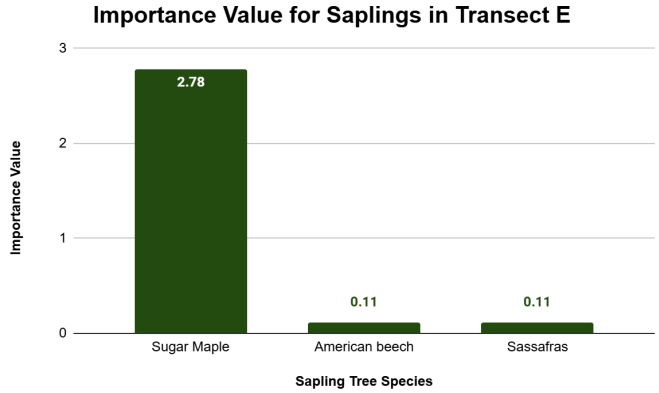

Chart 20: Importance value of sapling tree species observed in Transect E.

Transect F:

Transect F was located on the northwestern side of the property, just south of the stream. This transect followed the curvature of the trail instead of being straight due to challenges in accessibility. The absolute density and importance value of the mature species observed are shown in Chart 21 and Chart 22. The most observed mature tree species, with a total of 19 recorded, was Sugar Maple, *Acer saccharum*. The absolute density for Sugar Maples was 88.5, which means that there should be a total of approximately 89 Sugar Maples within the transect area. Mature Sugar Maples also had the highest importance value of all species observed. This means that Sugar Maples are the dominant species in the stand and serve the most important role in the community around this transect. Mature Black Cherry, *Prunus serotina*, was the second most abundant and second most important in the community.

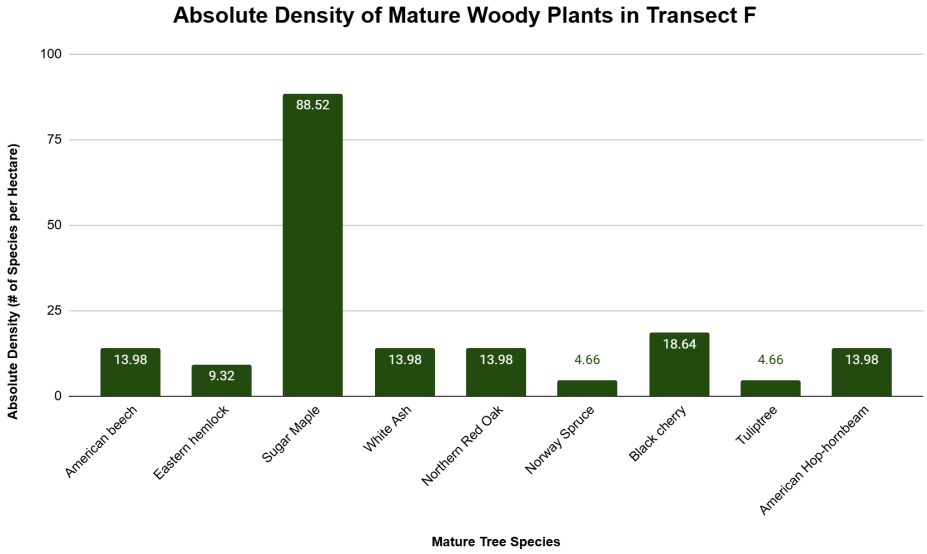

Chart 21: Distribution of Absolute Density, in numbers of species per hectare, of the Mature Tree Species observed in Transect F

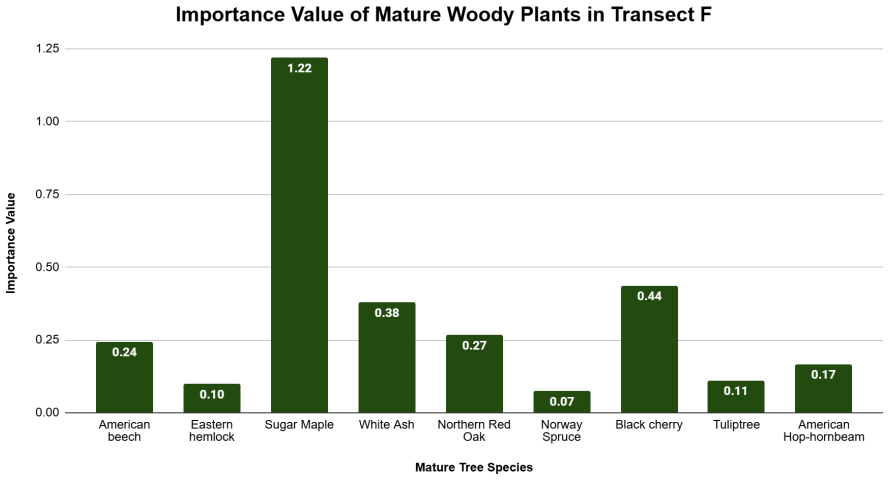

Chart 22: Importance values of mature tree species observed in Transect F

The absolute density and importance value of the sapling species observed are shown in Chart 23 and Chart 24. Sugar Maple, *Acer saccharum*, was the most common species observed with a total of 25 recorded. The absolute density of Sugar Maple saplings was 311.4 and had the highest importance value of 1.91. American Beech is the second most important species and has the second highest absolute density. Japanese Barberry, *Berberis thunbergii*, was recorded 38 times across all 10 sampling points along the transect.

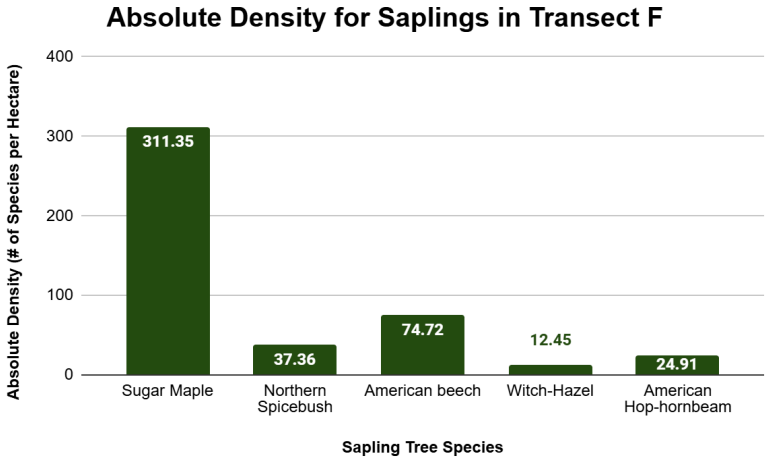

Chart 23: Distribution of Absolute Density, in numbers of species per hectare, of the Sapling Tree Species observed in Transect F

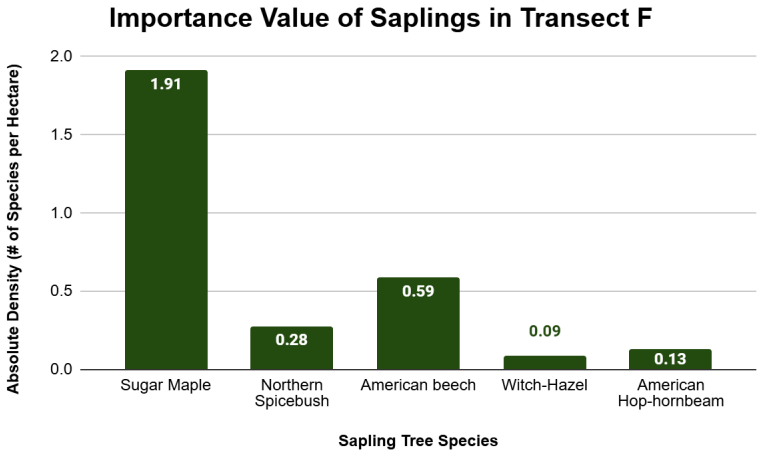

Chart 24: Importance value of sapling tree species observed in Transect F.

Discussion

The results of our plant survey varied based on the location of the transects. The first four transects, A-D, were located in or around the original pine stands, which explains why the majority of species recorded were various pine/spruce species. However, it is important to note that the majority of the understory was occupied by American Beech or Downy Serviceberry. This combined with the fact that the overstory was dominated by mature pines and spruces suggests the forest is in a stage of late succession. In other words, this section of the forest contains mature, old growth trees. In this stage of succession, some of the old growth trees die off and leave gaps in the canopy. These gaps in the canopy allow new species to establish and grow in the understory. Species like American Beech and Downy Serviceberry are shade-tolerant, allowing them to grow and dominate the understory. As the old-growth pines die,

the American beeches will be able to reach the top canopy and eventually may dominate the forest stand. Transects E and F were located on the northern portion of the property along both sides of the stream. The historical map shows multiple species were planted in these areas like Basswoods, Catalpas, and Cherries. Our visual survey confirmed the presence of most of the species listed in the area but the majority of the forest overstory and understory was Sugar Maple. The land cover data was combined across all transects and mostly consisted of 78% leaf litter, followed by 9% woody debris. This is typical for the understory of a mature forest with a full canopy. The 2% artificial land cover recorded was found in transect F, and was a result of the transect being laid along the trail and wooden boardwalk. Because of this, the results may be skewed slightly and may not accurately represent the total land cover of the property.

Conclusion

The results of our vegetation survey represent the dominant overstory and understory composition across the property. It is important to note that the point-quarter method doesn't capture unique species well. Since this property had different species planted in different areas, our transects may not have captured the small groups. To account for this, a visual survey to confirm the presence of historically planted species was conducted. Our visual survey found several dense clusters of Japanese Barberry along the trails.

Geospatial Survey

Mapping Overview

Before this project, the maps and geospatial data for Pier Cove were primarily in paper format and of a historical nature. Historic maps are available of the property from O.C. Simonds' writings, and were utilized in combination with modern sampling practices, to create the updated maps for this management plan. Currently, visitors are able to access a map of Pier Cove through the entrance sign and an attached handout. An example of the historic maps available to visitors are below in Figure 18:

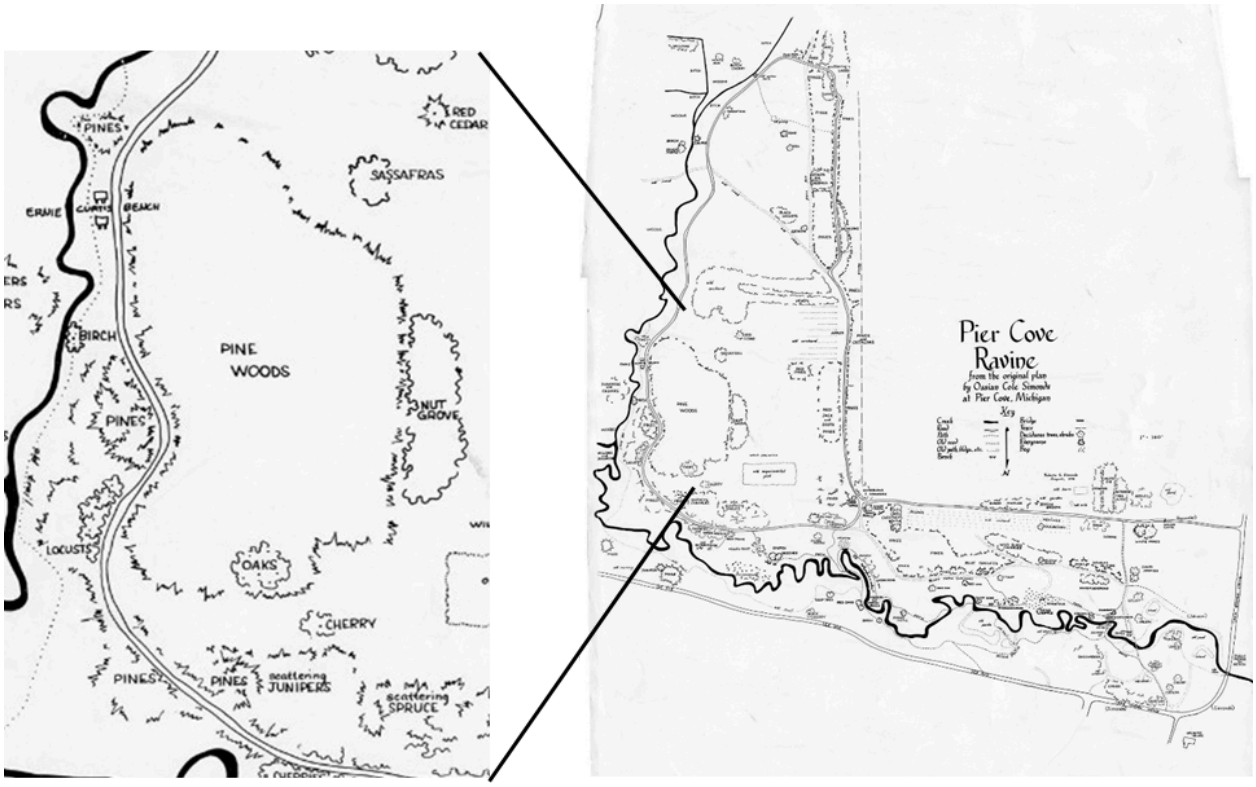

Fig 18: Example of scanned historical imagery

Geospatial Goals

All geospatial objectives for this project are inherently aligned with the overall goals of this project. Each component of this project needed access to updated geospatial data, and maps, in order to create a compiled analysis of Pier Cove. As a result, the highlighted geospatial objectives within the project framework are as follows:

