Creating a Vision for SEAS Properties

by

Maxwell DeYoung, Zimeng Ding, Zhengyu Li,
Lara O'Brien, Peter Siciliano, Cyrus Van Haitsma

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Project Committee:

Dean Jonathan Overpeck
Professor Robert E. Grese
Lecturer Shannon J. Brines

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ABSTRACT

The University of Michigan's School for Environment and Sustainability (SEAS) currently owns 1,761 acres across six properties in Southeastern Michigan, including Saginaw Forest, Stinchfield Woods, Newcomb Tract, St. Pierre Wetland, Harper Preserve, and Ringwood Forest. These natural areas accompany various satellite properties owned or managed by other University departments, existing as part of a broad patchwork of preserved property across the state of Michigan. The diverse array of habitats across the sites and vast networks of local and regional stakeholders present a unique opportunity to reexamine the goals and management plans for these properties, and to further demonstrate the University's commitment to land preservation, sustainable stewardship, and carbon neutrality. With these goals in mind, our team utilized several interdisciplinary research methods during the course of this project, largely consisting of carbon sequestration and storage analyses, remote sensing and GIS, and social research considerations. Over the past year, these approaches were used to arrive at holistic, concrete recommendations for both current and future property uses and considerations, which will lay the groundwork for forthcoming SEAS masters projects at each specific property. Our results point towards a wealth of new management and utilization objectives, including carbon neutrality and pricing, stewardship program initiatives, joint management models with land conservancies, and expanded opportunities for engagement with U-M faculty and students, local and regional institutions and organizations, and the general public.

EXECUTIVE SUMMARY

The University of Michigan's School for Environment and Sustainability (SEAS) currently owns 1,761 acres across six properties in Southeastern Michigan, including Saginaw Forest, Stinchfield Woods, Newcomb Tract, St. Pierre Wetland, Harper Preserve, and Ringwood Forest. These natural areas accompany various satellite properties owned or managed by other University departments, existing as part of a broad patchwork of preserved property across the state of Michigan. The diverse array of habitats across the sites and vast networks of local and regional stakeholders present a unique opportunity to reexamine the goals and management plans for these properties, and to further demonstrate the University's commitment to land preservation, sustainable stewardship, and carbon neutrality. With these goals in mind, the project team has outlined the following nine overarching goals in conjunction with our work over the past three semesters.

1) Land Acknowledgement

The creation of a formal statement officially acknowledging the original land acquisitions and tribal histories of the six SEAS properties is paramount. The land acknowledgment statement and related information should be included in all public communications regarding the properties, including signage, published materials, and presentations. It is also important for SEAS to reach out to the specific tribal groups, including the Saginaw Chippewa and Potawatomi, who have past associations with the properties as a way to build relationships and form possible collaborative and mutually beneficial partnerships.

2) Carbon Neutrality

SEAS properties were examined as carbon stocks of the University's goal of carbon neutrality. Carbon storage and sequestration were estimated from field data and literature values for SEAS properties and carbon stocks and rates were assigned monetary values based on three carbon pricing schemes.

3) Management Tiers

To best manage for unique needs and uses across the network of University owned natural properties, the properties need to be evaluated and managed based on a tiered use approach. Tier one would consist of properties within Ann Arbor. Tier two would be properties that exist within a 30 - 45 minute drive from Ann Arbor . Tier three of properties would exist past a 45 minute drive from campus. The tiered system could pool and focus resources to properties that have similar needs and uses.

4) Collaborative Land Management Partnerships

Across Michigan, many hundreds of thousands of acres of land are preserved and managed through systems of land trusts and conservancies as well as the evolving network of lands preserved as part of county and township natural areas programs. This network of land organizations has a rich history in the state, and is a currently untapped resource. A goal for the school should be securing joint-management solutions, particularly within the third-tier region.

5) Stewardship Initiatives
There exists an opportunity to employ a volunteer stewardship model to help keep watch over the properties, as well as host programming, disseminate information, and act as liaisons to the SEAS Facilities office. Through the use of local volunteers, our properties could see much untapped potential, and would be better positioned in the future in terms of both management, education, and participation.

6) Property Management, Funding, and Staffing
There is a significant need for permanent staff to oversee and manage the SEAS properties. This issue is of foremost importance, as many properties have presently succumbed to varying states of overgrowth and underutilization. Establishing a SEAS Properties Committee and fund, hiring a SEAS Properties Manager, Community Outreach and Volunteer Coordinator, and additional student caretakers would provide the needed oversight for all land management activities on the properties.

7) Research Database
All available data related to the SEAS properties should be uploaded to MField, a recently developed research and data hub for all U-M field properties to increase accessibility and awareness of past research, assist with current and future studies, courses, and property management, and also enable analyses of long-term spatial and temporal patterns.

8) Increased Awareness and Engagement
One of the biggest challenges when it comes to the SEAS properties is the lack of awareness among both the faculty and the student body. To address this issue, SEAS needs to develop new ways to actively promote the properties to faculty, students, and others, including through presentations, site tours, and the creation of a new website and social media accounts.

9) Future Master's Projects
Four additional master's projects are proposed that highlight areas of additional potential and need within the properties. These projects cover the topics of sustainable energy development, St. Pierre community engagement, Saginaw Forest restoration, and drone based biomass estimation.

Finally, for each property, past and present land use and management strategies were also examined to better inform recommendations for the future. This approach aided in the development of the larger visioning framework for the master's project - a collaborative model built on interdisciplinary methodology. Looking forward, the project team hopes that these recommendations will help better connect SEAS with associated stakeholders and community partners, putting into practice the ideals of our larger management vision established for all the properties.

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I. INTRODUCTION

The University of Michigan's School for Natural Resources and the Environment was renamed to the School for Environment and Sustainability (SEAS) starting in 2017. The change in name reflects the school's mission to tackle the diverse needs of the environment and sustainability through an interdisciplinary approach. The school's mission focuses on "the protection of the Earth's resources and the achievement of a sustainable society. Through research, teaching, and outreach, faculty, staff and students are devoted to generating knowledge and developing policies, techniques, and skills to help practitioners manage and conserve natural and environmental resources to meet the full range of human needs on a sustainable basis." Part of the school's potential to generate knowledge, train practitioners, develop policies, and engage in community outreach comes from the resources and opportunities provided by off-campus field research properties.

SEAS currently owns 1,761 acres across six individual properties in Southeastern Michigan, including Saginaw Forest, Stinchfield Woods, Newcomb Tract, St. Pierre Wetland, Ringwood Forest, and Harper Preserve. These natural areas accompany various other satellite properties owned by other University departments, existing as part of a broad patchwork of preserved property across northern, central, and southern Michigan. While rich in educational and sustainable potential needed to fulfill the mission of SEAS, these properties currently lack a cohesive management plan or integrative framework. Additionally, they are without a comprehensive plan for future protection, uses, and development. The diverse array of habitats across the sites and vast networks of local and regional stakeholders present a unique opportunity to reexamine the goals and management plans for these properties and to further demonstrate the university's commitment to land preservation, sustainable stewardship, and carbon neutrality. In this context, the project team hopes to redefine the role of these natural areas for SEAS, the University, and the larger community..

Many other American universities maintain systems of managed land, ranging from small-scale endeavors to broad networks encompassing many thousands of acres. These collegiate systems can serve as a guide in developing creative approaches to SEAS' unique properties, as well as management strategies that the University of Michigan can adapt and utilize. Additionally, surrounding these properties exists a vast, interconnected web of stakeholders, composed of faculty, alumni, land trusts, local governments, and local residents, all of whom harbor significant investment in this currently underutilized land system. These stakeholders, in addition to participating in property utilization and stewardship, have produced many related bodies of work over time, ranging from management plans to GIS analyses of many of the properties. In this current state of affairs, a concentrated effort is needed to synthesize all related sources of information, creating connections between all parties with a current stake in the natural lands owned by the university in order to arrive at a responsible, integrative, and future-minded set of recommendations.

II. PROPERTY BACKGROUNDS

- **Saginaw Forest** is the closest of the SEAS properties, located just 4 miles west of Central Campus in Scio Township. The 80-acre forested property was originally purchased in 1903 as a forestry demonstration site. The property had a history of agricultural use and was planted as a forest with unique blocks of trees beginning in 1904. Saginaw Forest encompasses Third Sister Lake, a 10-acre kettle lake. The property is open to public use with a system of trails for walking. It is also the location of the annual SEAS campfire (a tradition that dates back to 1906). Saginaw is a past and current site of teaching and research for the faculty and students of SEAS, other University of Michigan departments, and other Universities. The property resources include a caretakers' cottage and barn. There is currently no caretaker on the premises and the caretaker cottage is in need of updates before it can be used again. It is surrounded by institutional, commercial, residential, and agricultural land use, with increasing development.

- **Stinchfield Woods** is the largest of the SEAS properties at 777 acres. It is located 13 miles northwest of Ann Arbor. The property consists of 300 acres of planted conifers in addition to large tracts of native oak-hickory forests. It is open to the public with large amounts of recreational use in the forms of hiking, bird watching, and other public engagement. Additionally, Stinchfield is used as a teaching and research site by faculty and students throughout the university. The property resources include a caretaker house that is currently in use, two vacant observatory buildings, and a radio tower, as Stinchfield contains the highest point in Washtenaw county.

- **Newcomb Tract** is a 247-acre forested property, 17 miles northwest of Ann Arbor. Baseline Lake makes up the northern boundary of the property and the Huron River establishes the western boundary. The property also contains a small 3-acre lake. Newcomb is a research property that is closed to the public. The property consists of large planted conifer tracts, planted by the School of Forestry in 1950. Additionally, there are large patches of native oak-hickory forest. Facilities include a storage barn for SEAS research equipment. There is also a caretaker house on the grounds, although there is not currently a caretaker on the premises and the house is currently not habitable. Repair or replacement of the house would be necessary before a resident could be housed there. There is a canoe portage site on the western edge of the property, providing continued river access past an electrical dam on the Huron River.

- **St. Pierre Wetland** is a 130-acre wetland property on Bass Lake 19 miles northwest of Ann Arbor. The property is surrounded by residential properties. The property is closed to the public and is used as a research and teaching property in aquatic and resource ecology. The property consists of lowland marsh and open water wetland. There are no facilities on the property, but residential docks allow for boat access to the wetland. The Lakelands Trail borders the northern edge of the property.

- **Harper Preserve** is a 375-acre agricultural property in Argentine Township, 43 miles north of Ann Arbor. The property contains Murray Lake (a 40-acre lake), 80 acres of conventional cropland, oak-hickory forest, marshland, and old fields in transition to forest. The farm is currently under a private lease for farming in a corn-soy rotation by Wolverton Farms. This property is not open to the public but could potentially be used for teaching and research.

- **Ringwood Forest** is a 160-acre forested property in Saginaw county 93 miles northwest of Ann Arbor. The forest consists of a variety of conifer plantations and second-growth hardwoods. The south fork of the Bad River flows through the property. The forest has a history of research use but is currently a public use property. Ringwood Forest is leased to Saginaw County Parks and managed as a public park. The park system provides a series of trails through the property, parking lot access, a canoe launch, play structure, and pavilion.

III. OVERARCHING VISION FOR SEAS PROPERTIES

At their outset, many of the sites were originally used for forestry demonstrations. As the university has progressed away from forestry and timber focuses over the past several decades, these properties now require new multidisciplinary purposes in line with the focuses of the school's progressing academic goals. Presently, these goals largely revolve around the need for a holistic vision for these properties that fit into the larger context of its function as a school, community, and practitioner of ecology. This vision needs to come in the form of an overarching framework that encompasses current action plans, while also considering future use cases for the properties. In addition, this framework needs to recognize the unique opportunities and challenges associated with each property, as well as incorporate a geospatial database to better inform potential research uses. Finally, these future goals must be financially sustainable for the school, ensuring long-term implementation and success.

In light of these considerations, the project team has outlined the following nine overarching goals in conjunction with our work over the past three semesters. Particularly, we highlight overlaps between initial project goals and collected data, as well as broader-scale structures which could see further development in the future.

A. LAND ACKNOWLEDGMENT

The creation of a formal statement officially acknowledging the original land acquisitions and tribal histories of the six SEAS properties is paramount. The land acknowledgment statement and related information should be included in all public communications regarding the properties, including signage, published materials, and presentations. It is also important for SEAS to reach out to the specific tribal groups, including the Saginaw Chippewa and Potawatomi, who have past associations with the properties as a way to build relationships and form possible collaborative and mutually beneficial partnerships.

B. CARBON NEUTRALITY

In February 2019, President Mark Schlissel announced the creation of a commission (http://sustainability.umich.edu/carbonneutrality) to develop scalable recommendations and strategies that would allow the University of Michigan to reach its determined goal of carbon neutrality. The University has declared carbon neutrality a major goal for itself moving forward. The goal of carbon neutrality extends to all University of Michigan campuses (Ann Arbor, Dearborn, and Flint) as well as Michigan Medicine. The scope of the president's charge encompasses carbon emissions, sequestration, energy sourcing, technology development, policy change, physical facilities, and behavioral change. Moreover, the recommendations of the commission must be environmentally sustainable, financially responsible, and require participation and accountability across the university community. This charge also aligns with the city of Ann Arbor's carbon neutrality goal. Ann Arbor has declared its intent to be carbon neutral by 2030 (A2Zero, 2020).

The President's Commission on Carbon Neutrality consists of a multidisciplinary approach to problem solving. The commission is further broken down into analysis groups. There are external analysis teams that are examining building efficiencies and power infrastructure. These external teams consist of contracted external firms. In addition, there are internal analysis teams set up to examine University land use and biosequestration, food, commuting, campus culture, building standards, travel, collaboration, and energy consumption. These internal teams are populated by University faculty leads, graduate, and undergraduate research assistants. For both the internal and external project teams, there are key subtopics that must be addressed. These subtopics include carbon offsets, carbon accounting, climate justice, energy purchasing, and electrification of vehicle fleets.

The internal bioquestration team has partnered with the *Creating a Vision for SEAS Properties* master's project. Two of our team members, Cyrus Van Haitsma and Lara O'Brien, have joined this team as graduate student research assistants. This team has been specifically tasked with creating an inventory of University land holdings, calculating the carbon sequestration potential of these properties based on each land cover, and developing a set of recommendations for the Commission on Carbon Neutrality to curate and send to the President and Board of Regents. The work that was done by this project served as a jumping off point for the internal analysis team. The SEAS team assisted with creating land use and land cover (LULC) maps, estimating carbon storage/sequestration potential, and provided most of the data regarding the SEAS properties.

Creating a Vision for SEAS Properties began exploring the possibility of measuring stored carbon within the school's properties as a way to give monetary value to the properties. Expanded involvement, management, and community engagement with the properties requires an increase in funds that extend past the properties operating budget. As the University of Michigan works towards achieving carbon neutrality, offsetting its carbon emissions will become necessary. It is our group's hope that understanding the carbon storage and sequestration resources on each property will demonstrate an economic value to the University of Michigan and a consideration for future management options.