1. A baseline inventory of Pier Cove's vegetation
    A. Mapping of vegetation and stream transects with data
    B. Classification of Pier Cove vegetation
    C. Biomass estimation
2. Scenarios for restoring and enhancing Pier Cove's cultural and natural features
    A. Drone based photogrammetry products of the cove itself
3. Enhancing educational strategies
    B. Reference map of the property
4. Interpretive materials/strategies for sharing the history and unique natural features of the ravine with the local community.
    A. Digitized historic map with original plant species codified
    B. Watershed map highlighting land use of local areas

Based on the above project goals, the following products have been created:

1. Reference Topographic map highlighting trails, bridges, and parking Appendix D1
2. Photogrammetry scan showing seasonal change within the Ravine Appendix D2.11, D2.12, D2.13, Data Appendix D2.21, D2.22, D2.23
3. Survey Transect Map Appendix D3, Data Appendix D3.1
4. Watershed Map Appendix D4.11, D4.12, D4.13, Data Appendix D4.21, D4.22, D4.23
5. Classification Map with biomass estimation Appendix D5, Data Appendix D5.1
6. Historic Map with original vegetation Appendix D6, Data Appendix D6.1

Work Accomplished

Methods

The first step in modernizing the geospatial data within Pier Cove, was to collect spatial data within Pier Cove for linear features. The features surveyed for this writing were the bridge locations, streams, trails, entrances, property lines, and parking locations. This data was necessary for creating the reference map of the property and all subsequent maps which rely on the boundaries of the property. Some linear features like bridges, locations, and streams, were collected through ground collections via a Real Time Kinematic GPS device. Trails, parking, and entrances were already collected by the Trust, but required georeferencing, and digitizing, to create features within ArcGIS. Lastly, the property boundary is available from the Allegan County GIS department as part of the County's required property documentation.

The next step was to collect photogrammetric data. To accomplish this, an aerial survey with an unmanned aerial system (UAS) was conducted. Joshua Ische, served as the remote pilot in command while the remaining group members served as auxiliary roles. The platform used to conduct this survey was the DJI Air 2S which is capable of collecting high resolution imagery in the visual spectrum (RGB). Three surveys were conducted to assist in the classification of forest coverage, forest density, and the biomass of the forest. These surveys took place in August 2024, October 2024, and January 2025. These surveys are available as raw data in Appendices D2.21, D2.22, and D2.24, or as visual map representations in Appendices D2.11, D2.12, and D2.13.

The survey transect map was created with the assistance of all team members by conducting socialized GIS approaches utilizing the ESRI FieldMaps environment. Group members were tasked with the collection of spatial data during the pursuit of their vegetation and stream survey transects. Following the data collection, the transects were georeferenced and matched with the physical locations recorded by the ground researchers. The transect survey map is available in Appendix D3.

The Pier Cove Ravine watershed is a subcomponent of an already mapped watershed by the USGS. As this ravine is only a subcomponent of the larger watershed, and is not therefore differentiated, it was necessary to conduct a separate watershed analysis. The watershed analysis was conducted in accordance with the standard method in the model found in Appendix D2. In short, this method uses elevation models, hydrology lines (streams/rivers), boundaries, soil surveys, and land cover surveys as inputs. This method creates three polygonal feature classes representing the overall watershed, the watershed with land cover estimation, and the watershed with soil composition as outputs. This is available visually in appendices D4.11, D4.12, and D4.13. Alternatively, the data for this is available in appendices

D4.21, D4.22, and D4.23. Below is a visual representation of the method for watershed analysis in detail.

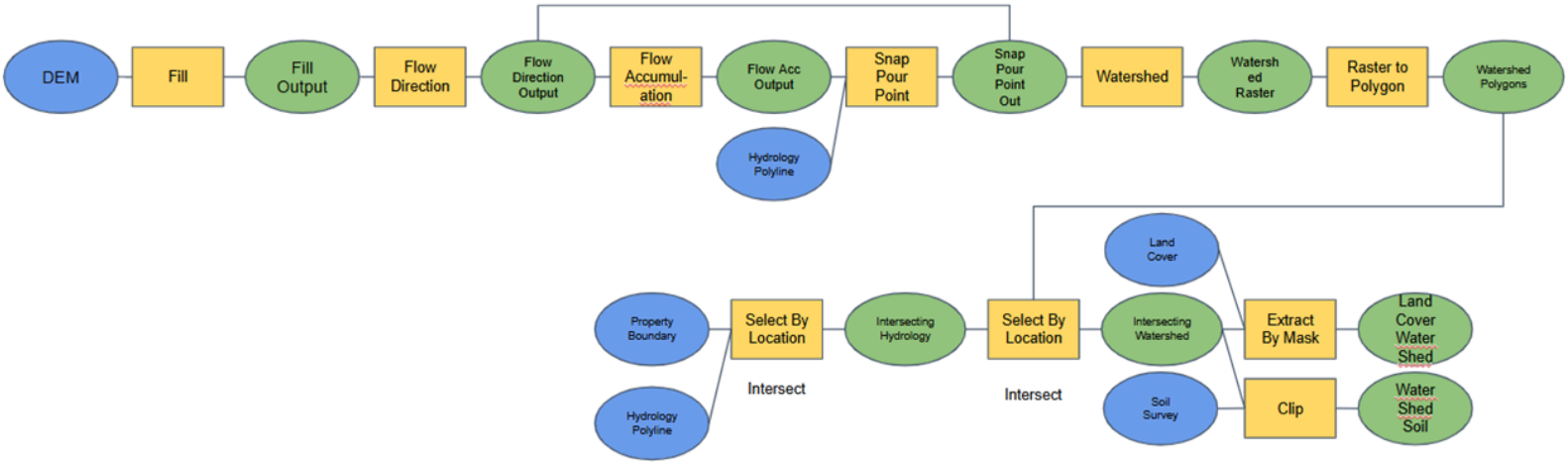

Fig 19: Model Diagram for Watershed Analysis

The three photogrammetric scans from the aerial UAS survey were utilized to assist in a supervised classification of the forest in the ravine. The aerial scan from October, 2024 was utilized for the overall classification as it offered the best contrast in tree types without suffering loss due to lack of canopy coverage and snow coverage. However, the winter survey was invaluable in determining training sample sites for the land cover types. For the initial classification there were 4 land cover types which were: developed, mixed forest, deciduous forest, and coniferous forest. The developed area land cover type was utilized to minimize the impacts of shadow induced errors by converting it to mixed forest after the initial classification.

After the classification was completed, it was necessary to have a method for accurately measuring forest height and density. The method for determining this was to utilize the digital surface model and digital elevation model to create a canopy height model. This model searched for peaks with a variable window filter to determine the canopy tops within the forest to create a pinpoint location, and count, of treetops within the forest. With this information, it is simply a matter of algebra to create the density of the forest and average canopy height within each classified parcel. This information, combined with the classification, was used within the biomass estimation algorithm to determine a biomass estimate by parcel within each land cover type. It is important to note that this is merely an estimate with a range of certainty. Due to differences in tree species throughout each parcel, individual tree heights, and diameters at breast height, this cannot be used to say the biomass with an acceptable degree of accuracy. The map of classified vegetation is available in Appendix D5 with the data available in Appendix D5.1.

$$D_{\text{pred}} = 0.557 \times (H \times CD)^{0.809} \times \exp\left[0.056^2/2\right]$$

$$\text{AGB} = 0.0673 \times (D^{\,2} \times H \times \rho)^{0.976} \times \exp[0.357^2/2]$$

Fig 20: *Tree DBH prediction algorithm based on global training data (Jucker et al., 2016)*

Fig 21: *Tree Above Ground Biomass estimation based on global training data (Jucker et al., 2016)*

The final product created for this writing was a georeferenced modernization of the historic plantings on the property. The original transposed map by the founder, O.C. Simonds, was used in a PDF form and applied with ground control points to georeferenced it over the current property boundaries. The given locations of plantings were then added into the map as polygon features with their plant type applied to them. The map of historic plantings is available in Appendix D6 with the data available in Appendix D6.1.

Future Work Recommendations

Future geospatial work within Pier Cove should focus on maintaining data as collected and seeking to refine data as collected. Efforts for geospatial refinement are not currently pressing and do not require significant costs currently. Additionally, there are some quality-of-life improvements that could be undertaken to increase visitor satisfaction.
Maintenance of current data will be minimal going forward. The only areas for required maintenance would be the linear locations as they change. Bridges, trails, and the stream have the potential to change location. Therefore, these linear locations need to be updated continually. Additionally, if the trust were to acquire more land, the boundaries of the study areas and reference areas would have to be updated as well.

Refinement of the geospatial data is necessary if technology improves, or greater resolution is required for a specific project. For example, if the biomass estimation is required to be more exact for whatever study may require it, then additional data collection will be necessary for all polygonal features listed to attain greater resolution on average tree height and density. Technological improvements are constant, and while the photogrammetric survey was conducted with a modern platform, it is possible that greater resolution cameras will be developed. Similarly, additional spectrums of collection like near infrared or thermal technologies may be developed as well. These advancements may very well necessitate new scans to further the data of Pier Cove.

Other improvements could be implemented as well, focusing mainly on the availability of navigational data within Pier Cove and enhancing visibility on the Trust's website. Adding the linear trail features to popular social media hiking apps like AllTrails and Google Maps would help users gain a better understanding of what Pier Cove has to offer and attract visitors. Additionally, creating an interactive map within the Trust's website could help aid visitors' knowledge of Pier Cove and help them identify trail systems when visiting.

Management Recommendations

Pier Cove Creek

Stream Bank Stabilization and Erosion Control

After several meetings with the Trust, and surveying the stream, erosion control is at the top of the priority list for managing Pier Cove. Due to the sandy, unstable nature of the stream's banks, bank stabilization is important for erosion management. Significant erosion along stream banks, primarily due to sandy soils and altered flow patterns exacerbated by debris, necessitates stabilization measures. Strategic natural vegetative planting is recommended, focusing on native species with deep, stabilizing root systems. Planting efforts should span from the toe to the upper edges of the banks, supported by berm plantings of trees and shrubs for additional runoff filtration and habitat connectivity enhancement.



Figure 22: Example of streambank stabilization using logs and T-posts. Photo taken by team member Caitlin Maloney in November 2022 at Fish Lake Road Kayak Launch in Holly, MI. Project was an effort by stewards of Blue Heron Headwaters Conservancy to stabilize the banks of the Shiawassee River.

One erosion control strategy that has been known to decrease erosion is to increase native plantings. As mentioned in the stream survey results, there is little non-woody vegetation present on the forest floor in the riparian zone. It is mostly dominated by bare soil, leaving virtually no obstacles to sedimentation along the riverbank.

Increasing the amount of native plants along the riparian zone would improve soil integrity and hopefully stabilize the banks to slow erosion. According to the Michigan Natural Features Inventory, Pier Cove's location in Allegan County is likely to be classified as a mesic southern forest. There are abundant mature beeches and sugar maples in Pier Cove, which are characteristic species of mesic southern forests (Michigan Natural Features Inventory,). Common ground cover plants include sedges, maidenhair ferns, yellow and white trout lilies, jack-in-the-pulpits, and wild geraniums, along with many other species. Utilizing native plants such as these would help with maintaining soil integrity and restore the forest floor, especially ferns and sedges that would likely do well near the stream's edge. These types of plants are generally attainable through native plant sales by local conservation districts or land conservancies, and can also be ordered through other vendors. Native planting days with volunteers would also segue nicely into community outreach strategies to get the community involved in maintaining Pier Cove.

Complementary bioengineering techniques, such as rootwad revetments, log and rock vanes, terracing, and regrading steep banks, are advised. These structural measures will help stabilize banks, redirect stream flows from vulnerable sections, and facilitate sediment deposition beneficial to stream stability and ecological integrity.