In evaluating the value of each property based on carbon pricing, it is important to distinguish between carbon stored and carbon sequestered. Carbon storage is the total amount of carbon stored in some type of reservoir. In forests this primarily consists of carbon stored in above and below ground woody material and the organic components of the soil. In wetlands, the majority of storage is in the deep organic layer of soil. The stored carbon within our properties can be estimated through a mixture of field data, Natural Resources Conservation Service (NRCS) soil data, and available GIS imagery. Carbon sequestration is the rate of carbon added or lost from the storage reservoir over a time period. The important distinction is the time step needed to create the rate of sequestration. Sequestration rates are the values used in carbon offset markets, because they have comparable units to carbon emissions. Carbon dioxide emitted in one year can be offset by the carbon sequestered in a managed property in that same year, so long as the sequestration that occurs is additional to the baseline rate of sequestration at the property if there was no management. This concept of additionality assures that carbon emissions are properly accounted for, and requires the University to invest in improved management of its field properties. The time component of sequestration adds to its difficulty in estimation. In order to estimate sequestration, there needs to be repeated estimates of carbon storage at permanent plots every year. Each year there is data, a rate of sequestration that can be calculated by taking the difference in carbon between the two years. However, our master's project only spanned one field season, so no rate data can be derived from our initial estimates of stored carbon. Instead, carbon sequestration rates were estimated through the minimum and maximum published rates in the Great Lakes region.

Because of the limited duration of our master's project, sequestration rates for the properties were estimated from a range of high and low literature values based on ecosystem type. The team found published sequestration values for deciduous forest, coniferous forest, wetlands, and herbaceous cover from the Great Lakes region (Table A-1). The highest and lowest published carbon sequestration rates for each cover type were then used to calculate an estimated range of carbon sequestration rates for each property (Table A-2 ; Curtis et al., 2002; Froelich et al., 2015; Gahagan et al., 2015; Bernal & Mitsch, 2012; Khalil et al., 2020). These were calculated using data from the National Wetlands Inventory (USFWS, 2018) for forested and emergent wetlands data, which were overlaid onto the LULC maps developed by the team for each property (See Appendix A). The team hopes that these calculations will give the School an idea of the current value of the properties in terms of the value of carbon sequestration ongoing at each property, and open the possibility of beginning management of the properties, so that additional carbon sequestration gained through management can be sold to the University as carbon offsets.

In order to connect carbon storage of the properties to a dollar value, three carbon pricing schemes were evaluated. First, the properties were assigned values based on the pricing models for the social cost of carbon from Hungate et al (2017). The social cost of carbon is the total economic harm derived from emitting one ton of carbon dioxide. This model contains a low value of $42, a median value of $137, and a high value of $400 per ton of carbon dioxide. Second, the properties' value were estimated using the International Monetary Fund (IMF, 2019) pricing model. The value of one ton of emitted carbon dioxide

from this model is estimated at $75. This value represents the cost of emitting carbon needed to sufficiently reduce demand on carbon in order to stay below 2◦C global temperature rise. Third, the properties' sequestered carbon was given value based on the current market value of one ton of carbon dioxide based on the current price from California's carbon market. California is currently the only state to have a real carbon market. This was the lowest value at $15 per ton of emitted carbon dioxide (Greenstone & Nath, 2019). This value is the only value that shows what people are actually willing to pay for carbon today, with the other models being estimates of future costs. The properties are ultimately assigned value based on the current market rate dictated by the California market. However, the other models are useful in capturing and estimating the total economic value of the ecosystem service of carbon capture provided the properties. The following figures highlight the range of values within the SEAS properties. Individual property values can be found within the Individual Property Resources and Recommendations section.

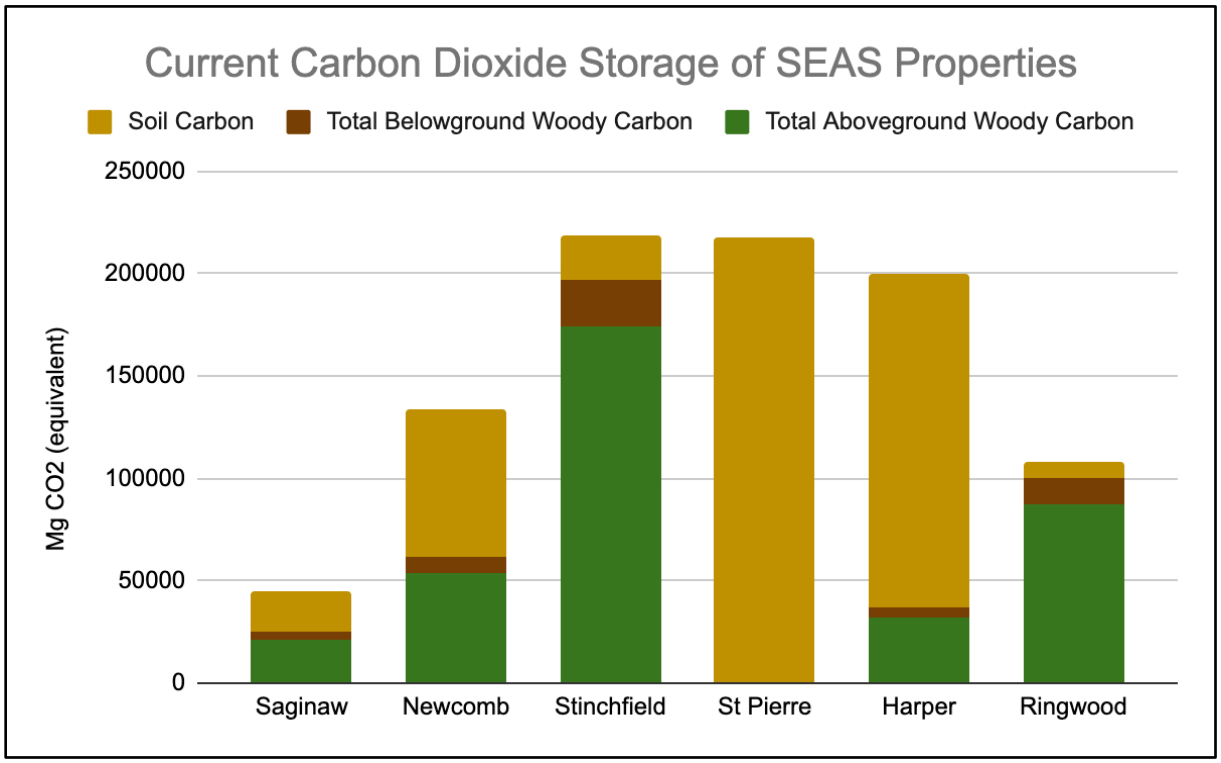


Figure 3-1. Value of stored carbon across all six SEAS properties (USD).

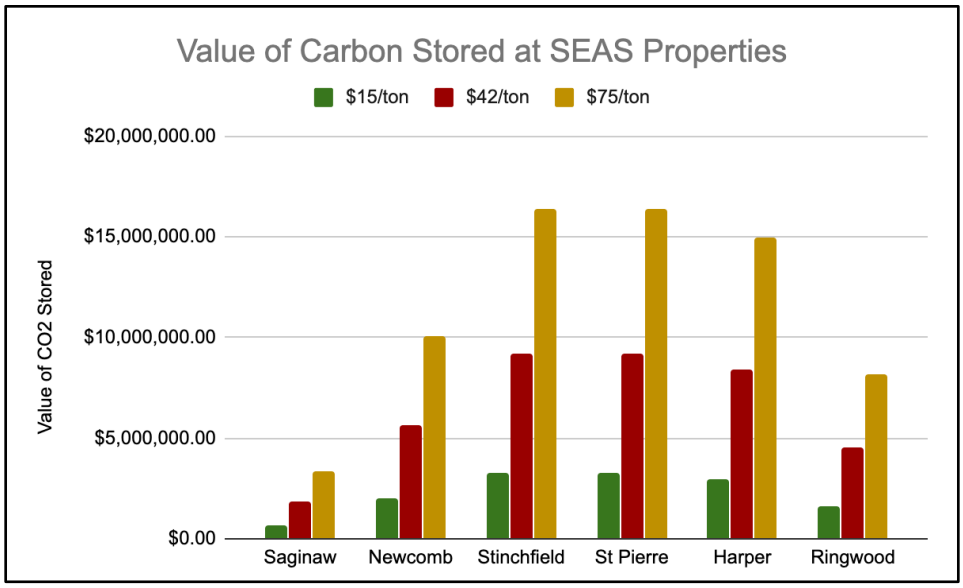


Figure 3-2. Total carbon storage across all six SEAS properties (Mg CO2).

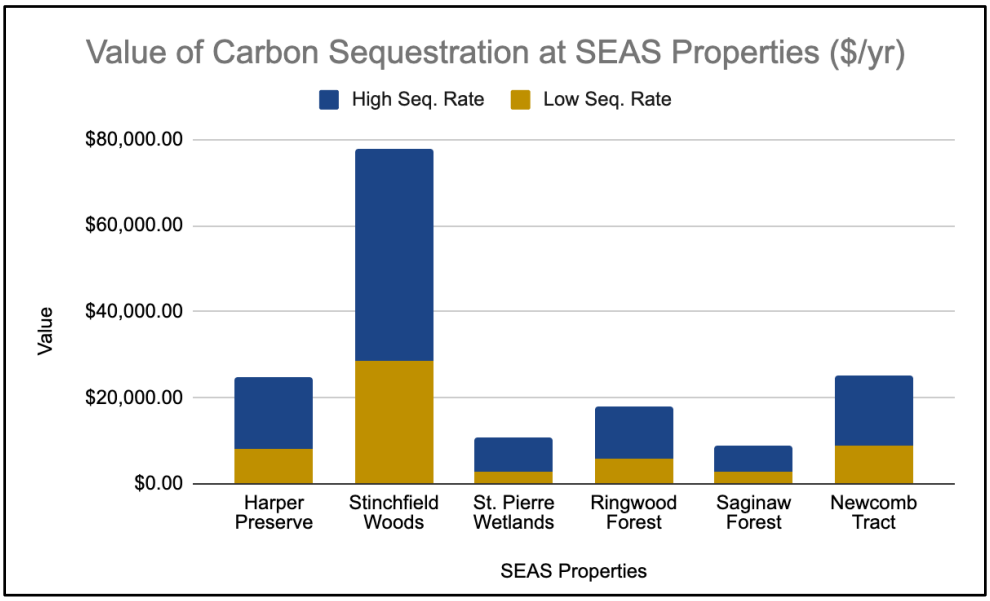


Figure 3-3. Value of carbon sequestration per year at each of the SEAS properties, at $15/metric ton CO_2.

Biosequestration is not the only use of the SEAS properties that aligns with the University of Michigan's goal for carbon neutrality. Within the properties, there are several potential sites for solar farm implementations. The creation of solar energy fields at SEAS properties not only reduces carbon emissions, but it will further help create a source of revenue that may be used to manage the properties. Additionally, the properties hold a wide assortment of buildings and structures that could serve as demonstration sites for sustainable building techniques. We recommend future SEAS master's teams with greater expertise in renewable energy systems and sustainable building techniques examine the properties' potential.

This team recommends that long-term recording plots be established within the properties in order to establish carbon sequestration values for the SEAS' properties. These plots could be set up with the goal of also monitoring ecological change and serving as research sites for the new Institute for Global Change Biology. Research could focus on ways in which to augment the amount of carbon sequestered as a function of each land-cover type, and thus serve as potential carbon offsets in addition to what is already being sequestered naturally. Long term monitoring of the sequestration will also be important in total carbon accounting for the University of Michigan in its goal of carbon neutrality. Poorly managed and degrading forests can transition from a carbon sink to a carbon source (Zhang et al., 2015). Similarly, peat-dominated wetlands such as at St. Pierre can also become a source of carbon to the atmosphere if tree and shrub invasion dries out the soils sufficiently that they begin to oxidize (Kayranli et al., 2009). It is with this knowledge, that our team also recommends the creation of best management practices for the management of SEAS properties. These practices could then be funded through money derived from the value of sequestered carbon at the properties and through funds raised by the sale of energy derived from solar installations at the properties.

Finally, an additional tool to assist long term data collection at the properties is the inclusion of weather and/or aquatic monitoring stations at each site. These stations would be a relatively simple way for SEAS to increase the research potential of each property for faculty and students, and would pair well with current long-term collection efforts. The equipment could be cared for by property caretakers (especially should they be reintroduced at Saginaw Forest and Newcomb Tract), local partners and collaborators, the SEAS Facilities Manager, or faculty that regularly visit the property for research purposes. Having long-term data available for specific locations is extremely valuable for ecological studies, and would significantly increase buy-in for academic research at each site. Additionally, this data could be stored in the new MField database so that it is easily accessible to both faculty and student researchers. A weather station would cost between ~$250-$8,000, and an aquatic monitoring station costs between ~$1000-$10,000. The equipment could be purchased through grants, or through funds available to the new Institute for Global Change Biology. As SEAS begins to develop and expand its interdisciplinary curriculum, supplementing field research with long-term data would exponentially boost the "research capital" at the school's disposal.

C. MANAGEMENT TIERS

The SEAS properties currently exist as independent properties owned and operated solely by SEAS. These properties exist across a large area of Southeast Michigan (Fig. 3-4) and encompass different levels of public use, research use, and partnerships in management. Additionally, the properties exist in a larger network of university land holdings. Within Southeast Michigan, the University of Michigan holds natural area properties through SEAS, Ecology and Evolutionary Biology (EEB), Matthaei Botanical Gardens and Nichols Arboretum, and the University Real Estate Office (Fig. 3-5). Each landowner has different management priorities and resources. These diverse land holdings offer the potential for partnership in managing and funding properties for educational, recreational, and research

uses. Recently SEAS has teamed with Matthaei Botanical Gardens and Nichols Arboretum, the Biostation, and the E.S. George Reserve to create a common digital platform called "MField" (mfield.umich.edu) for compiling and sharing research and teaching information about the University's field properties. This type of collaboration shows promise for other activities as well.

The varying university properties exist with varying accessibility and use cases. There are several properties that receive heavy use due to proximity to campus and Ann Arbor. There are other properties that have little university use due to large distances from campus and restricted public access. In talking with professors within SEAS, a leading determinant in the use of a property for field teaching is the ability to travel to a property within a window of a several hour class laboratory period. The varying distances establish different tiers of use for the University. To best manage for unique needs and uses across the network of properties, the properties need to be evaluated and managed based on a tiered use approach. University owned natural properties could be broken down into three management tiers. The first tier would consist of properties within Ann Arbor. The second tier would be properties that exist within a 30 - 45 minute drive from Ann Arbor (the limit of travel for class use). The final tier of properties would exist past a 45 minute drive from campus. The tiered system could pool and focus resources to properties that have similar needs and uses.

- **Property Tier 1:** The first tier of properties would consist of Nichols Arboretum, Matthaei Botanical Gardens, Horner/McLaughlin Woods, and Saginaw Forest. All of the properties are within the City of Ann Arbor, Ann Arbor Township, Superior Township, or Scio Township and all are open to the public. All of these properties have a history of research use, while maintaining publicly open trails year round. There is large community interest and involvement in these properties due to their access and availability to the Ann Arbor community and university community. These high use properties would require the greatest pool of resources and staffing to maintain desired use for a large community of needs. Management of the Botanical Garden and Arboretum properties already exists through the natural areas division of the Matthaei-Nichols organization, although to extend this management to additional sites would require new resources.

- **Property Tier 2:** The second tier of properties would create a network of mixed-use properties among Stinchfield Woods, the Newcomb Tract, St. Pierre Wetland, Mud Lake Bog (managed by MBGNA), and the ES George Reserve (managed by EEB). Of this tier, only Stinchfield is publicly open for recreational use. The other four properties are closed research use properties. The maintenance and goals of these properties are shared among SEAS, MBGNA, and EEB. EEB currently employs a caretaker at the ES George Reserve and SEAS utilizes a student caretaker at Stinchfield. By pooling funds, or creating more revenue through the implementation and sale of solar across the properties, a joint management team could be formed. This management team would specialize in the care of tier two properties.