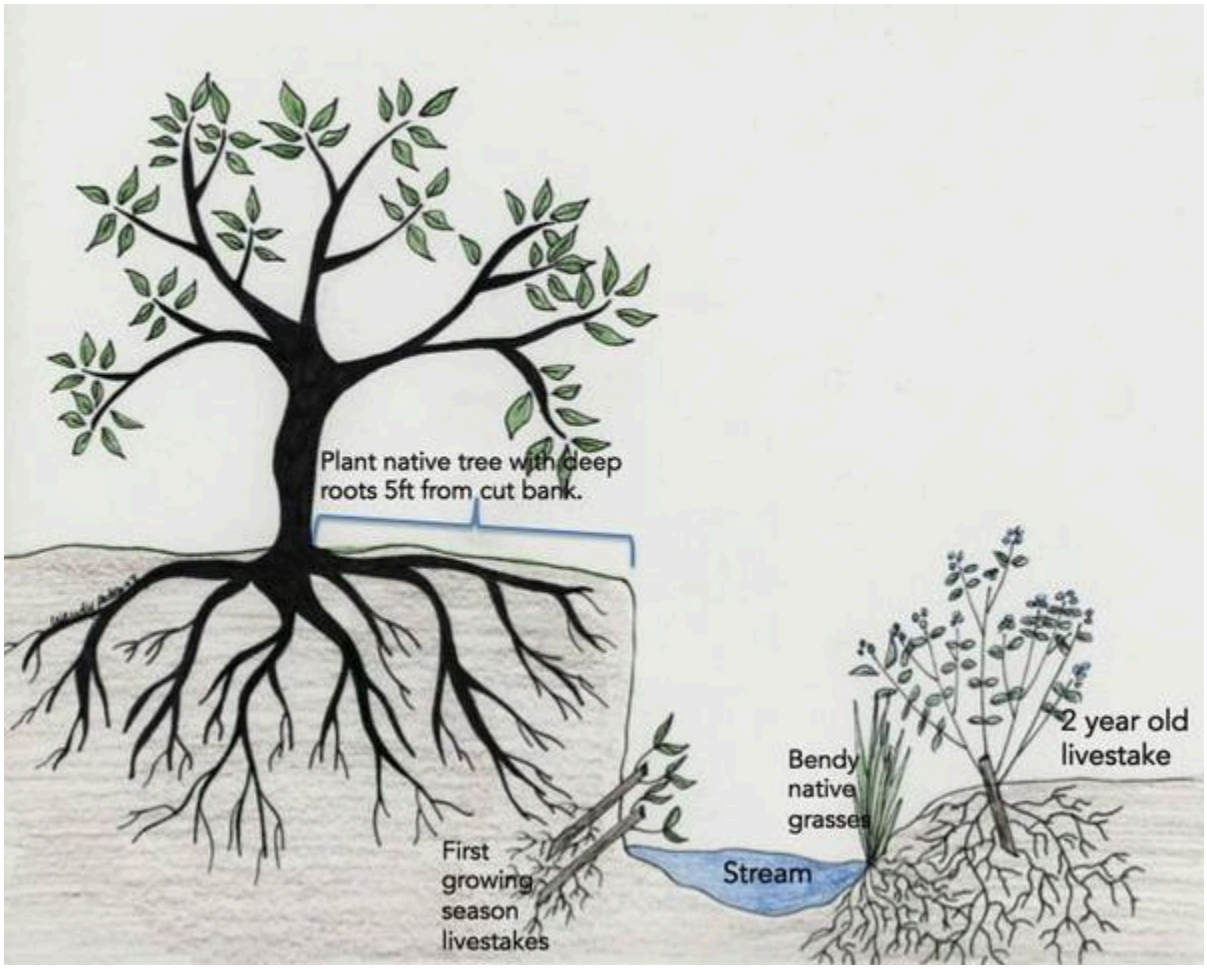

Figure 23: Diagram visualizing how different types of native plantings can stabilize streambanks. (“Options for Backyard Stream Repair | NC State Extension Publications,” n.d.)

Managing Large Woody Debris (LWD)

While LWD enhances habitat diversity, its excessive accumulation can disrupt flow and intensify erosion. Selective removal of debris causing significant flow blockages is advised, coupled with anchoring ecologically beneficial debris in stable locations. Redistributing debris strategically to less vulnerable areas and conducting regular inspections following storm events are crucial management practices. Community engagement in these management activities can foster local stewardship and support sustainable stream health. Since there is a large amount of trees

which have fallen into the stream, one option for erosion control is to section these trees into manageable sizes through chainsaw work, and then position these trees in a similar way to the picture below so that they serve as a more stable bank and slow the process of erosion. This would be a big project for the Cove to undertake, as it would require a sufficient number of laborers who are trained in both chainsaw safety and chainsaw operation. It would also require laborers who are willing to traverse through the stream along uneven terrain, as most of the eastern portion of the stream can only be accessed down a steep decline. The eastern portion also contains the most downed trees, which presents another type of difficult terrain to traverse. It is ultimately up to the Trust if this is a strategy that is feasible to slow erosion.

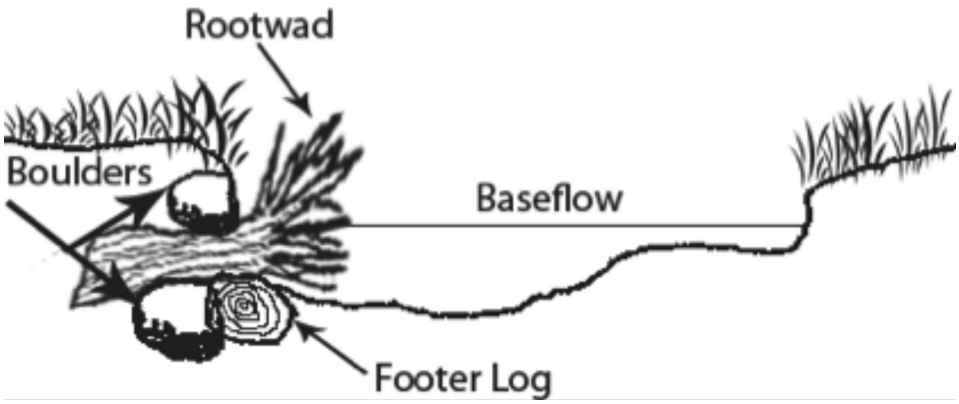

Figure 24: Diagram of a stream cross section visualizing how large woody debris in the form of a root wad can be removed from the main stream channel and reutilized as a stream bank stabilizer. (“Natural Stream Restoration and Enhancement - Oklahoma State University,” 2017)

Future Hydrological Monitoring

Implementing erosion pins alongside photographic documentation in future monitoring efforts will enable quantification of erosion rates. Regular assessment of stormflow and baseflow conditions will provide insights into sediment transport dynamics and hydrological patterns,

informing targeted management decisions.

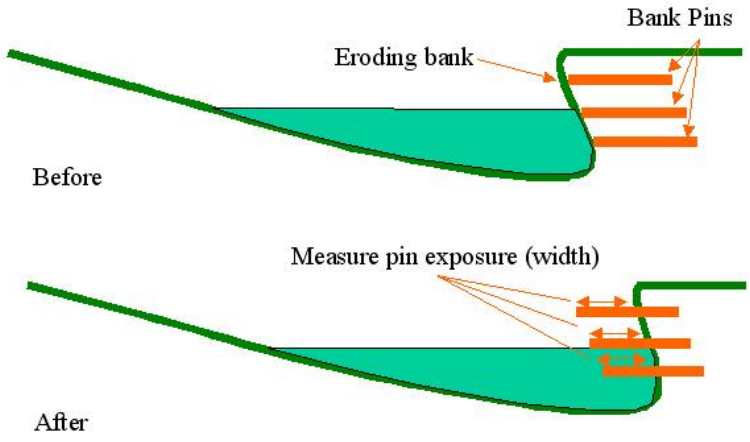

Figure 25: Diagram showing how erosion pins can be used to measure the rate of erosion for a streambank. (“Streams Management,” 2025)

Predictive Hydrological Modeling

Developing a predictive hydrological model is strongly recommended to anticipate stream responses to varying rainfall events. This model, integrating rainfall, discharge rates, sediment dynamics, and the impact of the newly installed culvert under Interstate I-196, will facilitate proactive management practices. Continuous data input will refine predictive capabilities over time, optimizing debris management schedules and erosion control measures.

Long-term Management and Collaboration

Ongoing stakeholder collaboration, consistent hydrological monitoring, and adaptive management flexibility are essential for the long-term success of restoration efforts. Establishing partnerships with local agencies can enhance resource availability, ensuring sustainable management of Pier Cove Creek's ecological integrity and hydrological resilience for future generations.

Invasive Species Control



Figure 26: Clusters of Japanese Barberry, *Berberis thunbergii*, (light green/yellow color) observed throughout the property.

The results of our plant surveys reveal that the invasive species Japanese Barberry, *Berberis thunbergii*, is present throughout much of the property as seen in Figure 26. Japanese Barberry was a popular plant in Northern America during the time when O.C. Simonds acquired the property. The shrub was originally planted in the property by O.C. Simonds and has since spread. These plants grow well in previously abandoned, reforested areas and do not need abundant sunlight to thrive (Degasperis, 2007). Dense clusters of the plant are found primarily along the trails throughout the property. It is unclear if Japanese Barberry negatively affects native seedlings directly, with various results found across different studies. However, the dense clusters that were observed during our survey would use the little light that is available in the undercanopy. This would effectively inhibit the growth of any other species that need abundant light. Therefore if native species are to be planted on the property in the future, some barberry clusters may need to be removed to give the seedlings enough resources to grow.

While the effects of Japanese Barberry on native tree seedlings are inconclusive, the effects they have on tick populations are well documented. Japanese Barberry is found to provide perfect habitat for blacklegged ticks, which presents a public health concern and may interfere with recreational activities (Williams, 2010). Members of the trust warned us of the ticks while we were conducting our survey. The presence of Japanese Barberry may explain why the ticks are so prevalent. Removing the plant could help to reduce blacklegged tick populations by up to 60%, making it safer for people to walk around and enjoy the trails (Williams, 2010).

It is recommended to remove the Japanese Barberry along the trails. The Japanese Barberry needs to be controlled throughout the property to allow for native species to grow, survive, and to reduce the population of blacklegged ticks in the forest. It is recommended that the Trust should use a combination of direct flame, herbicide, and physical removal of the shrub (Ward et al., 2009). A combination of those methods was found to be effective in controlling Japanese Barberry, but some management plans exclude the use of herbicide (Travis, 2016). Defoliation does not have any negative effect on Japanese Barberry growth and should therefore be avoided as a management strategy (Vanderklein, 2015). This treatment should be applied along the trails wherever feasible and avoid using the herbicide in proximity to the stream (Michigan Department of Natural Resources, 2012). Unfortunately, these treatments will most likely have to be applied at least twice to be effective which could be more costly (Ward et al., 2013). Once the Japanese

Barberry is removed in an area of the property, it is recommended that the Trust take action to prevent deer from grazing the native saplings which may sprout. The managed areas should be regularly checked to make sure new invasive species do not colonize the treated area. By removing some of the Japanese Barberry throughout the property, the tick abundance should reduce and make the trails more accessible. If the Trust still wants Japanese Barberry to be at the property, it could be worth looking into genetically altered shrubs that are sterile (Li et al., 2006).

Educational Strategies

Pier Cove uses a variety of educational strategies throughout the property to inform visitors about the property's history and ecological attributes. However, there are ways in which these educational strategies can be enhanced and expanded upon throughout the coming years. Both active and passive educational strategies are employed in outdoor education settings, but Pier Cove is currently only utilizing passive strategies (Carter, 2013). Although passive educational strategies can provide effective learning environments throughout arboretums, like Pier Cove, the impacts of active learning should not be forgotten as well. Passive educational strategies include things like interpretive signs, which can be found throughout Pier Cove (Carter, 2013). Whereas active strategies encourage behavioral engagement like volunteering (McKenna, 2020). This section of the management plan will focus on how Pier Cove can improve its passive educational strategies like interpretive signs, and trail wayfinding, while introducing active educational opportunities as well. This section will also establish a public outreach strategy targeting volunteers and visitors to Pier Cove. Finally this section will include ways in which the Trust can increase funding initiatives to finance some of the improvements not only listed in this section, but improvements suggested throughout the entire management plan.

Passive Education Recommendations

A key objective of this management plan is to restore and preserve Pier Cove for the enjoyment of visitors, community members, and future generations. In order to fully accomplish this goal, this management plan must assess, and expand upon, the current educational strategies implemented at Pier Cove. Currently, Pier Cove utilizes various methods of media like websites, books, pamphlets, and interpretive signs to educate visitors about the historical significance, and ecosystem services, that the property provides for the local community. Interpretive signs are posted at each entry point to the Ravine, which highlight information about the property and incorporate visual elements like photos and maps (Figure 27). Some of these interpretive signs highlight unique plant species that can be found, or were historically planted, throughout the property by Simonds himself. After the ecological team



Figure 27: An interpretive sign located at one of the entrances to Pier Cove

completed the plant species surveys for this project, some of the unique species identified on these signs were found to no longer exist in the specified portions of the property. Although historical species are still important to highlight, it may be beneficial to update signage throughout Pier Cove to also reflect the unique and current species that can be found throughout the property. One area that does not have an interpretive sign currently, but is still unique to the property, is the stream which feeds into Lake Michigan. As mentioned previously in this management plan under the site survey discussion, the stream is experiencing significant erosion. Information, like what contributes to stream erosion, and how citizens can help to improve overall stream health, should be highlighted on signs located near the stream to inform and educate visitors about how they can protect and contribute to water quality at Pier Cove. This is especially important as interpretive signs have been found to positively impact visitor behavior (Janeczko, 2021). Using the Forest Service's interpretive sign design guidelines, it is recommended that interpretive signs are at least 18" x 24" and include elements that grab visitors attention (Ziemann, 2005). Examples of interpretive signs that could be incorporated throughout Pier Cove can be found in Appendix E.