- **Property Tier 3:** The final tier of properties would include the Harper Preserve and Ringwood Forest. The third tier of properties could look to Ringwood Forest as an example for management. The management partnership established between SEAS and Saginaw County Parks allows for the maintenance of facilities and trails at Ringwood Forest (a property that has minimal use and access by the University of Michigan community). Seeking out management partners will be key to ensuring that the far away, lesser-utilized properties are taken care of and maintained (see Section C). Partnerships are essential in maintaining these properties, because of the restricted access of use created by large travel times for university staffing. These partnerships could come from local land conservancies, park departments or local natural areas programs, or other universities and other campuses of the University of Michigan such as U-M-Flint.

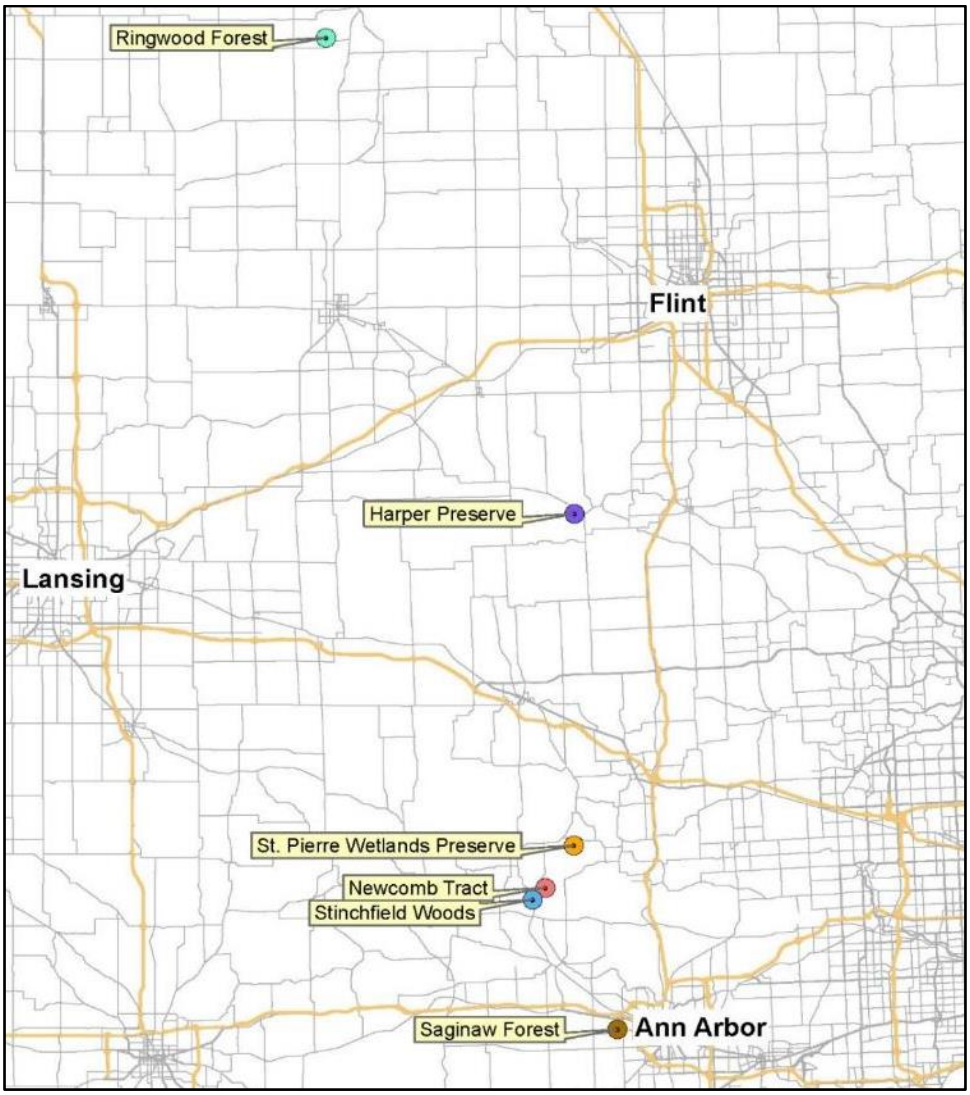


Figure 3-4. The six SEAS off-campus field research properties (Source: SNRE Properties Committee Presentation to Faculty 2016 - see supplementary files).

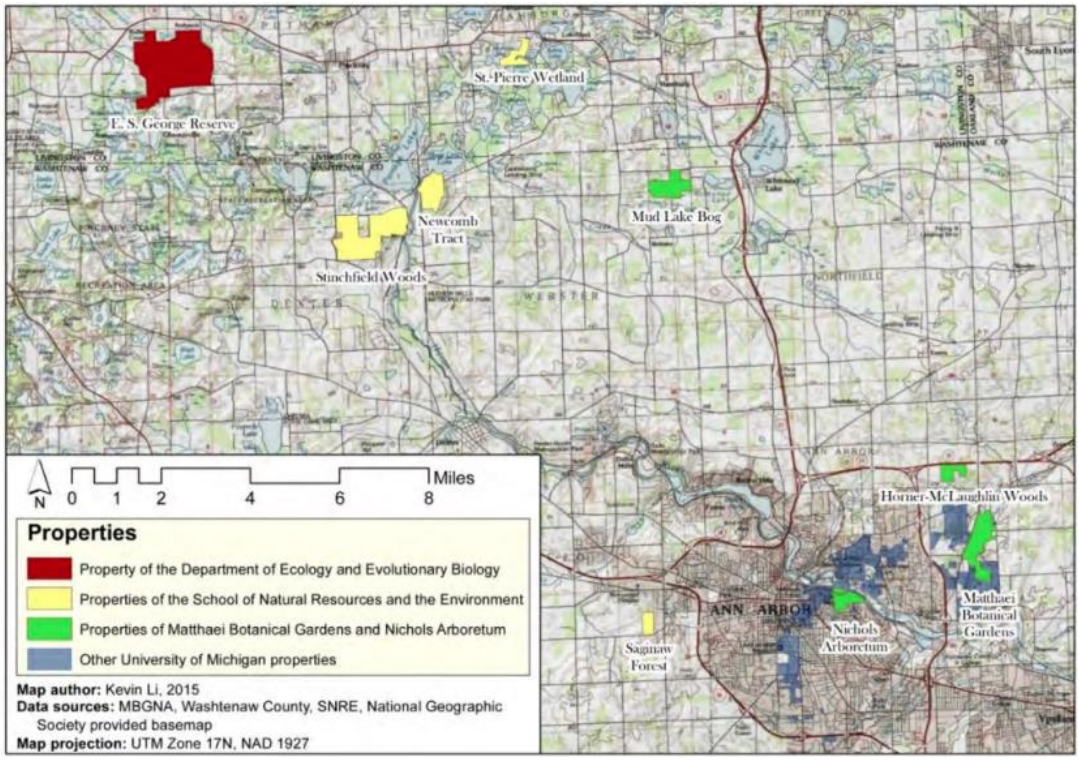


Figure 3-5. SEAS (formally SNRE), Matthaei-Nichols, and E.S. George Reserve Properties.

D. COLLABORATIVE LAND MANAGEMENT PARTNERSHIPS

Broadly across Michigan, many hundreds of thousands of acres of land are preserved and managed through systems of land trusts and conservancies as well as the evolving network of lands preserved as part of county and township natural areas programs. This network of land organizations has a rich history in the state, and is a currently untapped resource which could completely change and alter the state of SEAS property management. Over the coming semesters, a goal for the school should be securing joint-management solutions, particularly within the third-tier region (as outlined in the preceding section).

Collaboration with these land conservancies and local units of government will be paramount for the promotion, usage, and protection of the properties. Insights from land trust professionals over the past year have given the project team many ideas for how to best position our properties in regards to joint-management efforts, and will be important considerations going forward. Particularly, the carbon sequestration and storage data for each property (detailed throughout this report, but developed further via U-M research, see above) will essentially become “bargaining chips” for land trust co-management; these numbers are public-facing tools to help leverage buy-in for stakeholders, and are positive messages for both the university at large and the mission of land agencies. Ringwood Forest is a clear example of this type of management approach, serving as a practical and promising model for our other public-use properties. Herein exists an auspicious avenue for partnership - one that the school could see long-term benefits from in the future.

In addition, the management of these six properties stands to gain from the insights of other US universities that manage systems of land, particularly those with similar land management models (e.g., Duke, Cornell, University of Georgia, etc.). While many universities oversee many thousands of acres of land, many others manage acreage closer to that of SEAS, and share the same experimental focus towards sustainability. Over the course of the coming academic years, a concerted effort to reach out to these schools should be a focus; information regarding goals, management objectives, and other considerations can be sourced from staff, procuring tactics for both staff and student uses of the properties.

E. STEWARDSHIP INITIATIVES

At the three public-use properties (Saginaw Forest, Stinchfield Woods, and Ringwood Forest), there exists an opportunity to employ a volunteer stewardship model to help keep watch over the properties, as well as host programming, disseminate information, and act as liaisons to the SEAS Facilities office. This approach was confirmed through our social research methods, and reflects public support from those members of the public living near or frequently using the properties. Through the use of local volunteers, our properties could see much untapped potential, and would be better positioned in the future in terms of both management, education, and participation.

Many local residents have spent decades at the properties open to public use, and have cultivated significant emotional investment in our natural areas. Likewise, a fair amount of SEAS students across all disciplines have an interest in public land management, and additionally come from a background of environmental education and public participation. In this light, the development of a stewardship program at these locations would have significant buy-in at its outset - a promising beginning to a potentially successful initiative.

In creating a program of this sort, several overarching considerations need to be taken into account. First and foremost, the school would still maintain control of all management decisions, and would be responsible for disseminating information to all stewardship teams. Secondly, the issue of liability will be a consistent topic to keep salient, as any issues that arise at the properties would need to be processed through the SEAS Facilities office. In the case of any program, this factor would need to remain at the forefront of the planning process, and would have to be considered at each step of the planning process.

Within this type of stewardship initiative, there exist three arenas for involvement: student, faculty, and public. Below, we will detail the key potentials for each:

Faculty: In this context, faculty could be particularly helpful in planning and contributing to the success of a stewardship program, especially those who might have pre-existing ties to research at a particular property. While this would largely be a student and staff-led effort, there exists a wonderful opportunity for faculty to become visible in local citizen science efforts, and could become involved with leading or contributing to activities, restoration efforts, and other programming at the properties (should resources and timing

allow). As the university is widely respected in the communities surrounding the properties, there is considerable public interest in learning from our own instructors.

Student: A stewardship program would thrive from student involvement, especially outside of property caretakers. Aside from research responsibilities at the properties, both undergraduate and master's students could apply to be a property steward (likely only at Saginaw Forest and Stinchfield Woods due to distance). These students would be integral for leading programming and volunteer work days, and could gain valuable experience in environmental education, public participation, and interpretive practices. Such experiences would not only be rewarding to the students involved but useful from a career perspective much like the National Wildlife Federation's Eco-Leader program (https://www.nwf.org/ecoleaders). If compensation was to be involved, funds could be set aside by the SEAS Properties Manager, perhaps in the form of work-study or a related position. These positions could also become "named positions" funded through endowment funds.

Public: The success of any stewardship initiative would be determined by the number and quality of volunteers from outside the university. Due to the academic commitments of faculty and students, the majority of stewardship action would be sourced from public participation, and would be the core driver of future involvement. Directly overseen by the SEAS Properties Manager, these volunteers would disseminate the majority of the program to other public users, and would be a core asset throughout the life of the initiative.

Proper training and education through SEAS would be required to become a property steward, and could be as simple as attending a few workshops held at each respective property run by the SEAS Properties Manager and associated faculty/student volunteers. Property stewards could be identified through some sort of "uniform" (e.g., hat, nametag, jacket, etc.), and might commit to walking the property for a certain amount of hours each month. At the close of their monthly rounds, each steward could also turn in a short written report detailing observations and interactions to the SEAS Facilities department. Additionally, while these stewards would by no means be asked to put themselves in a potentially contentious situation with other public users, they could be empowered to respectfully ask property visitors to follow posted rules, and would report any violations to the SEAS Properties Manager or university police department.

Supplies for volunteer work days could easily be stored in pre-existing structures at both Saginaw Forest and Stinchfield Woods, and could be left under the care of both university staff and student caretakers. Additionally, flyers and informational brochures could be stored both on-site at the properties, as well as in informational kiosks in the Dana Building, the 2|42 Community Center lobby (annarbor.242communitycenter.com/ - located in the 2|42 Community Church, which has partnered with SEAS to increase access and parking for Saginaw Forest), communal areas in local housing cooperatives, and other public-facing areas in proximity of those who might be interested.
In terms of sourcing volunteers, residents in the housing cooperatives surrounding Saginaw Forest as well as attendees of 2|42 Community Church have expressed extreme interest in volunteering, as have former members of the Friends of Stinchfield, a volunteer

group of stakeholders at Stinchfield Woods that was formed by a former caretaker. At Ringwood Forest, any stewardship initiatives would be designed and overseen by Saginaw County Parks, but could potentially see university involvement from other university campuses (e.g., U-M Flint). Additionally, there are many overlaps with (and past communications involving) organizations such as the Huron River Watershed Council (www.hrwc.org/) and the Huron Arbor Cluster of The Stewardship Network (www.stewardshipnetwork.org/communities/huron-arbor-cluster), both of which have proposed similar local stewardship models. These organizations could help immensely with recruiting, and would be incredible partners in any related efforts more broadly. It will be essential to bring them on board in the future should these options gain traction.

F. PROPERTY MANAGEMENT, FUNDING, AND STAFFING

Currently, there is a significant need for permanent staff to oversee and manage properties. This issue is of foremost importance, as many properties have presently succumbed to varying states of overgrowth and underutilization, and currently see consistent trouble with vandalism and trespassing. In order to fully utilize the properties as resources for the university and the communities they serve, a concerted effort to place any measure of university oversight at these natural areas will be paramount in the coming academic years.

SEAS Properties Committee and Fund: To provide effective oversight for the use and management of the properties, it is recommended that efforts be made to reestablish the SEAS Properties Committee with positions held by faculty, staff, and students (including student caretakers).

A SEAS Properties Fund should also be created and managed by the SEAS Properties Committee. The SEAS Properties fund could be supported by carbon sequestration and renewable energy generation as mentioned above. A fund would further enable direct donations to be provided to help fund general management and maintenance costs for all of the SEAS properties. Donors should also be given the option to fund a specific property, project, or activity, such as constructing a new caretaker residence at Stinchfield or a stream restoration project at Saginaw.

Student Caretaker Positions: In the past, several properties which used to have student caretaker programs (Saginaw Forest and Newcomb Tract) have seen housing units fall into disrepair, lessening university presence and oversight. When these caretaker positions were in place, they provided valuable insight and monitoring data, and helped foster positive relationships between public users, SEAS, and the university at large. However, all caretaker living areas (save for Stinchfield Woods) have fallen into disrepair, and are in need of serious attention should they be livable for future students. In this regard, repairs and investment (either in the form of future masters projects, grant-funded studies, or otherwise) should be undertaken as soon as possible at Saginaw Forest and Newcomb Tract in order to place a primary focus back on property upkeep, monitoring, and outreach. Additionally, this will provide affordable living arrangements for new students, and create

opportunities for new student applicants to apply previously acquired experience in land management during the course of their graduate studies.

Permanent Staffing: Creation of a SEAS Properties Manager position is suggested to provide the needed oversight for all land management activities on the properties. This position would include working closely with student caretakers and any members of collaborative land management partnerships and land stewardship programs.

A staff position should also be created to help oversee all aspects of communication and community outreach related to the SEAS properties. Responsibilities would include organizing and coordinating all public events and activities on the properties, including volunteer workdays and community workshops. This staff member would also help build and maintain connections with faculty, students, and researchers from across the University of Michigan, as well as from other institutions and organizations. This position would also include actively promoting the properties through the development and curation of social media accounts and new SEAS Properties website (See Section H).

G. RESEARCH DATABASE

With research on some SEAS properties going back to the early 1900's, an incredible amount of research and data has been amassed over the years. To make this data more accessible to faculty, students, and researchers, available reports, publications, and datasets, including field data and geospatial data, should be uploaded to MField, a recently developed research and data hub for all U-M field properties (https://mfield.umich.edu//). Compiling this data in a comprehensive database will help increase awareness of past research, assist with current and future studies, courses, and property management, and also enable analyses of long-term spatial and temporal patterns and trends.

H. INCREASED AWARENESS AND ENGAGEMENT

One of the biggest challenges when it comes to the SEAS properties is the lack of awareness among both the faculty and the student body. To address this issue, the SEAS Properties Committee, working in collaboration with SEAS Facilities, Communications, and Development staff, should develop new ways to actively promote the SEAS properties to faculty, students, and others, including through presentations, site tours, and the creation of a new website and social media accounts.

Every fall, a presentation can be held during orientation week to help introduce new faculty and students to the properties, including possible ways to incorporate these living laboratories into their research and/or field-based courses. Site tours could be arranged at this time and virtual tours of the properties could also be provided through the use of aerial imagery and footage from drone flights conducted over each of the properties.

The main SEAS website does include information about the off-campus field research properties (https://seas.umich.edu/research/field_research_sites), however, it is difficult to find and is neither comprehensive nor up-to-date. To really highlight and showcase the properties, a new SEAS Properties website, similar to that run by Matthaei Botanical Gardens and Nichols Arboretum (https://mbgna.umich.edu/), should be created. This website would feature helpful information about the properties, including site descriptions, directions, parking information, updated trail maps, Story Maps, and more. The website would also have links to MField and past and present research and field courses.

A new website would also be useful to help build and strengthen relationships with the larger community and increase engagement for the properties that are open to the public. For example, information about upcoming events and activities could be regularly posted, including volunteer workdays, workshops, guided tours and lectures, and other public learning opportunities. Stories or reports about research or student class projects related to the properties could be shared here. The website could also have links to student caretaker blogs, new social media accounts featuring photos and information about the properties, and websites for community groups and organizations that utilize the properties, including Friends of Stinchfield Woods, 2|42 Community Church, and Washtenaw Audubon Society. Links could also be provided for those interested in volunteering or making a donation.

I. FUTURE MASTER'S PROJECTS

The scope of a one-year master's project does not lend itself to developing a comprehensive management plan and vision for each of the six unique properties. Our team had to impose a specific scope and focus for our project based on team member expertise and time constraints of a one year project. In light of these inherent limitations, our team has worked to propose several other SEAS master's team projects that will fit within the overarching vision for the properties and the school. All three proposals except biomass estimation were put in place for the 2021 cohort of master's students, with Shannon Brines listed as a faculty advisor. Below, we list potential projects brainstormed by our team, through conversations with faculty and other stakeholders, which could be put in place over the course of the coming academic years, with full proposals for the first three projects and a presentation on preliminary work for project four (see supplemental files).

-Project 1: Sustainable Energy Development

While the current master's project team has interdisciplinary interests and fields of study, there was a lack of sustainable systems expertise. In order to best serve the entire SEAS community, it is important that the properties are utilized by all study programs. Due to the understanding of our groups strengths, we recommend that a future team look into the use of the properties for their sustainable building and energy capabilities. The proposed project would look at the specific opportunities and needs for sustainability at Stinchfield Woods and Newcomb Tract. These two properties offer unique resources to the school

because of their land use, facilities, and proximity to Ann Arbor. Our team recommended a project with three main goals: 1) examine the sustainable restoration, repair, and adaptive reuse of the existing facilities, 2) investigate the potential for the creation of solar energy harvesting or renewable energy demonstrations (primarily at Newcomb, due to the available open land, compared to the primarily forest property of Stinchfield), and 3) engage in community outreach for Stinchfield Woods, including creating interpretive signage and conducting workshops, focus groups, and on-site educational activities. The team could also explore creative options for use of vacant buildings at Stinchfield, perhaps as models of energy efficiency/sustainable building adaptive use.

Additionally, there is a proposed project led by Sucila Fernandes that will focus on the sustainability of SEAS facilities that can tie in with some of our team's goals for the future of the school's properties and their facilities. There is the potential in this project to examine the use of solar energy offsets at Newcomb (or any other SEAS property) in order to offset the energy used by the Dana Building. Combining ideas from both of these proposed projects might lead to interest from future master's project cohorts.

-Project 2: St. Pierre Community Engagement

St. Pierre Wetland would benefit from a future master's project that could build on the existing community interest and partnerships within the Bass Lake/Chain of Lakes region. In addition, this property serves a unique opportunity for the school by being the only undeveloped shoreline on Bass lake. A future management plan for this property would look to enhance educational opportunities at the property, due to the wetland's unique and valuable ecosystem in terms of water quality and wetland habitat. The wetland habitat is ideal for SEAS courses in aquatic ecology, wetland restoration, invasive species ecology, and carbon sequestration. Additionally, educational resources are not limited to formal university classes; there is a large potential for the property to be a hub for community educational efforts focused on care and protection for Great Lakes wetlands and waterways. As the area has high public use and community engagement, this project would provide an excellent opportunity for students to practice communication, education, and outreach activities, such as creating interpretive signage, conducting workshops and focus groups, and leading on-site activities on the ecological and recreational value of wetlands (including invasive species management). Finally, a future team could look to increase accessibility to the underutilized property, as the creation of docks and boat storage could enable year-round access for research, university teaching, and community engagement.

-Project 3: Saginaw Forest Restoration

Saginaw Forest is the most well known property within the school community and it has the potential to be the most utilized property because of its close proximity to the school and Ann Arbor. This property can serve as many student's and faculty's entry point into the use of university properties. This creates a unique opportunity for a master's project team to closely examine and create a future use management plan for the property. This

management plan would focus on the restoration of a badly eroded stream emptying into Third Sister Lake (limited funding is currently available for this project; project might help identify additional sources). In addition to stream restoration, the whole property should be examined for restoration and long term management (including staffing needs). Like other proposed projects, Saginaw would benefit from increasing community engagement efforts and the creation of a stewardship network program. A future project could also examine the sustainable redevelopment of existing facilities along with the development and implementation of other sustainable building and energy projects. This could be a key site for renewable and green technology demonstrations due to its proximity to campus and Ann Arbor. Finally, a future team could explore the past research history of the property and look at ways to continue and expand research capabilities at the property.

-Project 4: Drone-Based Biomass Estimation

Biomass is considered a good measure of ecological status and plant dominance on each property because it reflects the amount of sunlight, water and minerals a plant is able to capture and turn into plant mass. The current master's project team was interested in estimating biomass for each property. We explored the use of drone technology in capturing data useful for biomass estimations for EAS 540 (GIS and Natural Resource Applications) and EAS541 (Remote Sensing) class project (see supplemental files). In practice, due to time limits, we only flew the drone and collected a digital elevation layer for part of Harper Preserve and imported the data into our geodatabase. Estimating above-ground biomass of large-scale sparse coniferous and deciduous forests using unmanned aerial vehicles (UAVs) oblique photography is feasible and effective, especially for specific time series data collection. Due to the understanding of our topic, we highly recommend that a future team work on biomass estimation to do the long-term monitoring of the properties. After collecting elevation data or surface data from the drone, the difference between these two layers is the canopy height data. Next, a future team could construct a time series model to come up with an equation people can use to estimate biomass from Lidar-derived canopy height and density. Biomass estimation is significant to forest/property management and can help assess the value of a site. Lastly, a future group could execute geoprocessing analysis at a deeper level and visualize final results. Such efforts would greatly enhance the use of properties as active laboratories for the evolving Geo-Spatial Data Sciences field of study.

IV. INDIVIDUAL PROPERTY RESOURCES AND RECOMMENDATIONS

In the following sections, we address each of the properties individually, and include interdisciplinary data based on our mixed-method approaches. Specifically, we highlight our carbon sequestration, remote sensing, and social research considerations, and propose individualized, tailored visioning plans and recommendations for each distinct property.

For each property, the following principle research questions guided the majority of our research during the course of this project:

- **Historical Uses:**
  - How were each of the SEAS properties used in the past?
  - What kinds of management strategies were used?

- **Present Uses:**
  - What is the current land cover and land use for each property?
  - How are the sites being managed today?
  - Who are the various stakeholders/interested parties for each property?
  - What are the biggest challenges that need to be addressed for each property?
  - What is the present carbon stock and carbon sequestration rate?

- **Future Uses:**
  - What management strategies are needed to address the current challenges?
  - Who are other potential stakeholders or partners?
  - How can we increase stakeholder and community engagement?
  - How can we increase student and faculty awareness for each site?
  - Are there ways to create revenue to fund property management and educational/recreational activities and opportunities?
  - Are there ways to use the properties for renewable or sustainable energy?
  - What is the potential for carbon sequestration?

A. SAGINAW FOREST

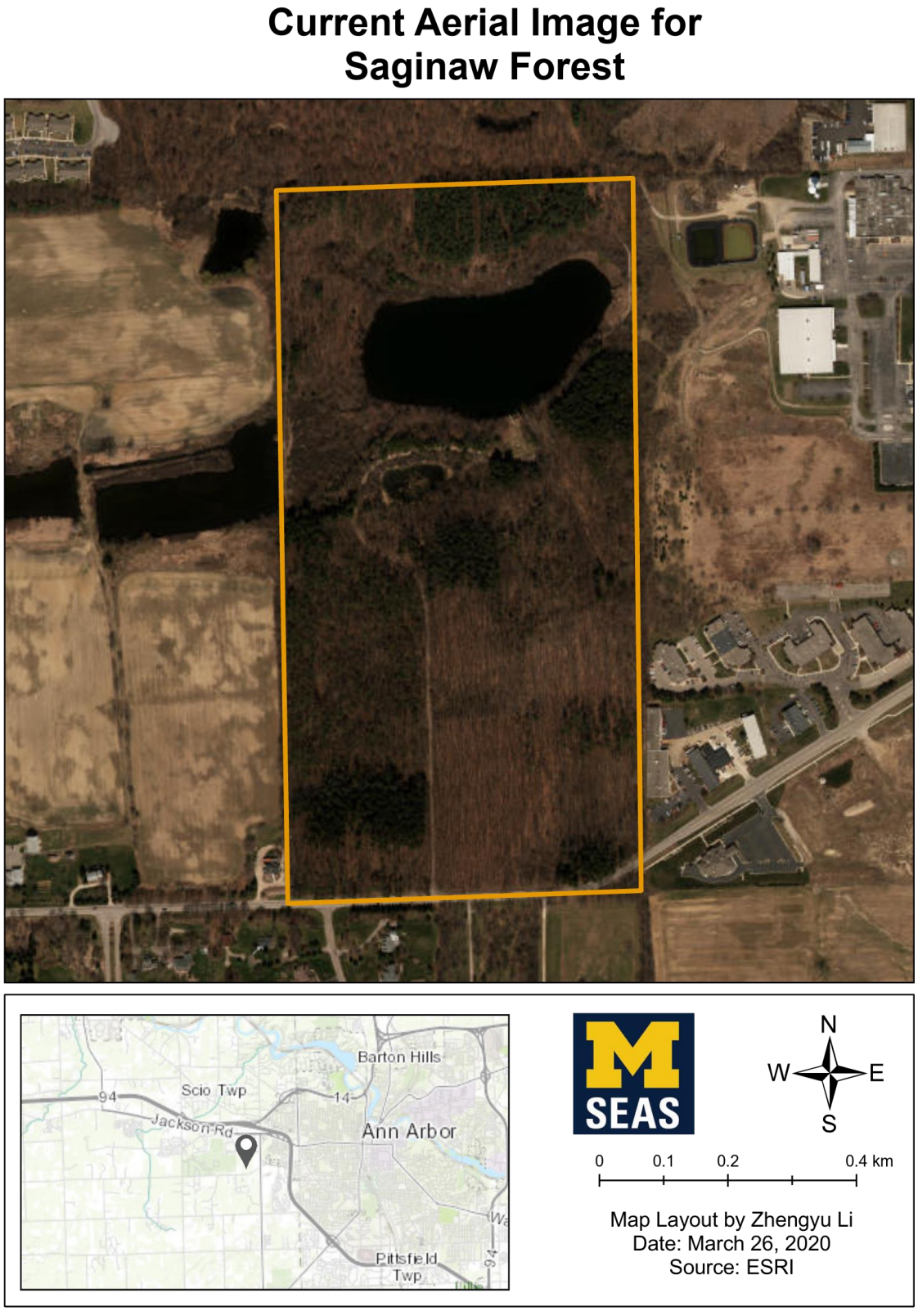


Figure 4-1. Current aerial image of Saginaw Forest.

Figure 4-2. Third Sister Lake at Saginaw Forest (Photo by Aubrey Lashaway, CIGLR).

Historical Uses:

Saginaw Forest was donated to the School of Forestry by University Regent Arthur Hill, of Saginaw, in 1903. The land was given with the stipulation that it was to be used as a demonstration and experimental forestry area and was named the "Saginaw Forestry Farm." Much of the property had been converted to agriculture during the 19th century, had been mostly clear-cut, and was suffering badly from erosion. The School of Forestry divided the property into plots and about 40 different species of trees were planted, 28 of which were non-native to Michigan. Many of these initial tree plantings survive to this day in varying states of forest health. The planting continued until 1915 with cooperation from the U.S. Forest Service. Much of the forestry research then turned to thinning experiments and forest management. A student caretaker would live in the cabin on the property from 1947 until the cabin was deemed unsafe and the caretaker position was terminated on the property in 2015.

After the School evolved into the School of Natural Resources, the management of the property declined dramatically. In 1985-86, it was discovered that Gelman Corporation, which was located on the east boundary of the property had been leaking water contaminated with 1,4 Dioxane into Third Sister Lake, which has since been spreading into the groundwater. Currently, there are ongoing efforts to clean up the contamination.