Figure 28: Tree markers located at Pier Cove

Pier Cove also utilizes tree markers to spotlight unique plant species found along the trails, like the Great Rhododendron and Church Beech (Figure 28). Tree markers, and interpretive signs, have been shown to meet visitors' curiosity and provide new points of interest for returning visitors to natural areas (Hughes & Morrison-Saunders, 2002). Unfortunately, many of these tree markers no longer exist or have been weathered and need replacing. If the Trust desires to keep the tree markers, it may be beneficial to invest in printed markers that can be attached to the species itself or anchored to the ground. Information on these tree markers should include the common name of the plant species, the latin name of the species in italics, a description of the species, and why it is unique or important to Pier Cove (Ziemann, 2005). Some debate has occurred in the literature about how long informational signs should be. It is suggested that signs should contain no more than fifty words as it's been shown that readers spend less than

twenty five seconds reading informational signage (Cole et al., 1999). However, some literature states that signs should be designed to be read for up to three minutes (Ziemann, 2005). An overwhelming majority of the literature argues that people are spending less time reading interpretive signs, especially when recreating (Cole et al., 1999). Therefore, many of the designs created for this project have less than fifty words and use minimal scientific jargon as a means to be more inclusive of all audiences (Janeczko, 2021). Some examples of potential tree markers can be found in Appendix D, which highlight information from species that either have already been marked throughout Pier Cove and need replacing, are historically unique to Pier Cove, or have ecological importance to Pier Cove. Having both updated interpretive signage and tree markers throughout Pier Cove is important for both educational purposes and safety.

Pier Cove could also enhance visitor experience by clearly marking trails with waypoints to guide visitors safely throughout the property. As discussed earlier throughout this management plan, many of the trails throughout Pier Cove wind around steep drop-offs, or could be confused with discontinued paths. The trail map displayed on interpretive signs throughout Pier Cove does not allow for revisions, especially if portions of the trail system are impacted by natural disturbances like downed trees, erosion, flooding etc. It could be beneficial to allow for waypoints to be updated when these issues arise. Several varieties of waypoints exist and have different levels of effectiveness. For example, paint, cairns, posts, affixed markers, etchings and flags are all different types of common markers that exist along hiking paths (Hodgkins, 2024). Paint, for example, is more permanent than flags, but can fade due to weathering over time. Affixed metal markers are more permanent than paint, but are not as easily changeable. Flags allow for relocation, if the trail is re-designed or impeded by natural disturbance like a downed tree, and may be the most effective strategy for Pier Cove. Whatever trail marker the Trust decides, the trail markers should be unified and easily understandable (Hodgkins, 2024). One potential guide to follow is the UniGuide Program established in 2002 by the National Park Service on wayfinding and signage. If the Trust decides to create trail signs instead of using flags, this guide provides guidelines for wayfinding designs (National Park Service, 2002).

Active Education Recommendations

Pier Cove could benefit from adding active environmental education strategies to their passive educational strategies, while still keeping the property a quiet place for retreat. As listed earlier in this report, improvement to trail systems and removal of invasive species needs to be addressed. If the Trust aims to reduce costs for these projects, it could be advantageous to use them as opportunities to involve community members and volunteers. While participating in these projects, volunteers would gain access to knowledge about invasive species removal and other initiatives being done at Pier Cove. Volunteering has been found to not only have a direct impact on the volunteer, but to have an impact on increasing civic engagement (Wilson, 1999). It could be beneficial for the Trust to host, or co-host alongside an environmental volunteer group, refurbishing days at Pier Cove in order to increase environmental civic action and knowledge about Pier Cove. Research suggests that those most likely to volunteer in

environmental settings are those who are around middle-aged, have higher incomes, have received education, and are employed full-time (Liarakou, 2011). The demographic for Allegan County fits these criteria and there are several environmental organizations that Pier Cove could collaborate with which will be listed under the public outreach strategy section below (U.S. Department of Commerce, 2023).

Public Outreach Strategy

Pier Cove currently uses its website as its public interface, but there is little media coverage on the property itself. The adjacent Pier Cove Beach can be found on local tourism board websites such as the Saugatuck Douglas website where they advertise the beach as a rock and fossil hunting location (Pure Michigan, 2024; Pure Michigan, 2024b). The Pier Cove website makes it clear that they want the property to remain a quiet place for retreat, so the goal of any public outreach strategy would be to attract visitors that would respect the rules of the property (Pier Cove Ravine Trust, 2024). Pier Cove could benefit from a public outreach strategy to engage volunteers, increase connections with surrounding environmental organizations, and increase ecotourism ventures. With these goals in mind, the Trust could implement the PIE strategy (plan, implement, and evaluate), used in environmental education and outreach, to create a strategy which targets one or all of these audiences (Jacobson, 2015). If the goal of the public outreach strategy is to attract more volunteers to do improvement work, it may be beneficial to reach out to local environmental organizations that already have similarly established programs. The West Michigan Conservation Network may be a place to start as there are no membership fees and the network includes over seventy organizations, businesses, and private groups (West Michigan Conservation Network, 2025). This network also is awarded grant money which helps the network do management work for invasive species removal and other sustainability initiatives for the groups within the network. If the goal of the public outreach strategy is to attract more visitors to the property, the Trust could also look into advertising the property on tourism board websites like the Saugatuck Douglas website and other west Michigan websites that have been established. The Trust could also use this management plan as a media tool to showcase that Pier Cove is looking to increase stewardship initiatives and education around environmental initiatives. A media package with high quality photos, descriptions of the project, etc. is provided in Appendix E for the Trust to use if they so choose.

Funding Initiatives

Visitors passionate about the outdoors and conservation have been known to contribute to conservation initiatives and the local economy (Santarém, 2015). With Allegan County being a popular tourist destination, there is ample opportunity to increase funding through visitor dollars for the property (Allegan County, 2021). Pier Cove currently has brochures attached to some of its signs encouraging visitors to become members (Figure 29). The membership tier system is also located on the Pier Cove website which lists donations starting from Family at $100, Tree Hugger at $150, Trailblazer at $250, Bridge Builder at $500, and Sustaining Naturalist at $1000 (Pier Cove Ravine Trust, 2024). QR codes are also found on some of the interpretive signs which lead back to the website where people can navigate to donate. Pier Cove could provide QR codes that go directly to a place where visitors can donate, using a platform like Venmo, rather than having to navigate through the website. This QR code could also have a portion where visitors can type in their donation amount rather than having to abide by the tier system. However, visitors may have hesitancy towards donating for a multitude of reasons (Barker, 2019).



Figure 29: A sign with a box for flyers located outside of one of the entrances to Pier Cove

In the absence of visitor donations it would be essential that Pier Cove establishes diversified streams of funding. There are several grants that the Trust can apply for to alleviate some of the financial responsibility of the property maintenance outlined in this management plan. The Michigan Department of Natural Resources offers several grants provided to Michigan communities for the creation and maintenance of green spaces and the protection of wildlife. Specifically, grants like the Wildlife Habitat Grant Program help fund projects that help manage sustainable wildlife populations which become available every two years. The last grant period began in 2024, so it would be expected to be offered again in 2026 (Department of Natural Resources, 2025). Another potential grant offered through the Department of Natural Resources is the Fisheries Habitat Grant which supports projects that benefit the public and aquatic resources (Department of Natural Resources, 2025 (2)). This grant could potentially be used to support erosion control projects for the stream running throughout the property and feeding into Lake Michigan. This could also be another potential project for future University of Michigan SEAS students to take a part of, if awarded this grant. Another potential grant offered by the Department of Natural Resources is the Michigan Invasive Species Grant Program which targets projects that tackle invasive species removal and control in both terrestrial and aquatic

ecosystems (Department of Natural Resources, 2025 (3)). One potential issue with these Department of Natural Resources grants in particular is that most of them are awarded to nonprofits. The Trust may need to contact the Department of Natural Resources to see if Pier Cove would still qualify for this grant specifically or consider adjusting its entity to include nonprofit status to gain access to increased funding.

Federal grants exist as well for private landowners to restore forested areas. One relevant grant is the Federal Landscape Scale Restoration Grant awarded to private landowners in collaboration with a State agency, local nonprofit, University, or Tribe. This grant is also awarded to land owners in a city of less than 50,000 people for science-based restoration projects tackling issues like invasive species removal and watershed protection (Michigan Department of Natural Resources, 2025 (4)). This grant could be extremely relevant and a potential opportunity for the Trust to partner with another University of Michigan master's student project. One potential issue with all grant opportunities is that they are evolving and may not be available. Thus, it is imperative that the Trust continues to search for grants that could possibly fund these improvement projects.

Educational Strategies Conclusion

Overall Pier Cove has an established environmental education strategy which can be improved with the suggestions outlined in this management plan. Improvements to both passive and active educational strategies should provide visitors with engaged learning activities and strengthen their connection to the property. With the help of volunteers, donor funding, and awarded grants, improvements to Pier Cove should not only be feasible, but educational as well. To attract visitors and potential volunteers, and donors, a public outreach strategy could be implemented. The goal of this public outreach strategy would be to target volunteers, increase connections with local environmental organizations, and increase ecotourism use of the property.

Conclusion

Overall, there are several effective strategies that the Trust can take to manage Pier Cove for future generations to enjoy. After conducting stream and hydrological surveys, it was found that erosion is negatively contributing to the degradation of the stream running throughout the property. In order to combat this issue, several recommendations were provided from downed-tree removal, removing invasive plant species, and planting native species throughout the riparian edge. After erosion is minimized, it may be beneficial for the Trust to improve and repair the trail system and foot bridges which were damaged from the impacts of erosion as well. This should be simpler to accomplish as new maps and data have been generated to help improve wayfinding and access for visitors.

Several vegetation surveys were conducted throughout the property as well and identified a large presence of invasive species like the Japanese Barberry (*Berberis thunbergii),* which not only contributes to native species decline, but also has the potential to increase the presence of blacklegged ticks *(Ixodes scapularis)*. Many members of the Trust have had direct experiences with these ticks and have expressed concerns over their abundance. Although O.C. Simonds planted the Japanese Barberry, it may be beneficial to remove it using the management techniques outlined throughout this plan, as the plant is contributing to declines in biodiversity.

The team recognizes that several of these strategies can be costly, which is why several funding strategies were proposed throughout this management plan. There are several grants which the Trust can apply for to help increase funding if donations do not cover the costs of repairs and maintenance. The Trust can also utilize volunteers as a way to refurbish and maintain Pier Cove while contributing to community outreach initiatives and increasing environmental educational opportunities for community members. If Pier Cove does not have the capacity to hold volunteer days themselves, they could partner with local environmental organizations which could help drive community stewardship as well.

With these results and management recommendations for consideration, Pier Cove will have the ability to refurbish and maintain the property for generations of people to enjoy. O.C. Simonds' vision of Pier Cove will be restored again, with some modern improvements, restoration, and management. O.C. Simonds once said "nothing in nature is more charming than woods" and Pier Cove will continue to be a testament to the timeless beauty and tranquility for all who visit (Simonds, 2000).

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Pier Cove Restoration Management Plan

Appendix B: Riparian/Benthos



Riparian Zone Terms & References

Definitions

Riparian zone: The 10 meter x 10 meter plot that starts at the streambank edge and extends 10 meters into the forest from the streambank edge. See diagram below for reference.

Transect: The sampling point in the stream that riparian zone observations and invertebrate samples are taken from.

Canopy: Any plant species above 5 meters tall in the riparian zone.

Understory: Any plant species between 0.5 meters-5 meters tall.

Ground Cover: Any plant species less than 0.5 meters tall.

Woody Vegetation: Any tree species found in the riparian zone canopy.

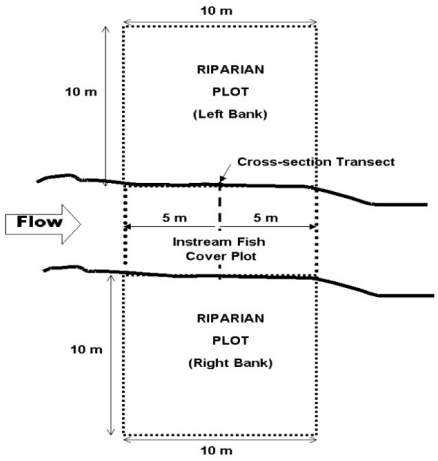
Woody Shrubs/saplings: Any woody plant species that cannot be classified as a mature tree.

Non-woody Vegetation: Any grass, forb, or other plant species that does not contain woody bark.

Bare Dirt: Open forest floor that is not dominated by plant species, but instead by leaf litter or soil that is exposed with no cover whatsoever.

DBH: Diameter at Breast Height. This is measured roughly 4 feet up a tree to determine whether a tree is mature or a sapling.

Riparian Zone Visualization



PRK/DVP 8/06

Figure 10.3 Riparian Zone and Instream Fish Cover Plots for a Stream Cross-Section Transect

US EPA National Rivers & Streams Assessment - Wadeable Protocol Field Operations Manual. The above diagram shows how the riparian zone plot is determined. Note that while there is an instream fish cover plot labeled in this diagram, the Pier Cove team did not have the means or time to sample for fish during the duration of this project.