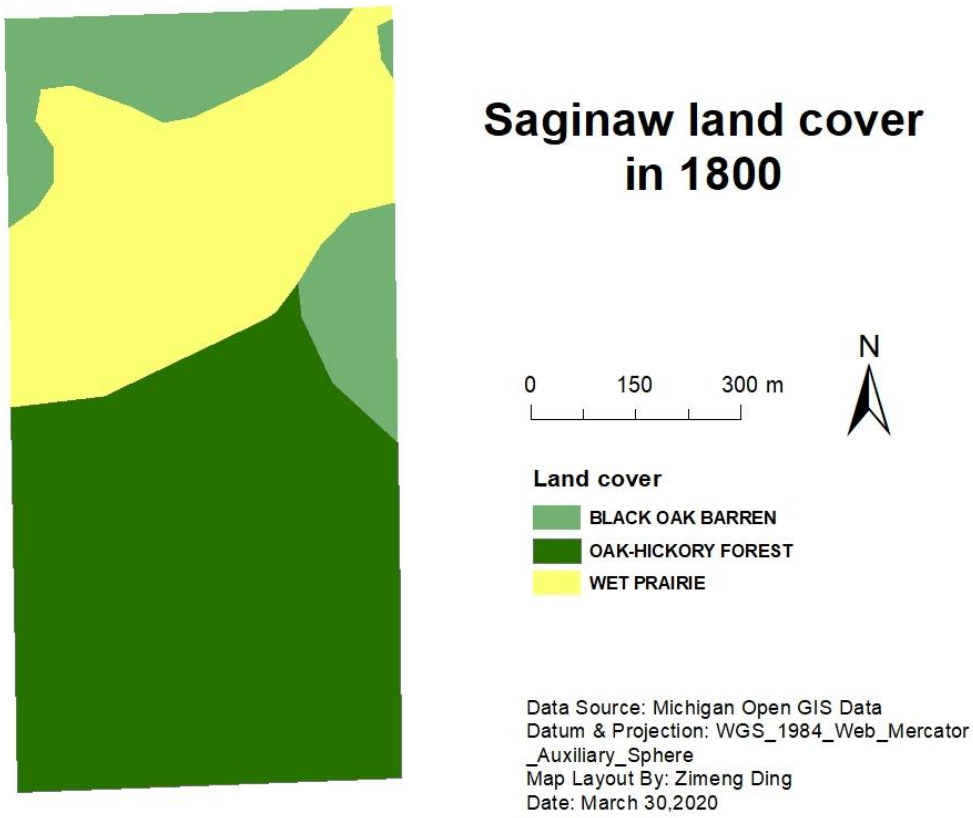


Figure 4-3. Saginaw Forest land cover in 1800.

Current Uses:

A great deal of courses and research have occurred at Saginaw Forest. At present, there are several research projects ongoing including work for several PhD dissertations and a long-term frog research project by Oakland State University that has been ongoing for over 35 years. Forest ecology, soil ecology, limnology, mushrooms, and restoration ecology courses make use of the property for field labs, landscape architecture classes have regularly used the property as a site for hypothetical design exercises, and Saginaw Forest is the site of the annual SEAS campfire in the Fall. The property is open to the public and there is great deal of use by neighbors for dog-walking and hiking. The neighboring 2|42 Community Church has also worked to make the property more accessible by adding a parking lot and trailhead, with hopes to connect the property by trail to the nearby Dolph Nature Area on the east and trails along Honey Creek and other Scio Township preserves to the west.

Figure 4-4. Current LULC for Saginaw Forest.

According to our supervised LULC classifications (Fig. 4-4) and data from the National Wetlands Inventory (USFWS, 2018), the approximately 80 acre property contains the 9.5 acre kettle lake, Third Sister Lake, 42 acres of deciduous hardwood stands, 21 acres of conifer plantations, and about 18.5 acres of freshwater forested/shrub wetland. Saginaw Forest is also one of only two known sites in the world of the Murray's Birch (*Betula murryana*), which was discovered and named by former U-M forest ecologist Burt Barnes.

Our analysis of the current carbon stocks of Saginaw forest showed that the equivalent of about 45,000 tons of CO_2 are currently stored in the forests and soils at the property. About half of the carbon stocks occur in trees, while soil carbon makes up the other 50%. Our estimates of carbon sequestration rates developed from the literature, show that Saginaw forest likely sequesters between 198 and 385 metric tons of CO_2 per year (Curtis et al., 2002; Froelich et al., 2015; Gahagan et al., 2015; Bernal & Mitsch, 2012; Khalil et al., 2020), the equivalent of $3,000-$5,800 per year at $15 per metric ton of CO_2 sequestered.

Stakeholders:

- 2|42 Community Church
- Neighboring co-housing communities
- Local landowners and residents
- Seasonal visitors and recreationalists

Future Vision/Recommendations:

Saginaw Forest has an old caretaker residence and storage shed that have been unused since the buildings were condemned in 2017. SEAS should either repair these buildings or construct a new residence and reintroduce the caretaker program at Saginaw Forest. Repairs to the residence would likely not be cost-effective due to many code violations, while building new residences for three caretakers would cost between $90,000-$225,000 (estimated by architect Lincoln A. Poley with Johnson-Hill Land Ethics in 2016). The yearly cost for the caretaker program is very low, since it only requires ~10 hours of work/week in exchange for free residence at the property. This also provides the school with a set of eyes on the property that can report any issues or challenges to the Facilities Manager. There is a long history of caretakers at Saginaw, and many visitors have fond memories of interacting with former caretakers about the property and the animals and plants that occur there.

The updated master plan for Saginaw Forest by Johnson-Hill Land Ethics (JHLE) and Lincoln Poley, Architect, suggested the renovation of the cabin as a storage/meeting space with construction of an open air pavilion/single occupant restroom nearby. These are the estimates for a combination of renovated and new structures at Saginaw from the JHLE/Poley study in 2016:

- $30,000-50,000 for renovating the cabin as a storage/meeting facility
- $60-85,000 for an open pavilion/restroom combination
- $90-225,000 for new housing for three caretaker with these options:
    - $174,000 to $225,000 for three "tiny" houses

- $90,000-120,000 for a modular residential structure for housing three students, and
- $150,000-200,000 for an "architecturally-designed" structure for housing three students

The above costs could be dramatically lowered if housing design and construction was incorporated into a landscape architecture master's project or the Green Building course offered by Joe Trumpey at the U-M Stamps School of Art and Design. A new caretaker's cabin could be constructed of locally sourced adobe and straw, similar to the ones at the University of Michigan Biological Station and the Campus Farm at Matthaei Botanical Gardens (https://stamps.umich.edu/creative-work/stories/heart-of-the-farm). Lumber could be obtained from fallen or harvested trees from the properties, and solar panels, rainwater catchment systems, compost toilets, and other additions could be installed to make it a livable, sustainable residence. Additionally, the Planet Blue Student Initiative Fund (http://graham.umich.edu/pbsif) has provided support for strawbale projects in the past, and could do so again in the future.

There is an ephemeral stream running through the property from the southeast boundary into Third Sister Lake. The stream is very susceptible to erosion due to high stormwater flows after rainstorms. There is evidence of prior attempts to stabilize the stream by adding cement weirs and barriers in the stream bed, but increasing development around Saginaw Forest has greatly increased the amount of runoff flowing through the stream. SEAS has received donations from neighbors to the property with the purpose of installing detention ponds on the edge of the property to slow down runoff from the surrounding area, in addition to restoring the stream banks to reduce erosion within the property. Detention ponds would also help to purify some of the runoff flowing from nearby developments and businesses, reducing pollution flowing into Third Sister Lake.

Historically, Third Sister Lake was surrounded by a wet prairie ecosystem that provided valuable habitat for the Blanding's Turtle (*Emydoidea blandingii*), a species of special concern in Michigan. Tree plantations and invasive plants, such as Canary Reed grass (*Phragmites australis*), and Buckthorn (*Rhamnus cathartica),* have degraded much of the wet prairie community in Saginaw Forest, and greatly reduced available habitat for the Blanding's Turtle. The shoreline wetland area of the property should be restored to a wet prairie habitat, through prescribed burns, invasive species control, and native plant seeding to restore this valuable ecosystem. Bob Grese's Ecological Restoration course developed restoration plans for the property that should be used by SEAS to develop a course of action (see supplemental files).

One way that SEAS can increase its presence at Saginaw Forest is by encouraging faculty to use the property for labs and coursework in new classes. The project team sees potential for prescribed fire/fire ecology, forest management, stream/wetland restoration, geospatial field methods, environmental education, environmental psychology, and behavior and environment courses to use Saginaw Forest as a field laboratory. The property is easy to travel to and close to campus, allowing it to even be used by classes that meet for an hour and a half (not just four-hour lab sections). SEAS should encourage faculty

to use the properties by providing logistical support in terms of transportation to and from the properties, making all needed research/field equipment available for classes, and by potentiallymaking funding for equipment available to faculty who plan on conducting courses at the properties.

Through meetings with the community and leaders of 2|42 Community Center, it was identified that there is a large interest in the community for the use of Saginaw Forest as a public learning center. Saginaw Forest serves not only as a field classroom and research site for university students and faculty, but also has a unique opportunity to serve as an outdoor "living classroom'' to the Ann Arbor community. It is already used by the homeschool community in the area for day trips and learning opportunities, and could be expanded to a broader group by offering university-led informational nature walks or other events with a range of focus topics. Topics of university-led events could include plant identification, invasive species management and restoration, birding, or even a BioBlitz. These educational events could also serve a spectrum of age ranges, from child focused events created to develop interest in nature from a young age to adult events for lifelong learning.

Using Saginaw Forest as a learning center for the community is not only restricted to formal events led by University faculty or students. Saginaw Forest can become an asset to the community for learning about natural systems through increased educational signage, interactive maps, and other web based learning tools. There is already a web-based tool that contains a map of the original planting plots through the property. This tool could be supplemented through publicly available story maps that highlight a deeper history of use and change of the property. Increased educational signage throughout the trail system could be used to direct the public through a guided nature walk. Themes of the signage could highlight research topics, tree identification, and animal identification (including information on rare species). Further educational opportunities could come from updating the SEAS properties website to include research topics, concerns, field guides, and history of the properties.

In addition to opening Saginaw Forest up to the community for educational events, our team recommends establishing a community stewardship program for the property, given profound interest within the community to take care of this beloved property. There are many passionate neighbors of Saginaw, and a stewardship program would allow them the opportunity to care for the property in ways that align with the school's vision. There are neighbors of the property already working on invasive species management through pulling garlic mustard, and a formal stewardship network would provide interested community members some base level of training in land management and trail maintenance. The stewardship program would also increase the eyes and ears at the property; without caretakers and staffing, Saginaw is in need of some formal presence on the property to ensure the well being of both visitors and property ecology. Stewards could also work with the SEAS to organize larger invasive species management or restoration work days for the community. This would allow community involvement for people who are not ready for the commitment of joining the stewardship initiative.

Trail maintenance and the reduction of hazards on the property could be addressed by having caretakers at the property, stewards, or additional staffing for SEAS properties overall. Additional stewards or staff walking the property regularly have the opportunity to identify necessary trail maintenance and hazard trees throughout the property. The additional staff could work to remove snags and hazard trees from the trail system. Wood could be reclaimed from these clearings and used in creative projects (signage, benches, facilities, or walkways), or left to promote habitat value for cavity-based fauna.

The proximity of Saginaw to Central Campus creates a unique opportunity to create student involvement on the property. Many SEAS students only know Saginaw through the annual campfire, and SEAS students are in a prime position to volunteer as property stewards or community event leaders. Many of SEAS students come from a background of ecological knowledge or social science knowledge. This background makes them ideal candidates to care for the property and engage the community. Being a steward of the property would give students hands-on experience in land management, community interaction, invasive species control, and restoration - practical skills for all manner of future sustainability leaders. Leading educational events for the community creates learning and experience opportunities across all of SEAS disciplines, and students would be encouraged to lead events in topics tailored to their individual research. It will also give SEAS students the opportunity to develop real skills in communicating science with the general public.

The most recent management plan for the property was established in 2009 by Lawrence Arbor Care and The Johnson Hill Land Ethics Studio (with the cost estimates for structures updated in 2016). Additional concerns and uses for the property were highlighted by the last report of the SEAS Properties Committee from May 2017 (see supplemental files). However, neither of the plans have been followed closely by the school, and an updated management plan that encourages the active use and revitalization of Saginaw as a research property, outdoor classroom, and community center is much needed. There have not been many major updates by the school in the care of the property despite the plans outlined over the past decade. Old management plans focus on ecological and facility improvements - many of which are still important to consider in an updated management plan. One major recommendation from the 2009 plan was fulfilled by 2|42 Community Center through the construction of a parking lot and trailhead that they have allowed the school and other visitors to the property to use. The management plans that exist also come from a time when SEAS was still the School for Natural Resources and the Environment. Now that the school has transitioned to the School for Environment and Sustainability, the property needs to update management plans in order to best serve the total SEAS and Ann Arbor community through new interdisciplinary curriculum goals (which serve as a beginning for the reconvening of the SEAS Property Committee). A comprehensive management plan that aligns with the School's overall vision for the property is especially important at Saginaw because it is by far the most utilized property by both SEAS students, faculty, and the greater Ann Arbor community.

B. NEWCOMB TRACT

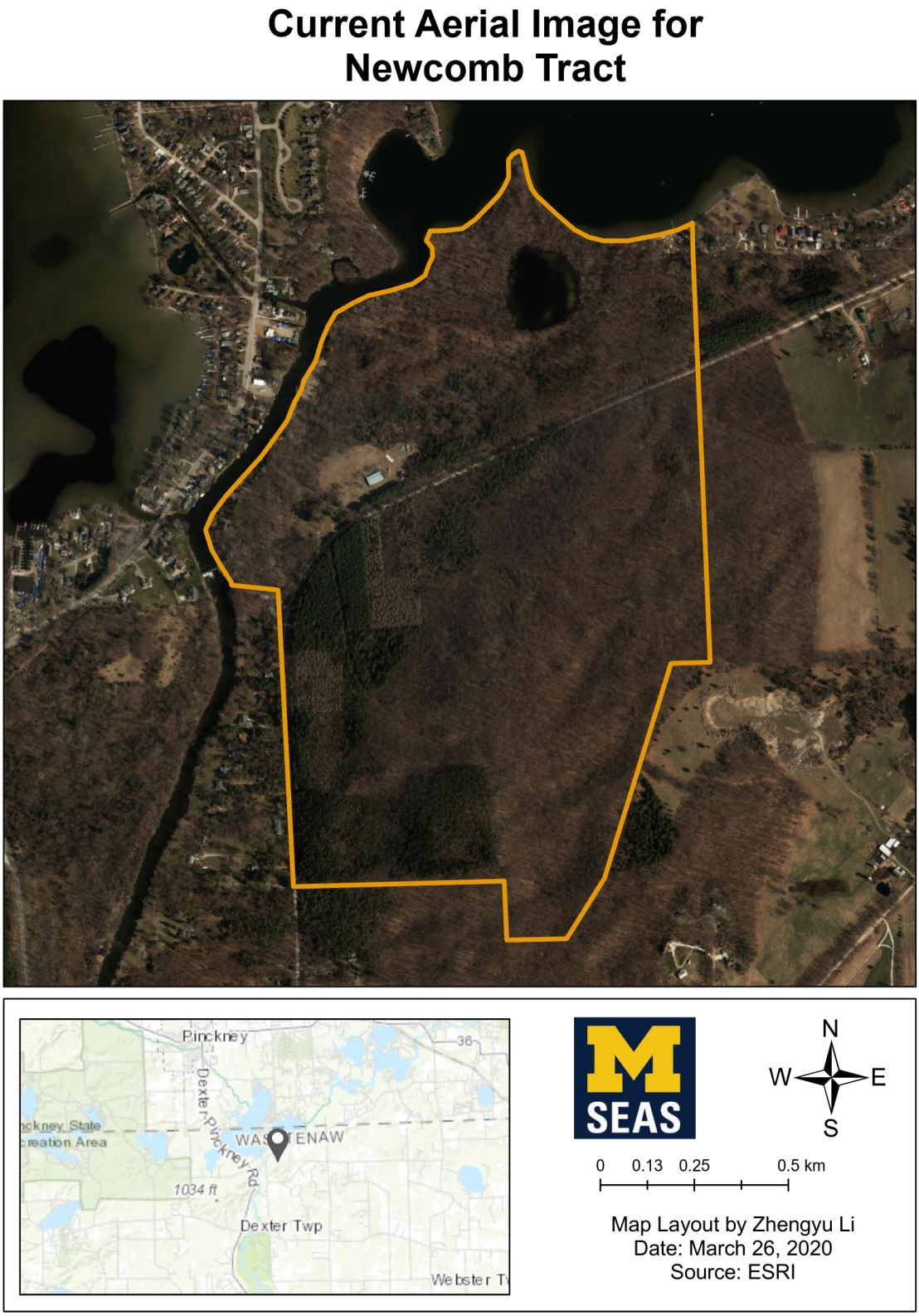


Figure 4-5. Current aerial image of Newcomb Tract.

Figure 4-6. Newcomb Tract (Photos by U-M SEAS Staff).

Historical Uses:

Newcomb Tract was purchased by the University in 1929 from William W. and Esther M. Newcomb, as a possible location for an observatory. The property was used as a research site by the Department of Zoology for the first 19 years. The School of Natural Resources began managing an 80 acre plot of the property in 1949, where they planted about 20 acres of conifer plantations including Scotch Pine, White Pine, Norway Spruce, and Tamarack.

Additionally, SNRE also managed a tree nursery at the property as a headquarters for forest management of neighboring Stinchfield Woods. Then, in 1951, the 33 acre Murdock Tract, which was composed entirely of native hardwood forest, was purchased and managed by SNRE. At present, SEAS now manages all 247 acres of the property.

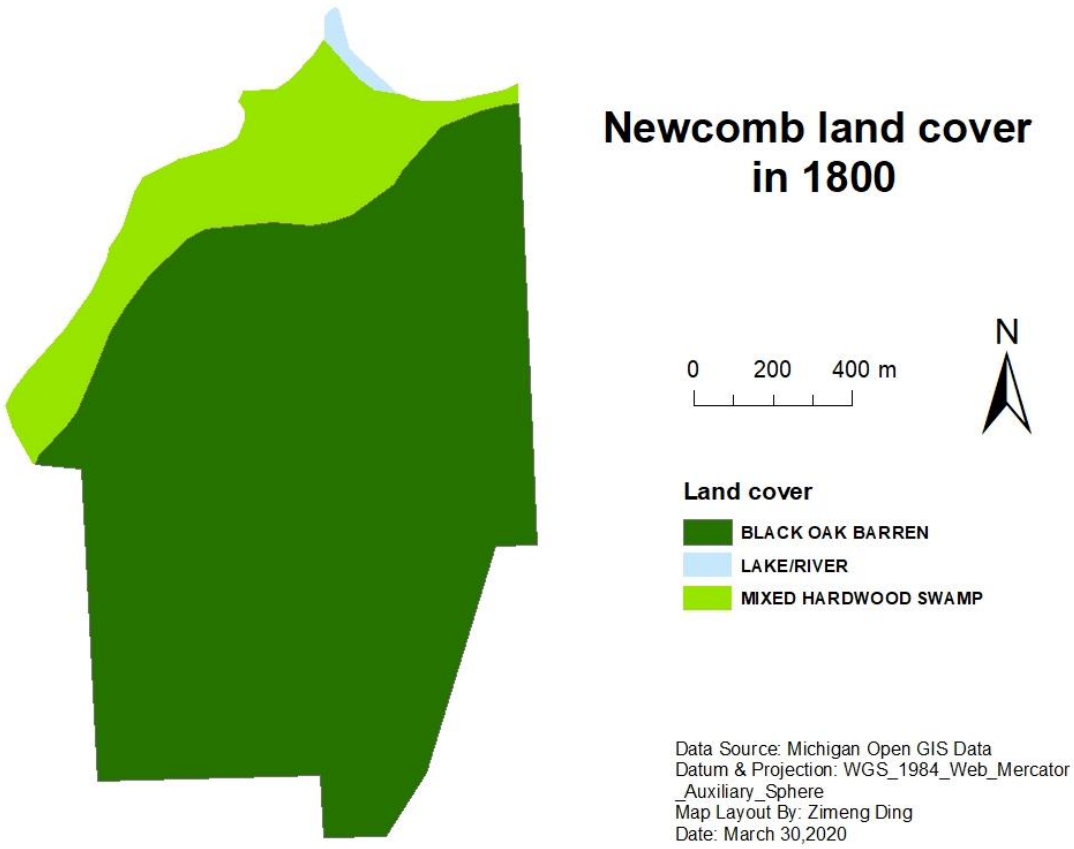


Figure 4-7. Newcomb Tract land cover in 1800.

Current Uses:

Newcomb Tract exists as a closed research property (no public access) owned and operated by SEAS. The property contains two storage barns that are used to store research equipment for SEAS faculty. Near the main entrance, there is a fenced area with electricity, and a privately-owned weather station used by university researchers. Additionally, there is a small observatory and trailer owned by the Climate and Space Science & Engineering program, as well as a storage container owned by the School of Public Health. The property also contains a former caretaker house, which would require major repairs before use as a student caretaker residence in the future. The University of Michigan Sailing Club is located on BaseLine Lake in the northeast corner of the property. In the northwest section, there is access to a Consumer's Energy dam along the Huron River; at the dam, there is also a canoe portage built for people to continue passage down the Huron River. This is a portage site and not an access point for boaters. The property still remains mixed between the conifer plantations of Scotch pine, White pine, Norway spruce, and Tamarack. The native hardwood stand from the Murdock tract is also still present on the property.

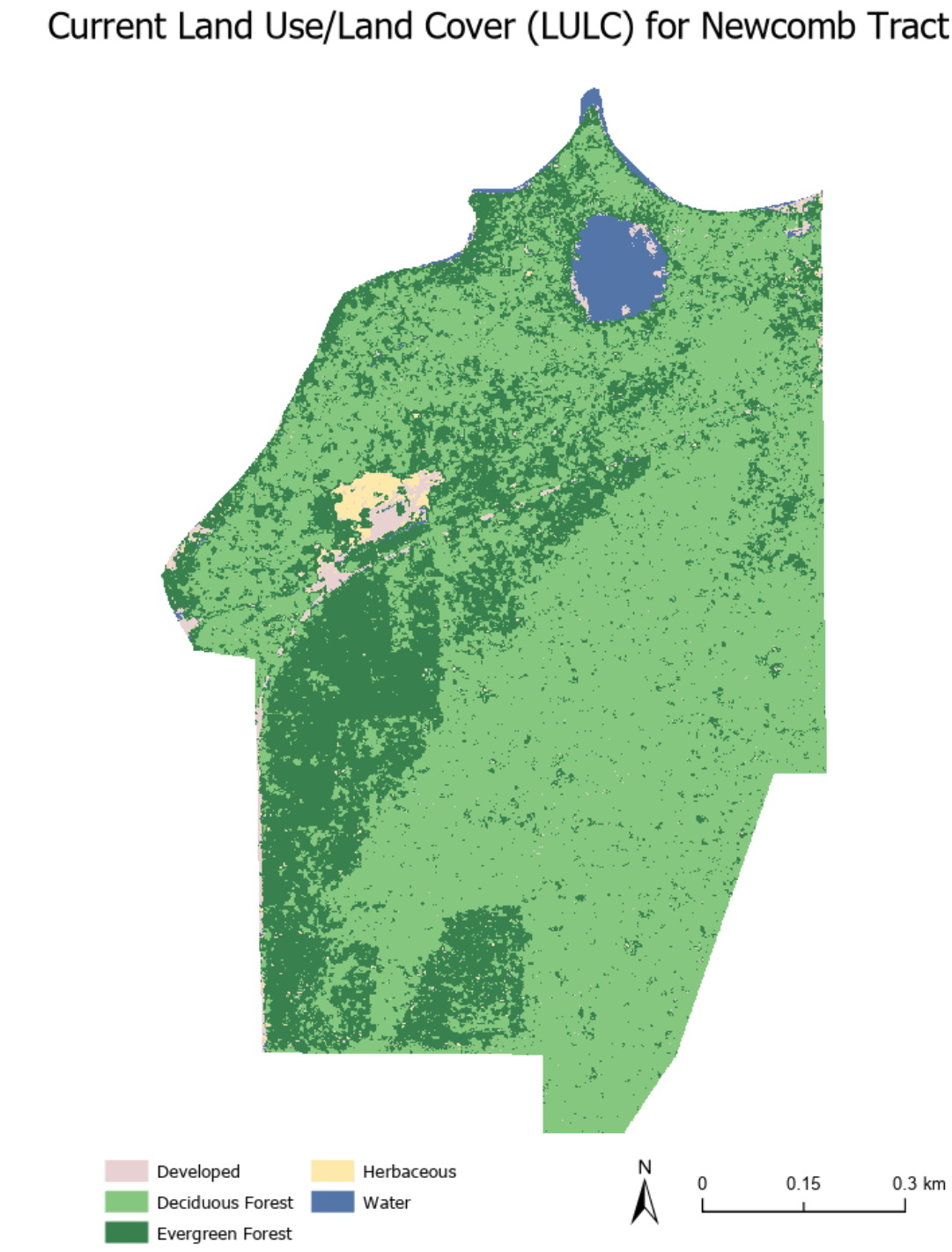


Figure 4-8. Current LULC for Newcomb Tract.

According to our supervised LULC classifications (Fig. 4-8) and data from the National Wetlands Inventory (USFWS, 2018), Newcomb Tract is a 247-acre property with approximately 142 acres of deciduous forest, 58 acres of coniferous forest, 37 acres of freshwater forested/shrub wetland, and 5.5 acres of water, including a small 3-acre lake in the northern section of the property.

Our analysis of carbon storage at Newcomb Tract resulted in an estimate of the equivalence of 133,000 metric tons of CO_2 currently stored in the forest and soil of the property. The trees account for slightly less than half of carbon storage on the property, while soils make up over 50%. This is, in part, due to the northern third of the property where there is an area of Silver Maple forested wetland. Our estimates of the carbon sequestration rate, based on literature review, at Newcomb ranges between 587 and 1100 metric tons of CO_2 per year (Curtis et al., 2002; Froelich et al., 2015; Gahagan et al., 2015; Bernal & Mitsch, 2012; Khalil et al., 2020), the equivalent of $8,800-$16,400 at current California carbon market prices.

Stakeholders:

- Bill Brinkerhoff and Kathy Sample (local residents/immediate neighbors to the east)
- University of Michigan Sailing Club
- Chain of Lakes boaters and users
- Other neighbors and local residents

Future Vision/Recommendations:

A major recommendation from our team is the reintroduction of a property caretaker. Caretakers are a simple and relatively low-cost method to increase the supervision and maintenance of a property, and even more important at seldomly-visited and distant properties. A caretaker on the property could monitor for trespassing, deer stands, and trash dumping, along with working on invasive species removal. Having supervision and affordable labor on the property will help ensure the property is used effectively by SEAS, but would first require the repairing or replacing the caretaker residence. The old caretaker house is in extremely poor condition and would need major renovation to create a livable site for a caretaker. An alternative would be to create a new energy-efficient structure using sustainable building practices and sources of energy. By investing in the caretaker residence, we allow for longer-term engagement with land, and create a solid grounding for the many exciting uses which Newcomb could realistically see in the coming future.

Newcomb Tract has a large storage barn used for the storage of SEAS research equipment, just south of an open field. Between the two spaces, there is potential to implement solar in a meaningful way. The location represents the closest meaningful opening for solar implementation within SEAS land holdings (see Section III, Subheading I). Despite a greater open area for solar at the Harper Preserve, the closer proximity of Newcomb to U-M's

Central Campus serves as reason to further explore solar at the barn and adjacent field. Along these lines, Newcomb Tract is within a distance from campus that would allow for class and lab trips to the property. As such, students would be able to visit and learn from the solar implementation as part of their SEAS education. It is for these reasons that our team recommends an evaluation of the property for solar implementation and an evaluation of the pricing and cost models associated with developing solar as a school or through a power company. Doing so would significantly (if not fully) decrease the reliance of the Dana Building on grid power, and would set a major precedent for the School amidst other Rackham programs on campus.

Newcomb is a closed public property with minimal engagement by community stakeholders. The community input for the property came from the owners of the neighboring farm and woodlot: Bill Brinkerhoff and Kathy Sample. Bill and Kathy have a 240 acre farm and forested property that is the largest neighbor of Newcomb. They are also a great resource to the school because of their work in the local food system and their passion for sustainable agriculture. Bill and Kathy are the owners of Argus Farm Stop, an every day, year round farmers' market that focuses on developing the local food economy. On their property, they took farmland, which had been in traditional agricultural production since the 1800's and have begun to introduce sustainable food production practices to the farm. The hope of these practices is to rejuvenate the land and soil, while producing sustainable local food. In addition to sustainable farming on the neighboring property, they have worked to conserve 30 acres of hardwood forest. This neighboring woodlot is conserved through a conservation easement from Washtenaw County's Natural Areas Preservation Program and creates an opportunity for collaboration between the school and the county's conservation program (in addition to the program in neighboring Webster Township).

Bill and Kathy are also alumni of the University of Michigan and have a strong passion for partnering and working with the University. They saw having Newcomb Tract as a neighbor and a relationship with SEAS as a potential for building a sustainability hub for university students. Newcomb has the potential to become a sustainability hub due to the mix of habitat and resources contained at one property. The barn roof provides a potential area for solar. Restoring the caretaker house has the opportunity to implement creative sustainable building techniques. The closed forested property would serve as an ideal site for the construction of long term monitoring sites for carbon sequestration and global change biology. The open field could be used either for a possible solar implementation or for sustainable agricultural plots. A sustainable agricultural presence on the property has the potential to partner with Bill and Kathy's neighboring farm. In light of these ideas, there is a strong interest from Bill and Kathy to open up their property for student engagement. They have a salient desire to build a relationship with the school and have the property be well-utilized by students - potentially creating a hub for sustainability in the future.

On the property, there are small areas dominated by invasive species at Newcomb Tract, including Black Locust (*Robinia pseudoacacia)*, Buckthorn (*Rhamnus cathartica)*, and Common Privet (*Ligustrum vulgare*), that should be managed, especially in the native Oak-Hickory forest sections of the property. Invasive plant management could be carried out by

a caretaker, if the residence was repaired. The caretaker could also organize volunteer workdays to control invasive populations at Newcomb, which would give an opportunity for neighbors to engage with SEAS and the property.

The clearings of invasives could also serve as the potential sites for restoration classes or research on the property. Areas could be cleared of invasives or unhealthy and failing Red Pine stands and restored back to the 1800 land cover of oak barren or hardwood swamp. This clearing of trees could also generate lumber for the school to use for building projects, building restoration, or sale - resources which could easily feed back into property projects. During the restoration process, plots throughout the property could be cleared and restored at varying times to create a time-log on succession during restoration. Classes or researchers at the school could look to develop restoration plans to increase the use of Newcomb as a research and teaching property. Nevertheless, Newcomb can serve as much more than a research property for forest restoration; it has a diversity of resources and the opportunity to service many SEAS students, and could greatly enhance the research capacities of SEAS in terms of sustainable ecology and pedagogy. Many students across disciplines could design and implement projects across the property relating back to creating a field-based sustainability hub - an extremely auspicious opportunity.