Benthos References

Common Names of Invertebrates in Pier Cove Stream

Order (Latin Name)	Common Names
Amphipoda	Scuds
Diptera	Dance flies, horse flies, deer flies, black flies, blood worms
Oligochaeta (class)	Earthworms
Trichoptera	Common netspinner caddisflies, tubemaking/trumpet caddisflies, netspinning caddisflies
Ephemeroptera	Flathead mayflies, small minnow mayflies
Coleoptera	Long-toed water beetles, predacious diving beetles
Hemiptera	Broad-shouldered water striders
Isopoda	Isopods
Odonata	Broad-winged damselflies
Collembola	Springtails
Corydalidae	Dobsonflies, fishflies, hellgrammites

Definitions

Benthos: The aquatic macroinvertebrates, or “bugs”, that reside in the substrate of the streambed.

Substrate: The type of sediment material that makes up the streambed - this can include rocks of varying size, woody debris, sand, and/or fine soil/muck.

Pier Cove Restoration Management Plan

Appendix C: Vegetation



Pier Cove Ravine

from the original plan
by Ossian Cole Simonds
at Pier Cove, Michigan

Key

Creek
Road
Path
Old road
Old path, bldgs., etc.
Bench
Bridge
Fence
Deciduous trees, shrubs
Evergreens
Bog

1" = 160'

Roberta L. Simonds
August, 1978

WILLOWS
DITCH
WHITE ASH
BLACK CHERRY
DITCH
WOODS
DITCH
DITCH
WOODS
SASSAFRAS
BIRCH
SILVER MAPLE
JUNIPER
old water tank
old pump
CEDAR
ASH
JUNIPER
OAKS
PINES
scattering LARCH
PINES
OAKS
PINES
PINES
CATALPA and WILD CHERRIES
old road
old road
old road
BLACK LOCUSTS
CATALPA
PINES
CATALPAS
WOODS
old orchard
PEARS
RED CEDAR
APPLES
old orchard
PINES and CATALPAS
SASSAFRAS
RED PINES
PINES
ERNIE CURTIS BENCH
JUNIPERS and CEDARS
BIRCH
PINE WOODS
NUT GROVE
RED JACK and SCOTS PINES
PINES
WOODS
PINES
WILLOWS and DOGWOOD
LOCUSTS
WILD ORCHIDS
old experimental plot
OAKS
CHERRY
PINES
PINES
scattering JUNIPERS
scattering SPRUCE
SHADBLOWS DOGWOODS
CRAB APPLE
PINES
SUGAR MAPLE
EDDIES BENCH
AM. CHESTNUTS
SCOTS PINE
WILD CHERRIES
CHERRIES and WITCH HAZELS
PAW PAWS
BLUEBERRIES
YELLOW ROOT
CHURCH
BEECHES
SILVER MAPLE
old spring
PATH
BENCH
PINES
old nursery
JUNIPER
PINES
old trail
LYCOPODIUM
HEMLOCKS
123 AVE.
TULIP TREE
RED OAKS
MARSHALL MARION BENCH
BIRCH
SUGAR MAPLE
PATH
old trail
BLACK CHERRY
123 AVE.
PLUMS
old orchard
PEACHES
MULBERRY
PINES
WILD BLACK CHERRIES
PINES
BLUE SPRUCES
PINES
PINES
PINES
BLUFF PATH (old road)
RED OAK
RED OAK
TULIP
YELLOW BIRCH
PINES
DOUGLAS FIRS
SUGAR MAPLES
RHODODENDRONS
SWEET GUMS
RHODODENDRONS
HORSETAILS
PATH
KING APPLE
MAGNOLIA
old steps
old ponds
old trail
HIGH PATH
SHADBLOWS
RHODODENDRON
KELCHER BRIDGE
SYCAMORE
JOHNSON BENCH
LOCUST
island
WILLOW
(Johnson)
POPLARS
LARCH
old pond
island
old dam
PUBLIC ACCESS to BEACH
BASSWOODS
old windmill
SWEET GUMS
old shed
SPRUCE
CHERRY
CATALPA
BIRCHES
LAKE SHORE DRIVE
(Simonds)
LAKE SHORE DRIVE
(Simonds)
ORCHARD HOUSE
old barn
old garden
SCOTCH BROOM
old crib
SUGAR MAPLES
WHITE FIR
DOGWOOD
JAPANESE TREE LILACS
APPLES
old pond
(Gauntlet)
WAWA GATE
SUMAC
CLEARING
WHITE PINES

Appendix C2 Historical Vegetation Composition

Common Name	Scientific Name	Confirmed Presence?
Balsam Fir	*Abies balsamea*	Yes
White Fir	*Abies concolor*	Yes
Boxelder	*Acer negundo*	Yes
Norway Maple	*Acer pltanoides*	Yes
Red Maple	*Acer rubrum*	Yes
Silver Maple	*Acer saccharinum*	Yes
Sugar Maple	*Acer saccharum*	Yes
Serviceberry	*Amelanchier canadensis*	Yes
Pawpaw	*Asimina triloba*	Yes
Japanese Barberry	*Berberis thunbergii*	Yes
Yellow Birch	*Betula lutes*	
Paper Birch	*Betula papyrifera*	
American Hornbeam	*Carpinus caroliniana*	Yes
American Chestnut	*Castanea dentata*	Yes
Northern Catalpa	*Catalpa speciosa*	Yes
Bittersweet	*Celastrus orbiculatus*	
Pagoda Dogwood	*Cornus alternifolia*	Yes
Flowering Dogwood	*Cornus florida*	Yes
Gray Dogwood	*Cornus racemosa*	Yes
Red-Osier Dogwood	*Cornus stolonifera*	Yes
Deutzia	*Deutzia scabra*	
Bush-Honeysuckle	*Diervilla lonicera*	
Eastern Wahoo	*Euonymus atropurpureus*	
Running Strawberry Bush	*Euonymus obovatus*	Yes
American Beech	*Fagus grandifolia*	Yes
Forsythia	*Forsythia suspensa*	
White Ash	*Fraxinus americana*	Yes
Green Ash	*Fraxinus pennsylvanica*	Yes
Honeylocust	*Gleditsia triacanthos*	Yes
Witch-Hazel	*Hamamelis virginiana*	Yes
Wild Hydrangea	*Hydrangea arborescens*	
American Holly	*Ilex opaca*	
Winterberry Holly	*Ilex verticillata*	Yes
Butternut	*Juglans cinerea*	Yes
Black Walnut	*Juglans nigra*	Yes
Common Juniper	*Juniperus communis*	
Eastern Red Cedar	*Juniperus virginiana*	Yes
Mountain Laurel	*Kalmia latifolia*	
European Larch	*Larix decidua*	
Leucothoe	*Leucothoe axillaris*	
Common Privit	*Ligustrum vulgare*	
Spicebush	*Lindera benzoin*	Yes
Sweetgum	*Liquidambar styraciflua*	Yes
Tuliptree	*Liriodendron tulipifera*	Yes

Japanese Honeysuckle	*Lonicera japonica*	
Cucumbertree	*Magnolia acuminata*	
Umbrella Magnolia	*Magnolia tripetala*	Yes
Creeping Hollygrape	*Mahonia repens*	
Apples	*Malus spp.*	
Red Mulberry	*Morus alba*	
Black Tupelo	*Nyssa sylvatica*	Yes
Eastern Hophornbeam	*Ostrya virginiana*	Yes
Virginia Creeper	*Parthenocissus quinquefolia*	Yes
Norway Spruce	*Picea abies*	
White Spruce	*Picea glauca*	
Colorado Blue Spruce	*Picea pungens*	
Jack Pine	*Pinus banksiana*	Yes
Austrian Pine	*Pinus nigra*	Yes
Red Pine	*Pinus resinosa*	Yes
Pitch Pine	*Pinus rigida*	Yes
Eastern White Pine	*Pinus strobus*	Yes
Scots Pine	*Pinus sylvestris*	Yes
White Poplar	*Populus alba*	
Eastern Cottonwood	*Populus deltoides*	
Bigtooth Aspen	*Populus grandidentata*	
American Plum	*Prunus americana*	
Pin Cherry	*Prunus pensylvanica*	Yes
Black Cherry	*Prunus serotina*	Yes
Douglas Fir	*Pseudotsuga menziesii*	Yes
Pears	*Pyrus spp.*	
White Oak	*Quercus alba*	Yes
Northern Red Oak	*Quercus rubra*	Yes
Rhododendron	*Rhododendron maximum*	Yes
Poison Ivy	*Rhus radicans*	Yes
Staghorn Sumac	*Rhus typhina*	
Prickly Gooseberry	*Ribes cynosbati*	
Black Locust	*Robinia pseudoacacia*	Yes
Swamp Rose	*Rosa palustris*	
Blackberry	*Rubus fruiticosus*	
Black Raspberry	*Rubus occidentalis*	Yes
Weeping Willow	*Salix babylonica*	
Black Willow	*Salix nigra*	
Common Elderberry	*Sambucus canadensis*	
Scotch Broom	*Sarothamnus acoparius*	
Sassafras	*Sassafras albidum*	Yes
Greenbriar	*Smilax rotundifolia*	Yes
Japanese Tree Lilac	*Syringa japonica*	Yes
Common Lilac	*Syringa vulgaris*	Yes
American Yew	*Taxus canadensis*	

Northern White Cedar	*Thuja occidentalis*	Yes
American Basswood	*Tilia americana*	Yes
Eastern Hemlock	*Tsuga canadensis*	Yes
Blueberry	*Vaccinium corymbosum*	Yes
Maple-leaved Viburnum	*Viburnum acerifolium*	Yes
Arrowwood	*Viburnum dentatum*	
Riverbank Grape	*Vitis riparia*	Yes
Yellowroot	*Zanthorhiza simplicissima*	

Appendix C3 Current Vegetation Observed Across Transects

Common Name	Scientific Name	Functional Group	Total Individuals Observed Across All Transects
Balsam Fir	Abies balsamea	Inter	1
Red Maple	Acer rubrum	Meso	3
Sugar Maple	Acer saccharum	Meso	121
Juneberry/Downy Serviceberry	Amelanchier arborea	Meso	18
Japanese Barberry	Berberis thunbergii	Inter	*Individuals not counted for this species
American beech	Fagus grandifolia	Meso	76
White Ash	Fraxinus americana	Meso	3
Witch-Hazel	Hamamelis virginiana	Inter	1
Northern Spicebush	Lindera benzoin	Meso	3
Tuliptree	Liriodendron tulipifera	Inter	7
American Hop-hornbeam	Ostrya virginiana	Meso	5
Norway Spruce	Picea abies	Meso	32
White Spruce	Picea glauca	Meso	1
Red Pine	Pinus resinosa	Helio	33
Red Spruce	Picea rubens	Meso	2
Eastern White Pine	Pinus strobus	Helio	74
Pin Cherry	Prunus pensylvanica	Helio	3
Black cherry	Prunus serotina	Meso	10
Chokecherry	Prunus virginiana	Helio	3
Douglas Fir	Psuedostuga menziesii	Meso	1
Northern Red Oak	Quercus rubra	Inter	30
Black Oak	Quercus velutina	Helio	10
Black Locust	Robinia psuedoacacia	Helio	3
Sassafras	Sassafras albidum	Inter	30
Eastern hemlock	Tsuga canadensis	Meso	2

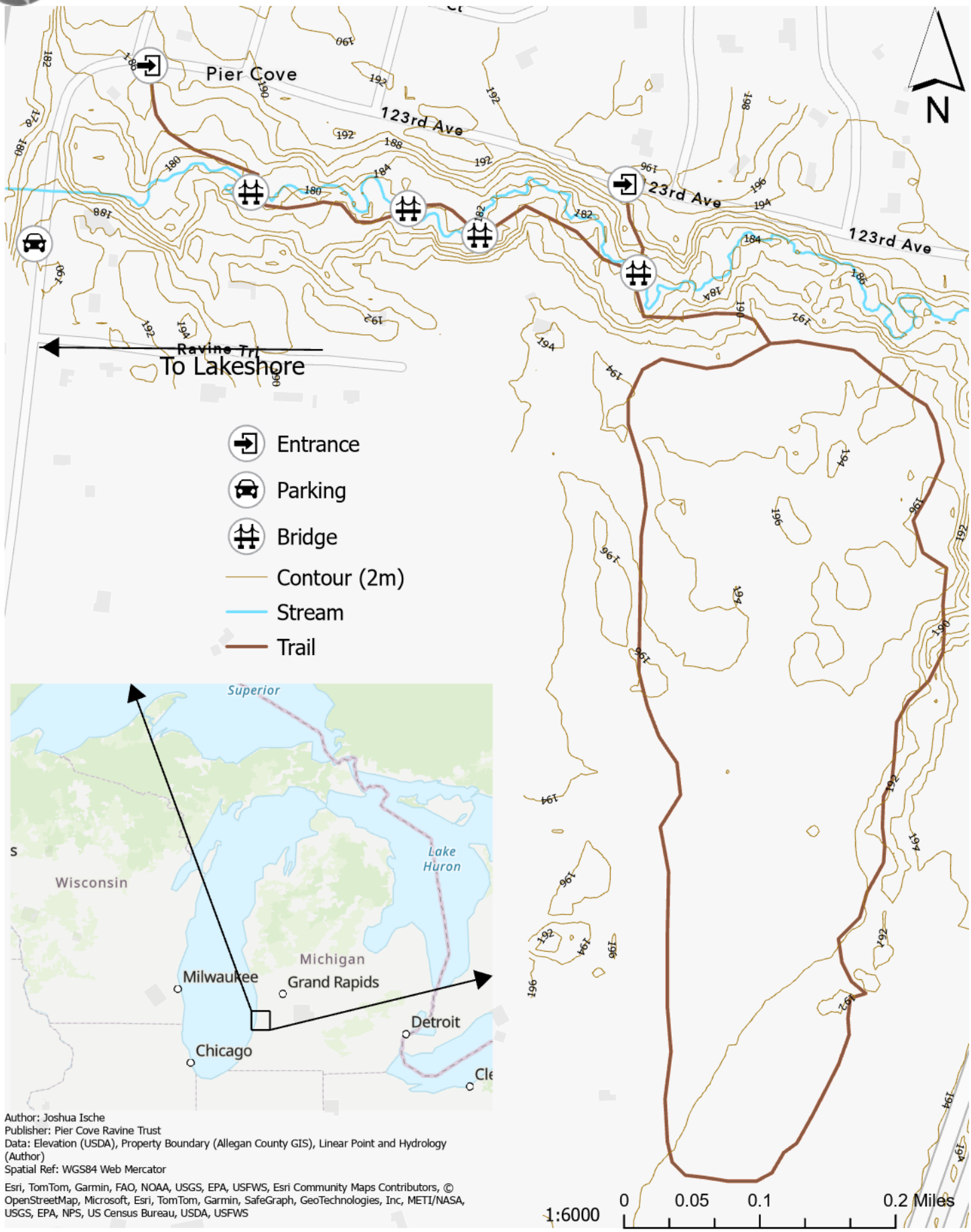
Pier Cove Restoration Management Plan

Appendix D: Geospatial





Pier Cove Reference Map



Author: Joshua Ische
Publisher: Pier Cove Ravine Trust
Data: Elevation (USDA), Property Boundary (Allegan County GIS), Linear Point and Hydrology (Author)
Spatial Ref: WGS84 Web Mercator

Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS, Esri Community Maps Contributors, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS



Pier Cove Photogrammetry (AUG)

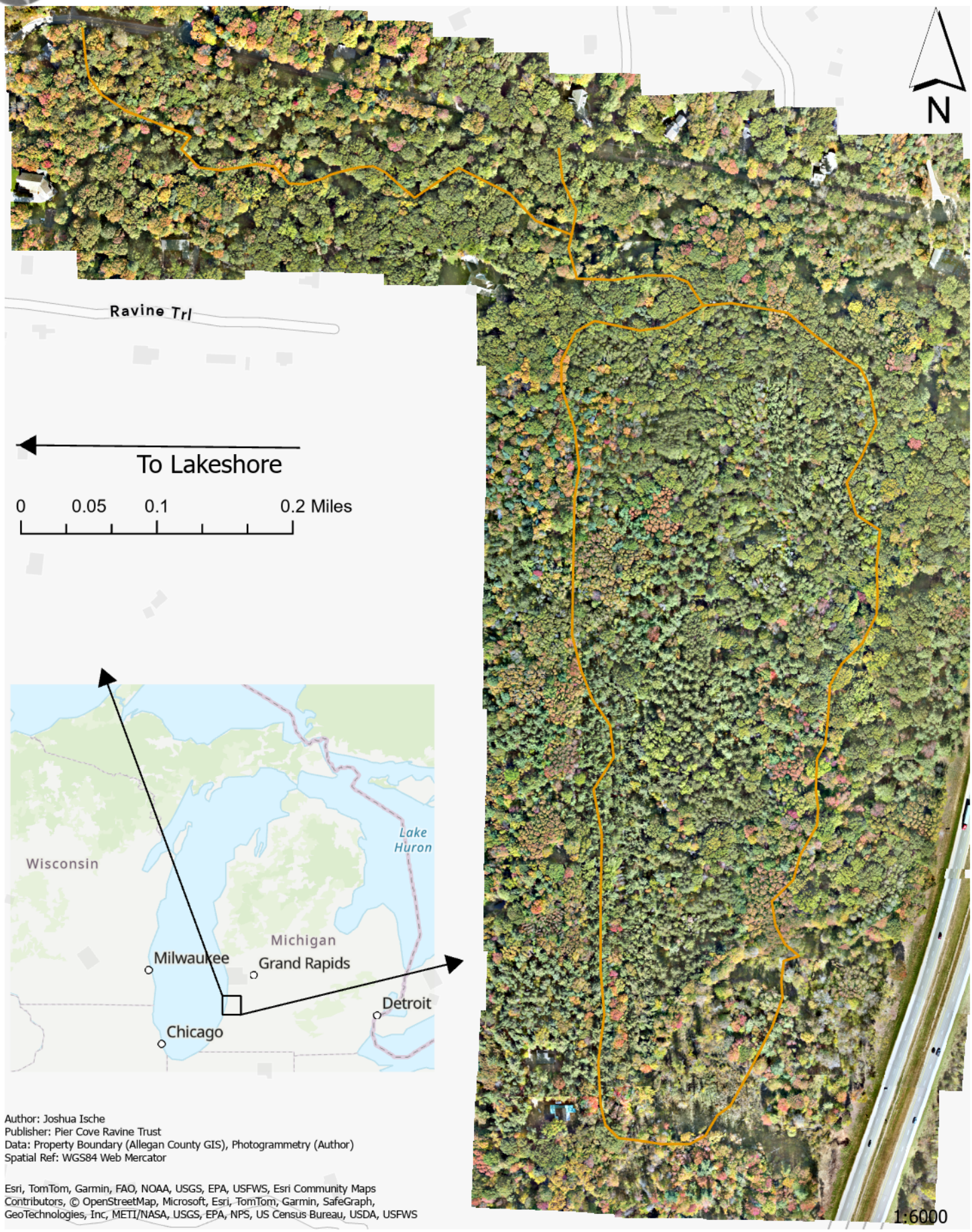


Author: Joshua Ische
Publisher: Pier Cove Ravine Trust
Data: Property Boundary (Allegan County GIS), Photogrammetry (Author)
Spatial Ref: WGS84 Web Mercator

Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS, Esri Community Maps Contributors, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS



Pier Cove Photogrammetry (OCT)



Author: Joshua Ische
Publisher: Pier Cove Ravine Trust
Data: Property Boundary (Allegan County GIS), Photogrammetry (Author)
Spatial Ref: WGS84 Web Mercator

Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS, Esri Community Maps Contributors, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS



Pier Cove Photogrammetry (JAN)



Author: Joshua Ische
Publisher: Pier Cove Ravine Trust
Data: Property Boundary (Allegan County GIS), Photogrammetry (Author)
Spatial Ref: WGS84 Web Mercator

Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS, Esri Community Maps Contributors, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS



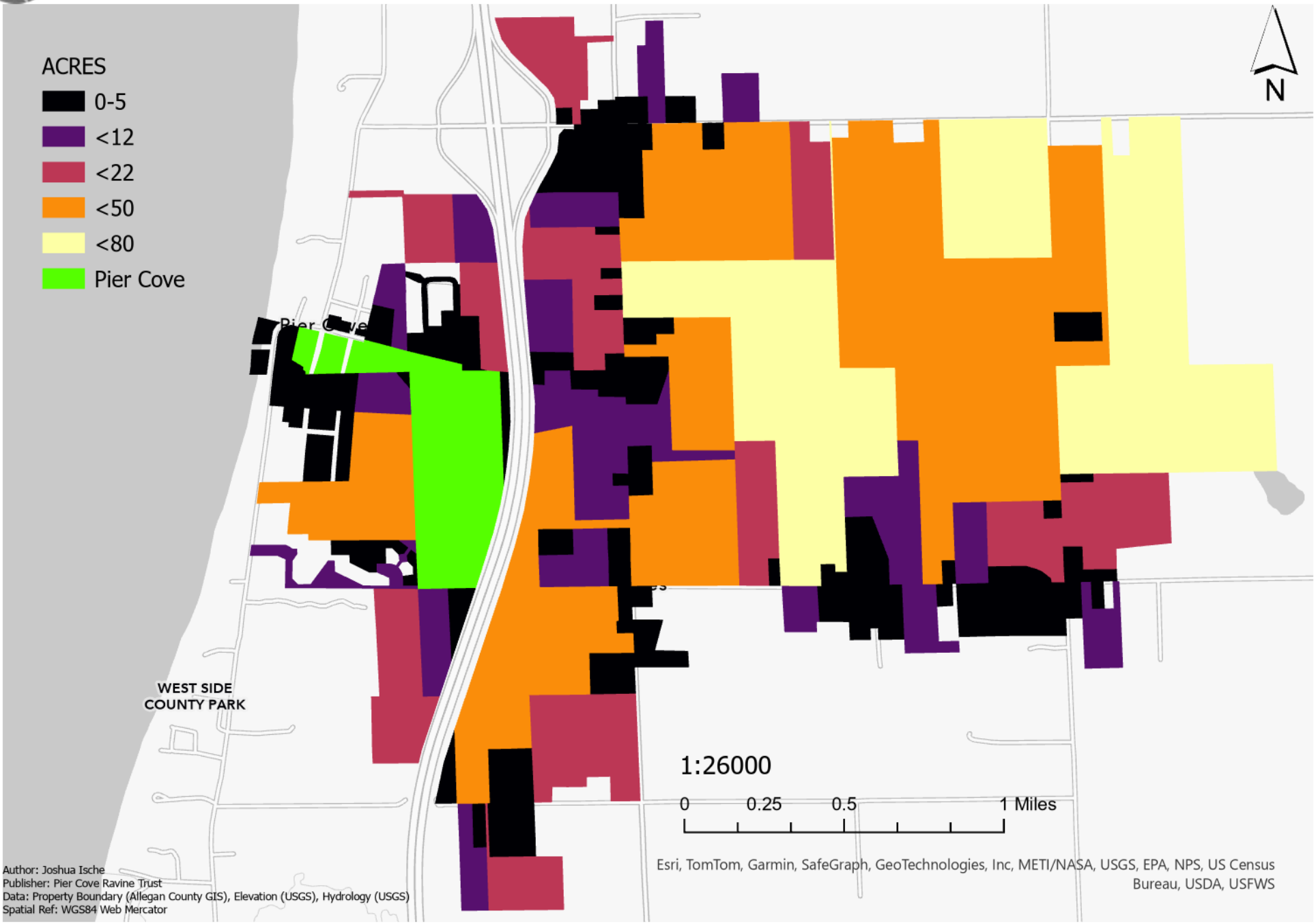
Pier Cove Stream Survey Transect Locations



Author: Joshua Ische
Publisher: Pier Cove Ravine Trust
Data: Property Boundary (Allegan County GIS), Elevation (USGS), Hydrology (USGS)
Spatial Ref: WGS84 Web Mercator