Additionally, Newcomb is positioned well as a property to build partnerships for management. If the interests and funds are not available to fulfill and position Newcomb as a sustainability hub of interdisciplinary research, Newcomb could seek to partner with a local land trust or conservancy to begin gaining basic resources and monitoring (a list of local contacts for partnerships can be found in Appendix C). Newcomb could also look to connect to Washtenaw County's Natural Areas Preservation Program, a program that fits well with the property because the neighboring property has already established a conservation easement with the program. Finally, a partnership with Bill and Kathy is a forefront consideration for the future success of sustainable enterprise and program development at Newcomb. They are passionate about the property and about sustainable agriculture, and could be a valuable partner as SEAS grows its own sustainable agriculture research.

In order to begin the use of Newcomb as a rich teaching and research property, the most important and practical measure is to increase awareness among faculty and students of the opportunities on the property. The timing is perfect for increasing awareness due to the growth of the school, and the new students and faculty coming into SEAS provide a great opportunity to expand the property's use across disciplines. It is extremely important to let the new members of the SEAS community know the full extent of SEAS for research and teaching, especially with such potential and resources so close to campus. The property already has the storage barn for research equipment and is within a reasonable driving trip from Ann Arbor, and is characteristic of a diversity of opportunity for research and teaching. These considerations make Newcomb Tract one of the most exciting teaching and research tools for the school in the coming future.

C. STINCHFIELD WOODS

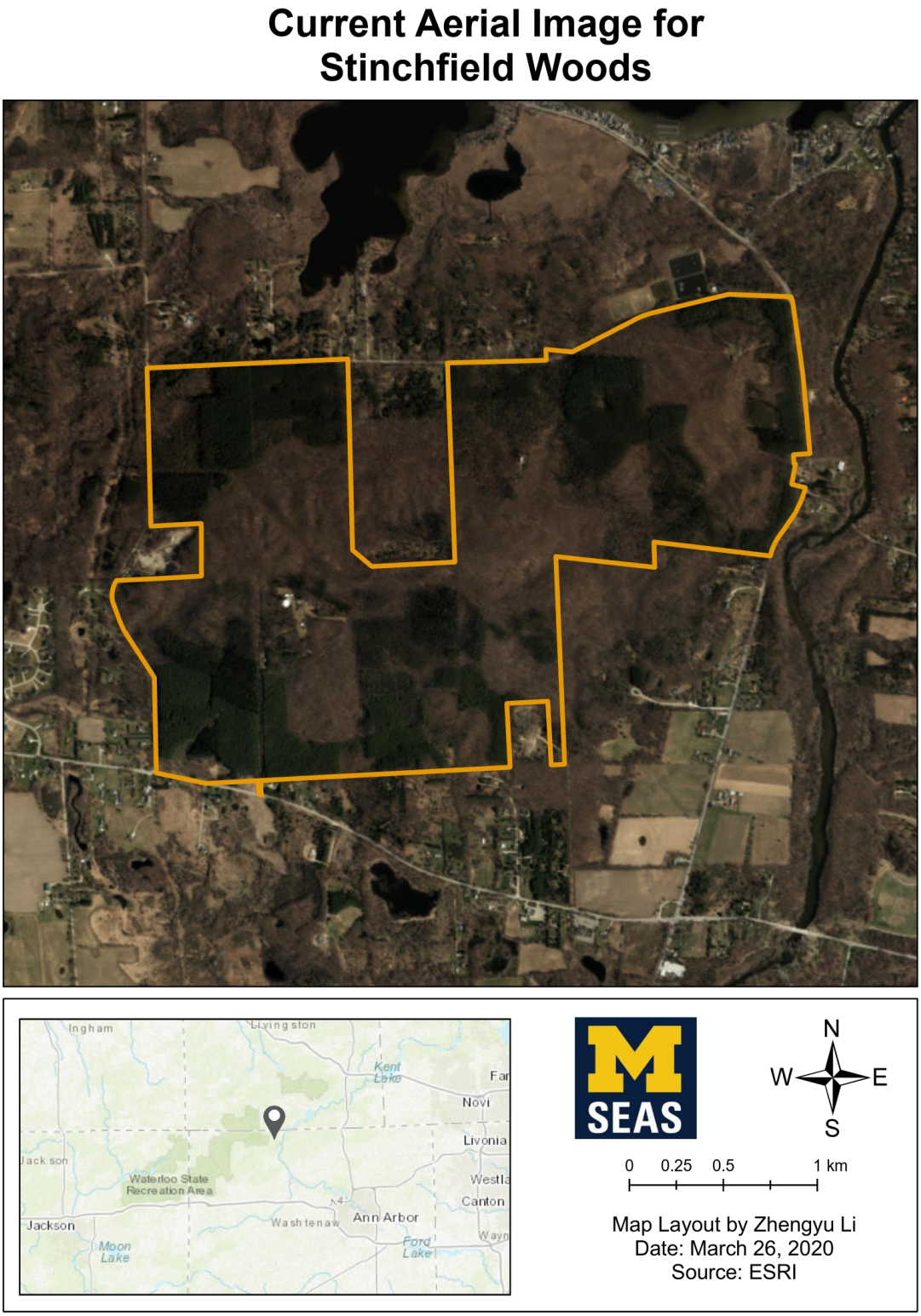


Figure 4-9. Current aerial image of Stinchfield Woods.

Figure 4-10. Stinchfield Woods (Photos by U-M SEAS Staff).

Historical Uses:

Stinchfield Woods was acquired in parts beginning in 1925. The first 320 acres of the property were given to the School of Forestry by Annie Tillson Stinchfield and named in memory of Jacob and Charles Stinchfield of Detroit. The Stinchfield brothers were descendants of the lumbermen that harvested Michigan's giant white pine in the nineteenth century. The 146-acre Peach Mountain tract was purchased from the State of Michigan Department of Conservation in 1947, and the remaining 311 acres were purchased over the next 10 years. The property was reforested by the school with conifer plantations and native hardwood forests. The class of 1942 helped fund the purchase and construction of a sawmill on the property, which was used by the school until it was destroyed by arson in 1977.

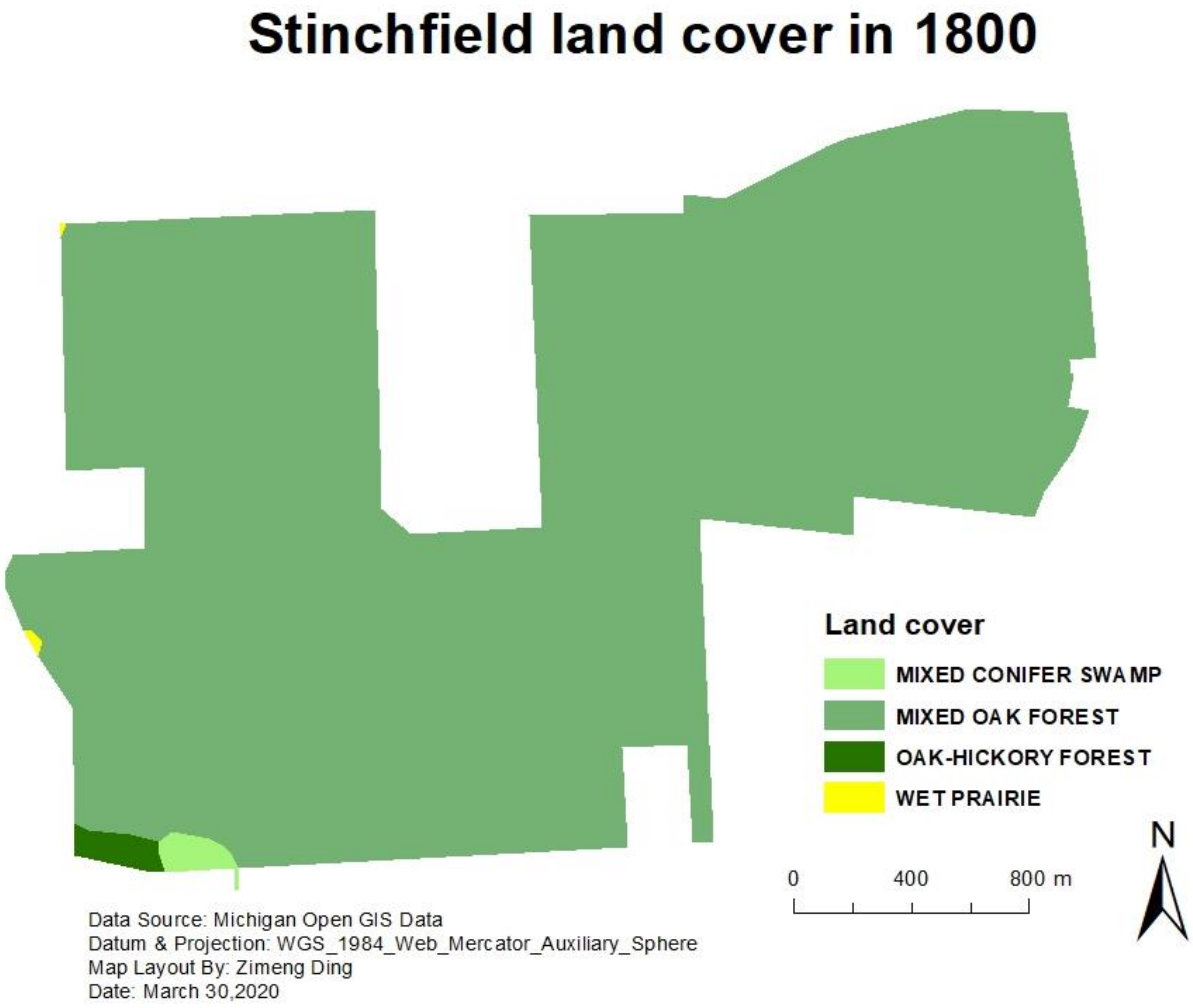


Figure 4-11. Stinchfield Woods land cover in 1800.

Current Uses:

The largest of the SEAS properties, Stinchfield woods is open to the public, and people may walk the trails in the property from dawn until dusk. This property sees heavy usage throughout all seasons, and is a focal point for many birding groups and studies. Previously, a "Friends of Stinchfield Woods" community group existed that was started by a former caretaker, which organized yearly litter clean-ups of the property.

According to our supervised LULC classifications (Fig. 4-12) and data from the National Wetlands Inventory (USFWS, 2018), the 774-acre property consists of approximately 478 acres of deciduous forest and 283 acres of coniferous forest. The site currently has very little management, but a student caretaker does reside on-site and oversees some property maintenance.

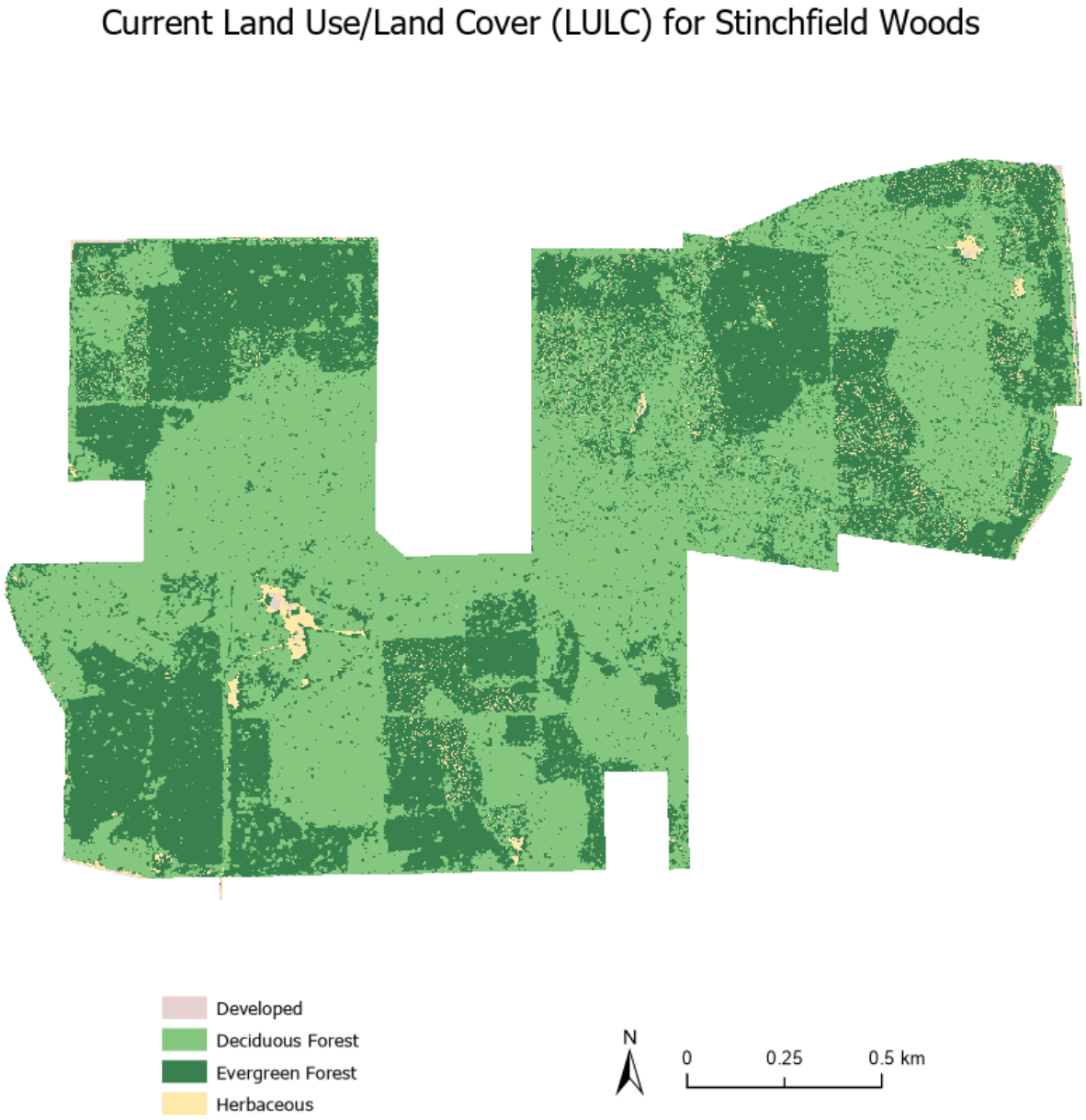


Figure 4-12. Current LULC for Stinchfield Woods.

The property is also used by a variety of courses, including: Soil Ecology, Woody Plants, Biology of Fungi, Ornithology, GIS, and Field Ecology. Stinchfield Woods has been used to complete research for over 70 master's theses and dissertations, in addition to over 100 publications through faculty research. The property also features a caretaker's residence, two observatory buildings, and the WUOM radio tower, which sits on top of Peach Mountain (the highest point in Washtenaw County).

Our analysis of carbon storage at Stinchfield Woods showed an estimated equivalence of 218,000 metric tons CO_2 stored in the forest and soils of the property. Using carbon sequestration estimates developed from literature review, the property sequesters between 1900 and 3200 metric tons of CO_2 per year (Curtis et al., 2002; Froelich et al., 2015; Gahagan et al., 2015; Bernal & Mitsch, 2012; Khalil et al., 2020), the equivalent of $28,000-$49,000 per year at current California Carbon Market prices.