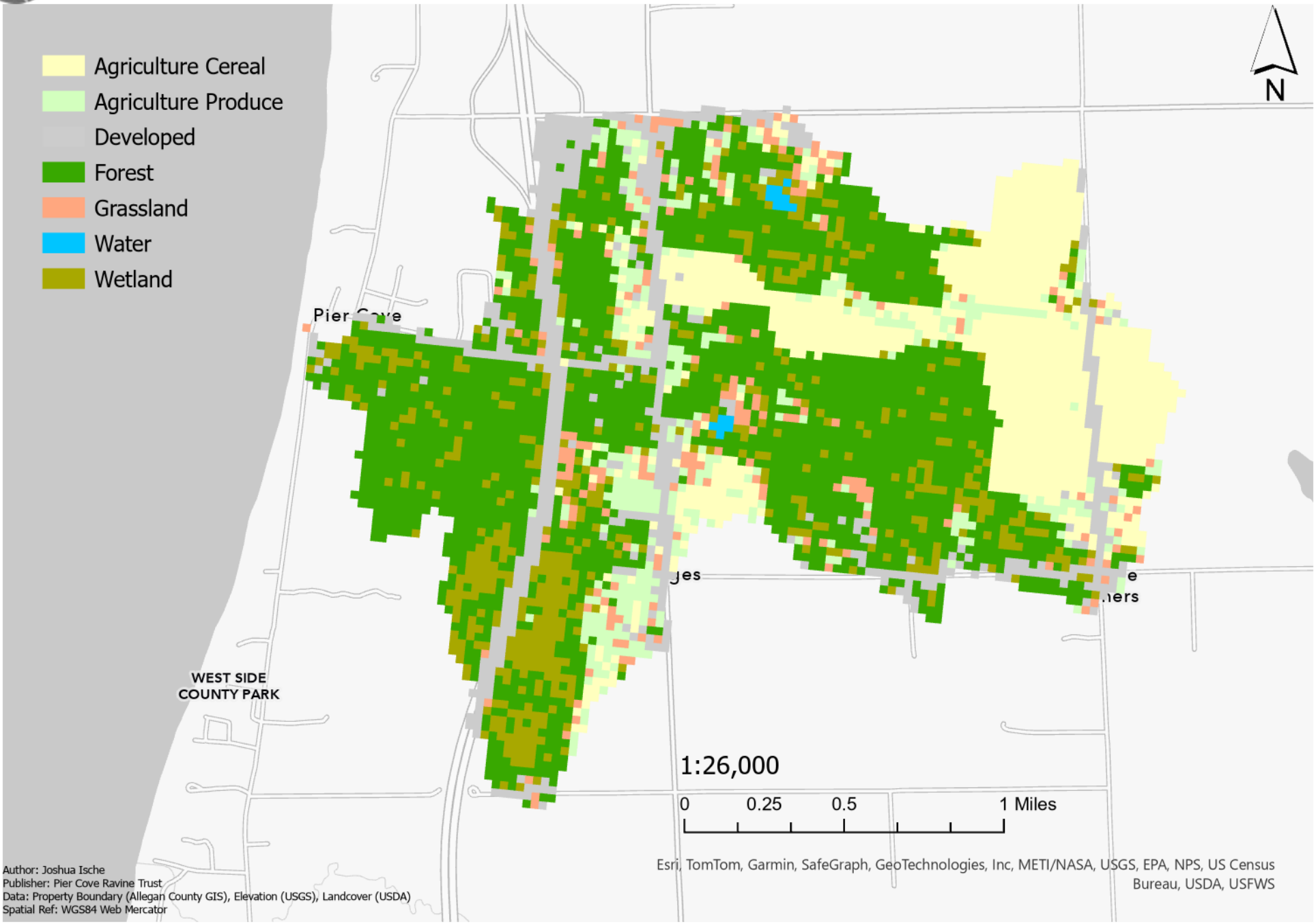


Pier Cove Watershed Parcels by Acreage





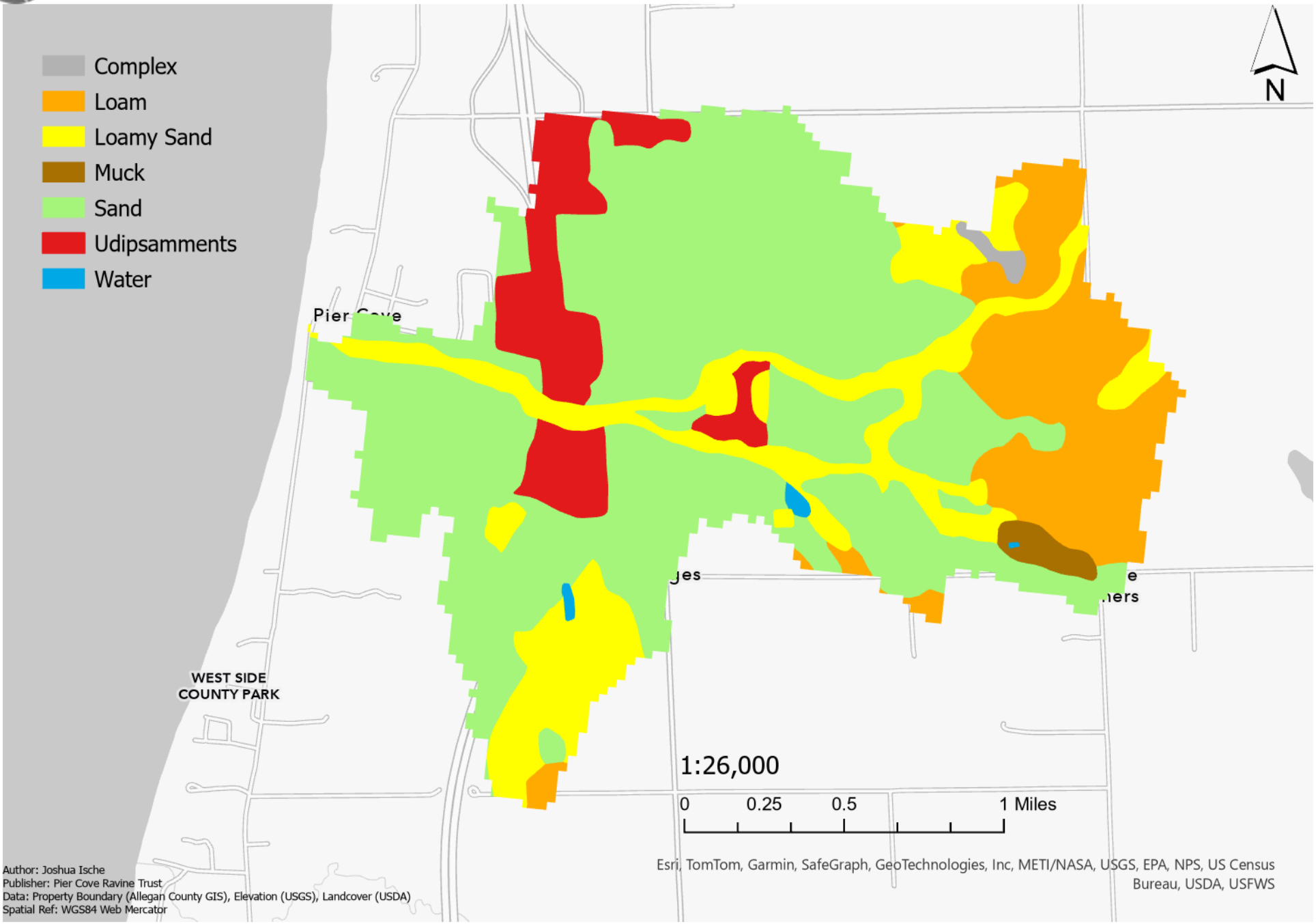
Pier Cove Watershed Landcover Types



Appendix D4.12



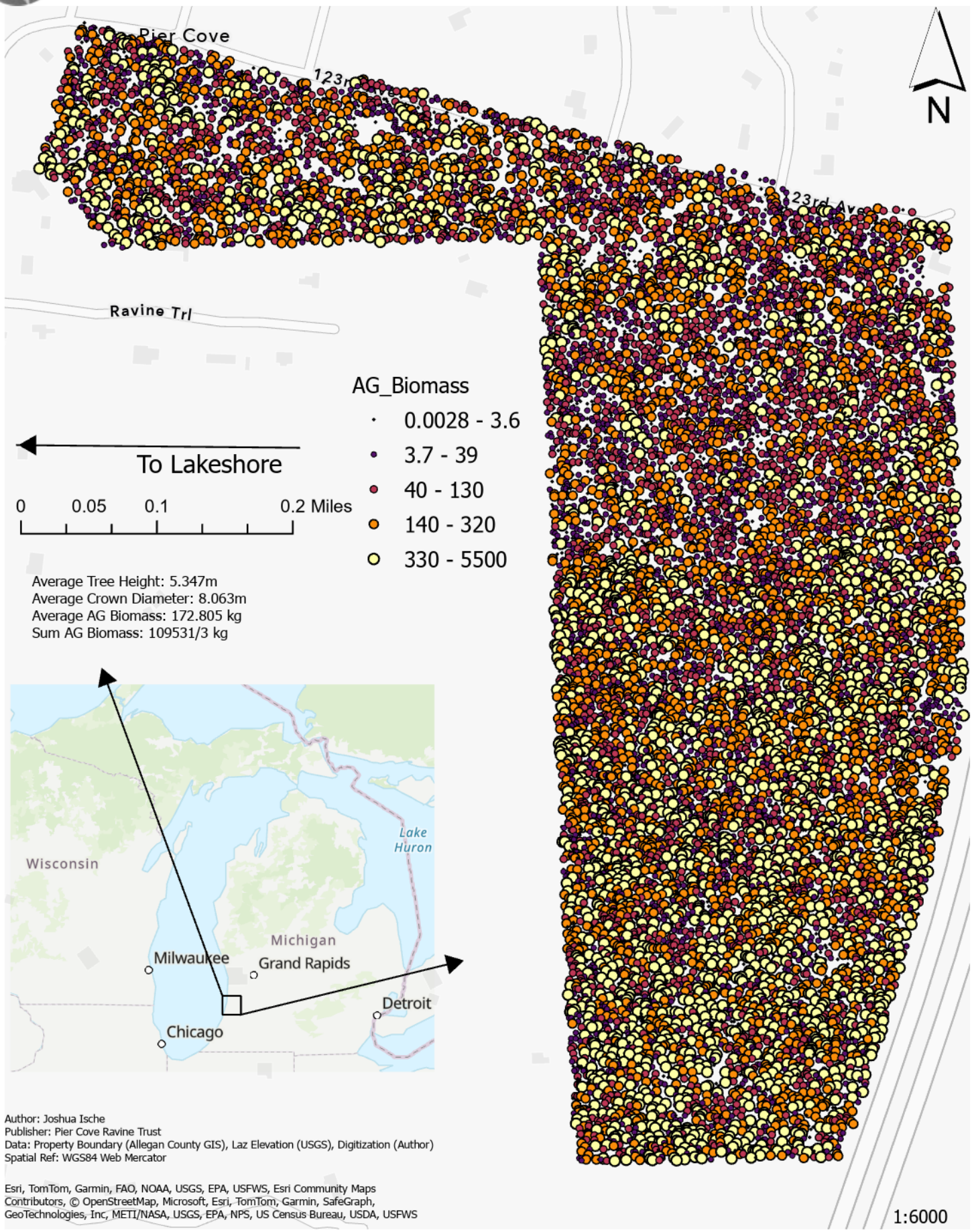
Pier Cove Watershed Soil Types



Appendix D4.13

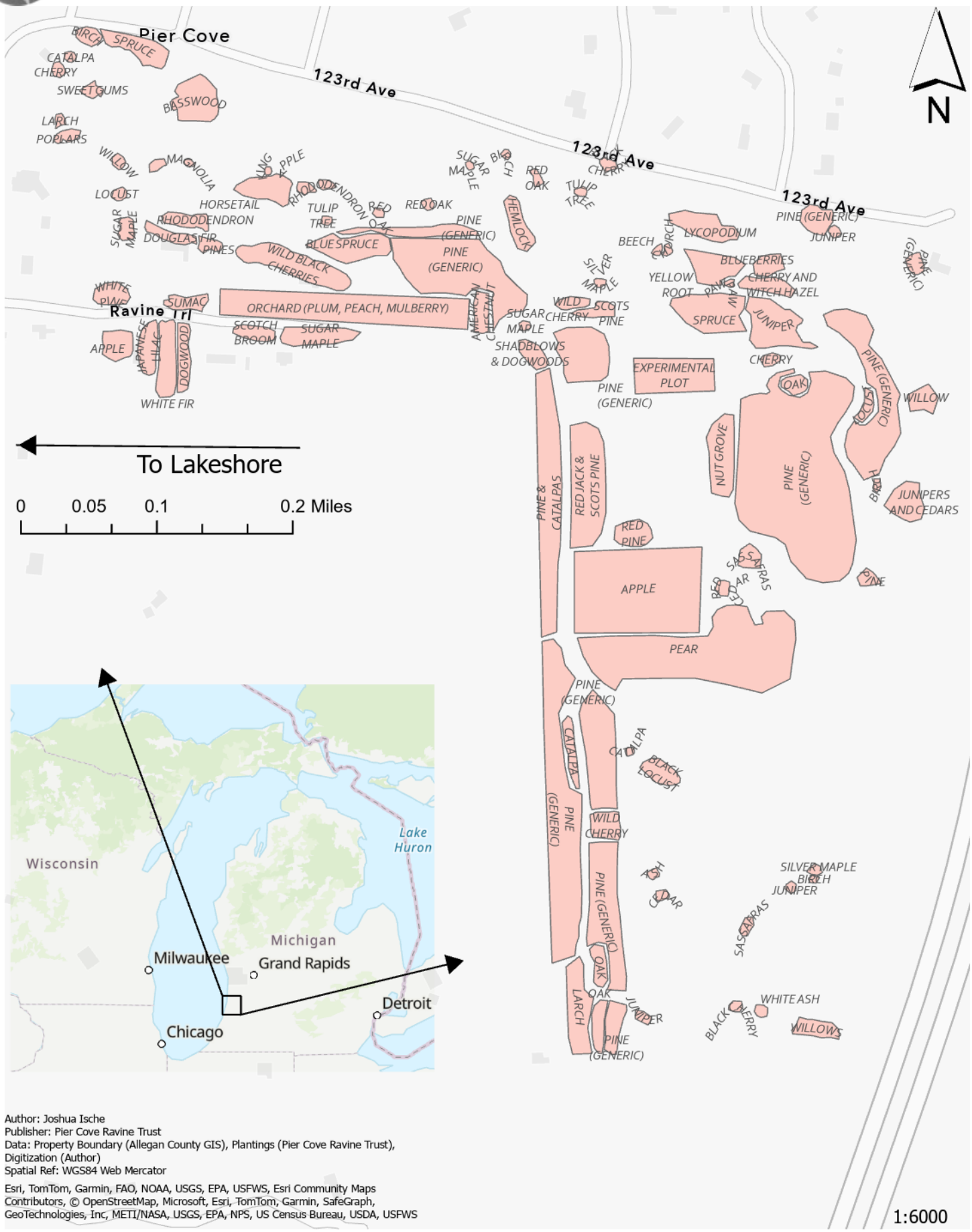


Pier Cove Ravine Biomass Estimation





Pier Cove Ravine Historic Plantings



Author: Joshua Ische
Publisher: Pier Cove Ravine Trust
Data: Property Boundary (Allegan County GIS), Plantings (Pier Cove Ravine Trust), Digitization (Author)
Spatial Ref: WGS84 Web Mercator

Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS, Esri Community Maps Contributors, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS

Pier Cove Restoration Management Plan

Appendix E: Education



Example: *writing to Audrey Whiticker from Mlive who wrote an article on Pier Cove Beach recently awhitaker@mlive.com *

Subject line: New management plans gets Pier Cove Community Enthusiastic About Upcoming Restoration Project

EMBARGO EMBARGO EMBARGO

DATE
Contact: contact name, phone number, email address

EMBARGOED FOR RELEASE AT TIME, DATE

Hi Audrey,

I recently read your article in MLive about Pier Cove Beach closing for renovations in March and wanted to pitch you a story about another restoration project occurring across the street at Pier Cove Ravine, also known as Pier Cove Park. Pier Cove Ravine is a historic arboretum serving its community as a place for outdoor recreation, reflection, and retreat. **Community members have expressed concerns over the significant erosion occurring throughout the Ravine,** impacting trail systems and the overall health of the ecosystem there. I am a part of a group of 5 masters students at the University of Michigan's School for Environment & Sustainability (SEAS) who have been working on a management plan for Pier Cove which will address these issues and transform the space by engaging community members in restoration projects such as planting native species, improving the trail system, and improving water quality for the stream.

This project is vital for restoring and protecting the future of a local historical landmark and tourist hotspot. Many community members feel a deep connection to the property's historical significance and hope the future of the property will honor its original purpose to be a space for outdoor recreation, where people can connect with nature and experience the property's unique features. Our team has worked alongside community members throughout this entire process, including the board of the Pier Cove Trust, ensuring that Pier Cove will remain a space that community members and visitors can enjoy for generations.

Our team wants you to be the first reporter to know about the management plan because of your personal connection to the area and your previous experience writing about Pier Cove. We will be presenting the management plan to board members at Pier Cove on April 26th, and the plan will be available to the public shortly after that. Community members are very excited about this project and would like to see this property protected and restored. This is a unique opportunity to write about a project gaining state-wide attention in collaboration with the University of Michigan.

If this is something that interests you, I would be happy to send you more information, including a press release. I appreciate you considering this idea, and I look forward to hearing back from you.

Thank you for your time,
NAME
Pier Cove Photos

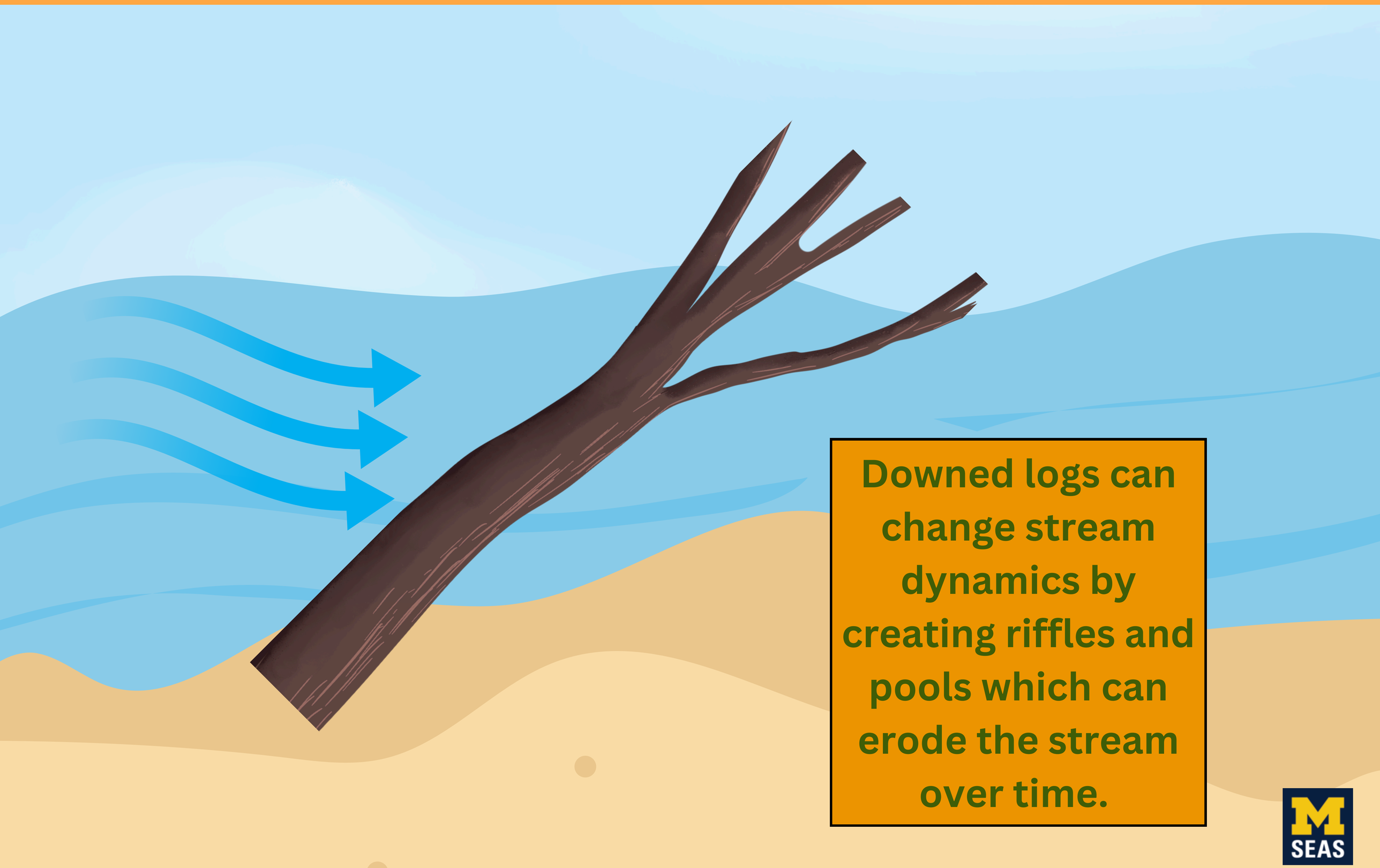
Pier Cove Creek Water Quality



Pier Cove Creek has a predominantly sandy streambed with the occasional presence of gravel. This helps to create diverse habitats for native aquatic species. Gravel, wood, and other substrates, help to support biodiversity and increase water quality.

M SEAS

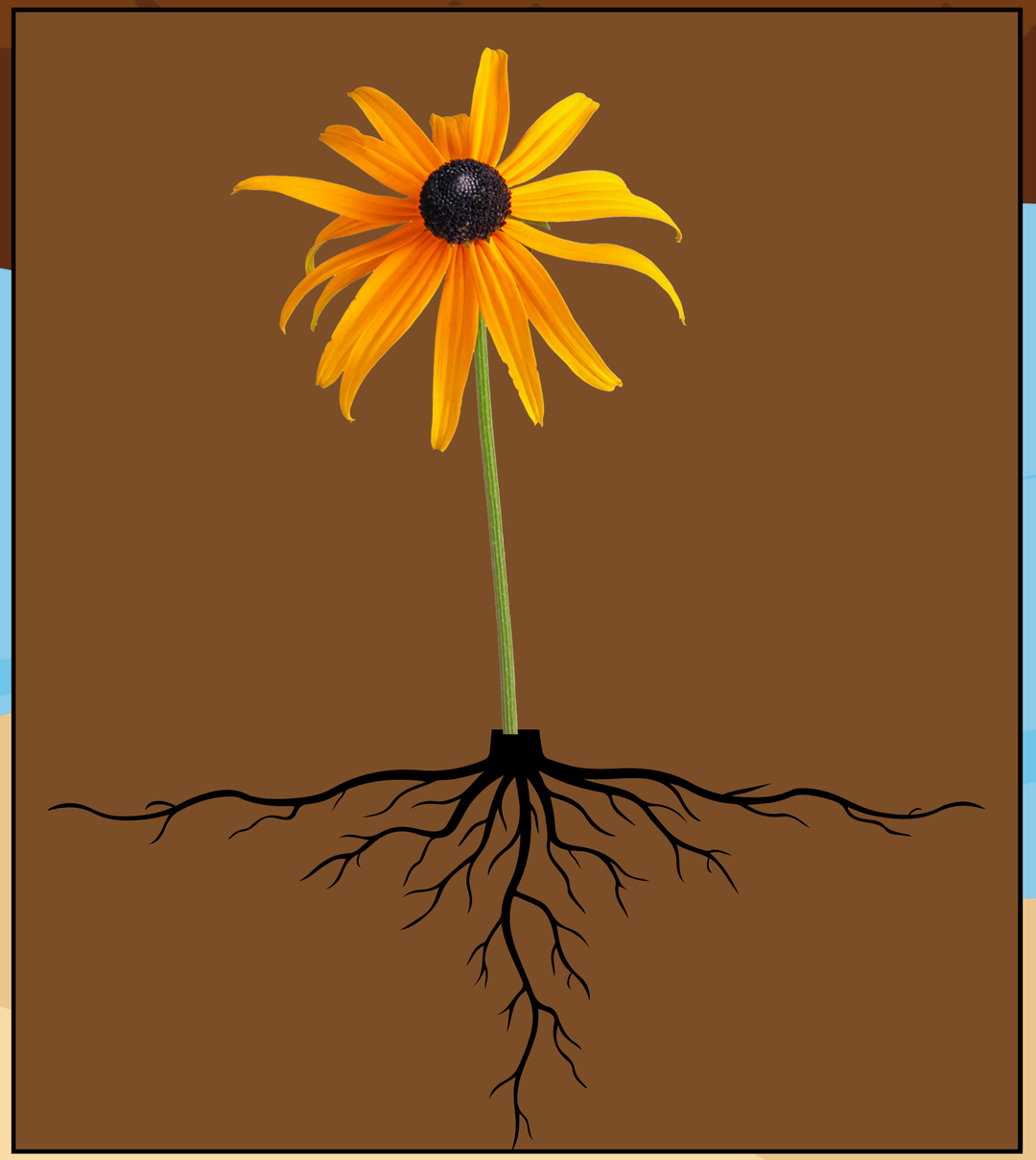
Stream Dynamics



Downed logs can change stream dynamics by creating riffles and pools which can erode the stream over time.

M SEAS

Native plants are crucial for preventing stream erosion and maintaining healthy water quality due to their deep root systems. Pier Cove is actively addressing the stream’s erosion issue to safeguard the health of the of the stream’s ecosystem by planting native species.



Jacqueline Dorman
Non-technical summary
2/13/25

A group of interdisciplinary master's students, at University of Michigan's school for Environment and Sustainability (SEAS), are creating a management plan for a historic arboretum in Fennville, Michigan. Pier Cove Ravine is a historic arboretum located in southwest Michigan serving its community as a place for outdoor recreation, reflection, and retreat. It was designed as an experimental arboretum by O.C. Simonds, a landscape gardener, in 1889 who also created the famous Nichols Arboretum at the University of Michigan in 1906. In recent history, the property has been maintained by members of the Pier Cove Ravine Trust and trails have been constructed throughout the property for visitors to use for recreational purposes. However, due to natural disturbances over time, the property is facing issues which are impacting the trail system, natural history of the property, and visitor experience. The management plan will address these issues and develop strategies to conserve the property for generations of visitors to enjoy. The management plan will be presented to the board April 28, 2025 and will be available to the public shortly after.

Fagus grandiflora
(American Beech Tree)

This beech tree known by as the “Church Beech,” is where O.C. Simonds and his wife, Martha, had their ashes scattered. Native to North America, beech trees provide food and habitat for various species.



PLEASE DO NOT CARVE OR PAINT THE TREES

Rhododendron maximum
(Great Rhododendron, Great Laurel)



The Great Rhododendron is not native to Michigan, but can be found throughout Pier Cove. O. C. Simonds used Pier Cove as his experimental arboretum, which is why plants like the Great Rhododendron, can be found throughout the property.

Pinus resinosa
(Red Pine Tree)



The Red Pine Tree is native to Michigan and is a coniferous tree. Coniferous trees produce cones and are well adapted to survive cold winter months due to their needle-like leaves which conserve water.

Acer saccharum
(Sugar Maple)



Native to Michigan, The Sugar Maple is a hardwood tree which can be found throughout Pier Cove. Sugar maples are best known for their bright colors in the fall and their ability to produce sap used to create Maple Syrup.