Stakeholders:

- Washtenaw Audubon Society
- Local residents and landowners
- Seasonal visitors and recreationalists

Future Vision/Recommendations:

Stinchfield Woods has many unique buildings and facilities. Many of these facilities are in need of repair, renovation, or restoration in order to become meaningful and usable facilities for the school and for the community. The extent of sustainable repair and reuse would serve as an excellent future master's project as highlighted in overall vision for SEAS properties. Use of the buildings could include expansion of caretaker space, community meeting spaces, field based classrooms, or a retreat center (similar to the at ES George Reserve). In addition to an exploration of sustainable systems on the property, Stinchfield should be explored for renewable energy implementation. The large property could serve as an important part towards SEAS becoming carbon neutral. This project would also examine opportunities at the nearby Newcomb Tract. These sites serve as an important resource for sustainable systems students due to their accessibility to Ann Arbor (they are within a travel tier that works for teaching labs).

The school's real estate department has been contacted about allowing the addition of a bike trail through Stinchfield. The trail would be a connector trail between the Border to Border trail (Washtenaw County Parks and Recreation) and the Lakelands Trail (MDNR) that cuts through the outside of part of the property. Our team recommends working with the trail group to implement the connector trail, composed of these two previous agencies, as well as the Village of Pinckney, Dexter Township, and Hamburg Township. Increased trails will increase Stinchfield's use for the community, and the placement of the trail can be selected to not harm existing or future research or teaching sites. An agreement between SEAS and the trail group should also include an expansion of parking for Stinchfield; the property has very limited parking for the public currently, and an increase in use from the bike trail could overwhelm parking presently available.

Because the property falls within an acceptable driving distance for use in classes and lab trips, Stinchfield is an essential and important research and teaching tool for SEAS. The property is actively used as a research site by SEAS faculty studying the oak hickory ecosystem, and is also used as a teaching and research site for soil ecology. Don Zak takes his soil ecology class to Stinchfield each fall to learn about the effect of slope and aspect on soil horizon development. In meeting with professors who actively use the properties for teaching, it was revealed that the soil pits are in need of stabilization. Research capabilities could be expanded on the property by incorporating long term research plots for carbon sequestration and global change biology.

Stinchfield is historically an oak forest, but the former School of Forestry planted large areas of the property in conifer plantations. However, several of these plantations are failing and dissolving, now is an appropriate time to investigate how to move forward to restore those areas. Several options exist for managing the aging conifer stands. One option is a business-as-usual approach where the stands are left to die and fill in with the dominant tree species. The other option is to turn failing plots into opportunities to study forest succession and restoration. Restoration efforts could begin through the use of prescribed burning in tracts of failing plantations or through cutting and removal of trees from failing areas. The SEAS Property Committee acknowledged the need for large scale removal of failing and hazard trees by professional foresters in their 2017 report (see supplementary files). Removing trees would also provide lumber that could be used on the property, by the school, or sold.

In order to understand the future course for the forest at Stinchfield, an updated management plan needs to be created. Large-scale clearing and restoration projects (like the one proposed earlier) need to make sense in the context of overall property management. SEAS, through the Property Committee, needs to write a formal management plan for this large and well-used property. Current management simply falls under short term necessities for the property. Similar to Saginaw Forest, Stinchfield needs to have an updated management plan to reflect the updated vision of the school. Stinchfield should not simply serve to be a site for forestry research, but should reflect the interdisciplinary approach to sustainability and environmental studies that has been adopted by SEAS. A new management plan should look to protect key forest resources needed for teaching and research, while expanding the total available resources to become a property that is useful across all disciplines of the School. Stinchfield has the capability to continue current research while expanding research topics to include carbon sequestration and global change biology, along with sustainable energy and development. Additionally, Stinchfield is well-suited to build community involvement in these topics.

Like Saginaw Forest, Stinchfield has a strong community of interest and active neighbors. There is a long history of community use of this large publicly open property, spanning many decades according to our social research. When connecting with the community, it became clear that community members are interested in the university using its property for community engagement and education. The university can increase its engagement by leading community educational events; these events could include university faculty or student led nature walks covering topics of land history, plant identification, invasive

species control, or sustainable land use. Events could also be themed or targeted to different interests, activities, or ages. There could simply be events that focus on getting children interested in being out in nature, as well as events that focus on unique interests like mushroom foraging or botany. In terms of birding, there is a particular enthusiasm in local property users for bird walks, masterclasses, and bird counts, particularly through the overlaps with Washtenaw Audubon Society (the annual breeding bird study notes that many species seem to travel between Pinckney Recreation Area and Stinchfield Woods). Largely, the model for these educational events would look like the model recommended at Saginaw. As Stinchfield and Saginaw are the two publicly open properties in Washtenaw County, they will have similar goals for engaging the community.

Public involvement can be further reinforced through the introduction of a stewardship program on the property. Community members would be able to volunteer in an official capacity through SEAS. These stewards would provide additional supervision for the property and be able to work on invasive species management and trail maintenance. Stewards for the property would receive some level of training and stewards can come from the public or from the University community (see Section III, Subheading E). Additionally, volunteer days can be run by the stewards or caretakers of the property for larger projects. These volunteer days create volunteering opportunities for people interested in the property who cannot commit to the larger time requirements involved in being a steward. Examples of volunteer projects would be larger trail maintenance and invasive species removal projects. These work days can help provide the hands needed to tackle the projects on the property that are too big for a single caretaker or steward to undertake. Herein also lies an opportunity for work days to become education days for the volunteers. Having knowledgeable leaders at these events can allow for work and education to coexist. While removing invasives, topics of plant ID and sustainable landscapes can easily be explored with the public. The leaders can help participants understand the importance of invasive species removal from all landscapes, not just natural areas properties like Stinchfield.

With the large size of the property and the access to the public, it is important to have clear and frequent signage regarding property rules and regulations. Signage with university logos increases the university presence on the property, and reminds the public that Stinchfield is not simply a public park. However, increased signage does not need to be siloed simply to portray rules - much university signage throughout the property should be geared towards the goal of education. Similar to many state parks run by the MDNR, guided trails with signage related to different ecological topics along the walk are excellent interpretive tools, as are signs portraying how ecological topics relate to the surrounding environment. Signage can guide the public through thematic trail segments targeted towards topics of plant identification, wildlife activity and behavior, land history, invasive species control, and sustainability lessons, among a host of others. This allows for Stinchfield to serve as a community education center without relying on university-led nature walks or larger community events. In this light, it will also be important to expand the university presence on the land through proper staffing to maintain safe trail systems for use by researchers, classes, and the public. Because this property sees use in all seasons,

it is paramount for the school to do all within its power to ensure the continued safety of the recreationalists who make use of Stinchfield.

The final recommendation for Stinchfield is the protection of the inholding property. This inholding is the large cut in on the north end of the property. The land has similar land cover to Stinchfield with a mix of plantation and native oak forest. If this land were to be bought by a developer, it would be a major loss to the surrounding ecosystem. Not only would there be a direct loss in forest acreage, but the nearby development would also increase stress on Stinchfield itself. There was an opportunity in the past for SEAS to purchase this inholding, but the funds did not exist for the large purchase. Today, the funds still do not exist to make such a purchase, but this could serve as a great opportunity for collaboration to conserve the land. SEAS could partner with Washtenaw County Natural Areas Protection Program or another partner to mark this property as a high priority for purchase and conservation. If conserved, this property would effectively be part of a larger conserved network of land by having adjacency to Stinchfield.

D. ST. PIERRE WETLAND

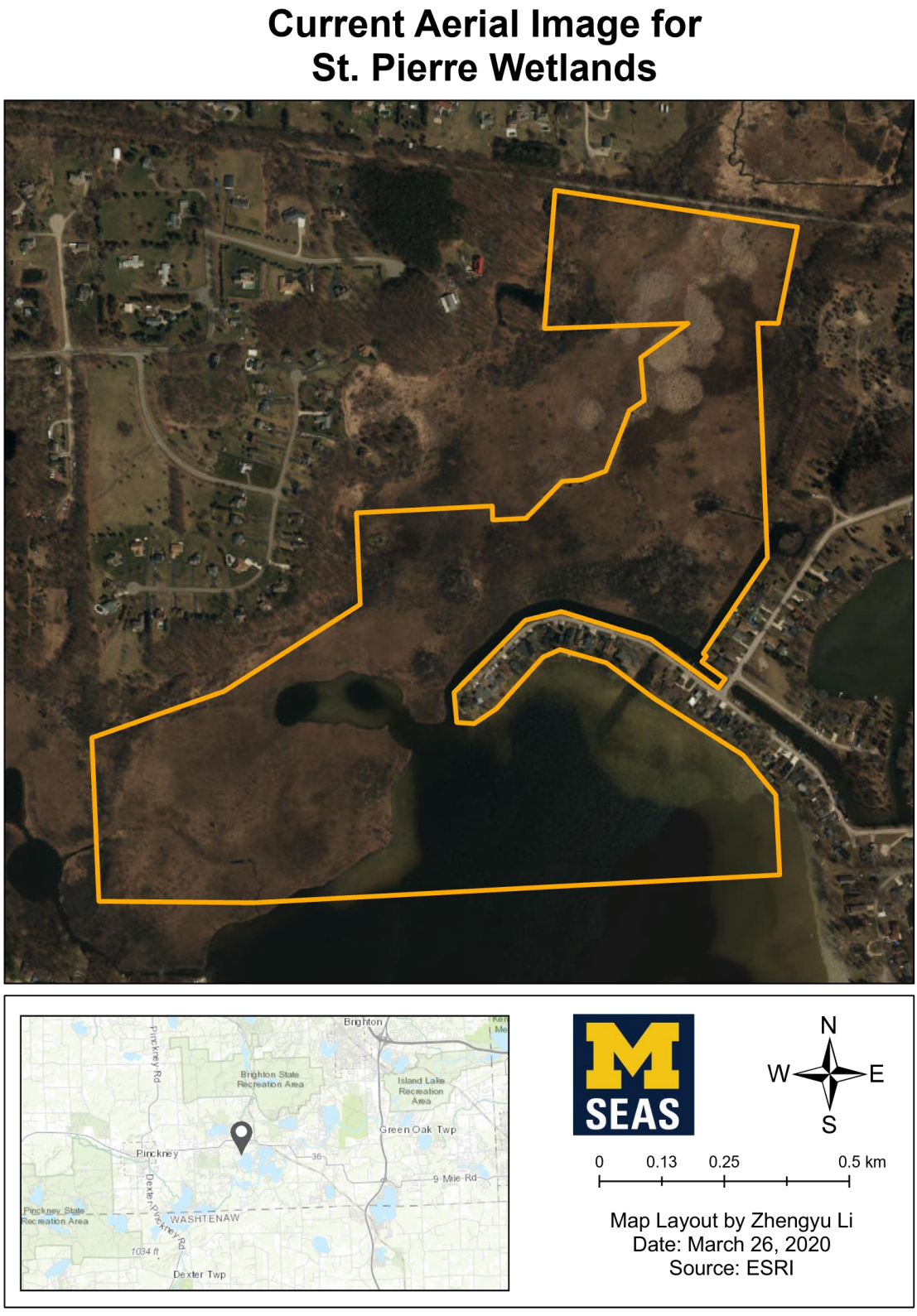


Figure 4-13. Current aerial image of St. Pierre Wetland.

Figure 4-14. St. Pierre Wetland (Photos by U-M SEAS Staff).

Historical Uses:

St. Pierre Wetland was donated in 1975 by Sam and Angeline St. Pierre to be used for teaching and research in fisheries, wetland ecology, stream biology, etc. It is located on Bass Lake in Livingston County, and is almost entirely surrounded by residential properties. The property has previously been used by faculty for teaching courses in Resource Ecology and Aquatic Ecology.

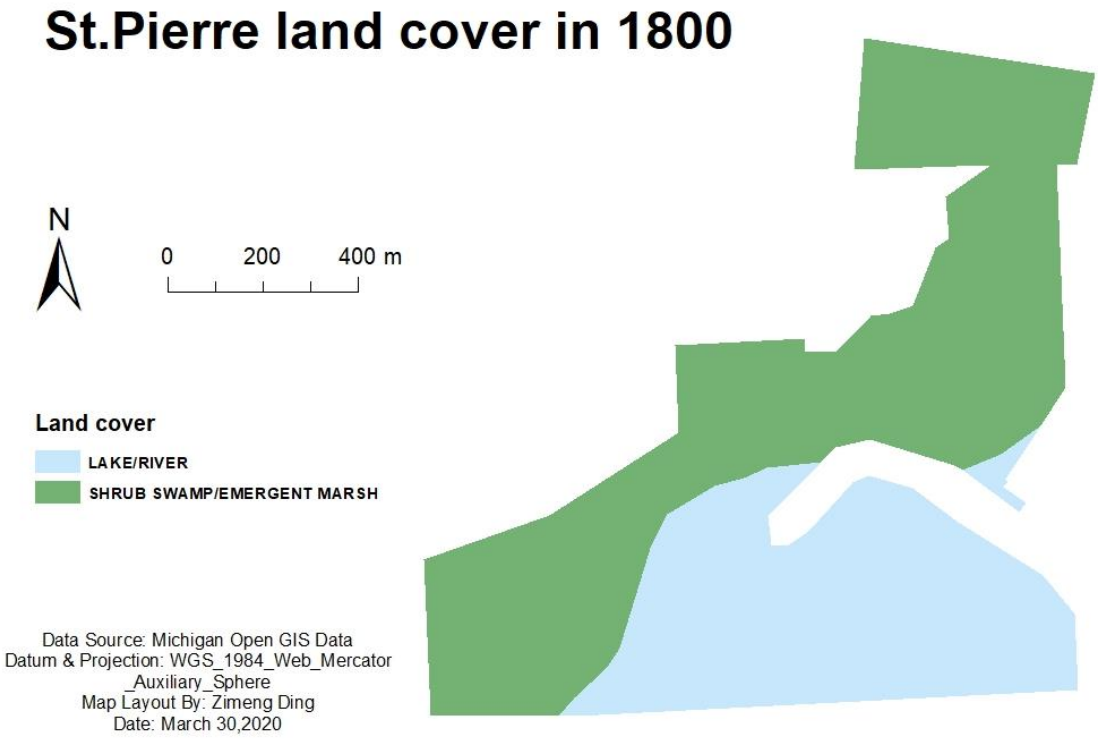


Figure 4-15. St. Pierre Wetland land cover in 1800.

Current Uses:

According to our supervised LULC classifications (Fig. 4-16) and data from the National Wetlands Inventory (USFWS, 2018), the current land cover of the ~127 acre property is 85 acres of freshwater emergent wetlands and 42 acres of water. According to a Bioreserve Site Assessment conducted by the Huron River Watershed Council in 2017 (see supplementary files), St. Pierre Wetland is rich in biodiversity and is ranked one of the "Top Ten" wetlands in the entire Huron River watershed (https://www.hrwc.org/our-watershed/maps/). There is currently no management at the property, but there is interest from neighbors in contracting out for invasive plant management, primarily of Common Buckthorn (*Rhamnus cathartica*).

Our analysis of carbon storage at St. Pierre Wetland showed that there are huge stocks of carbon in the soils of about 218,000 Mg CO_2 equivalence. Wetlands have immense carbon storage capabilities (Moonmaw et al., 2018), as submerged organic matter decomposes much more slowly than organic matter that is exposed to oxygen. Our estimate of carbon sequestration at St. Pierre ranges between 190-595 metric tonnes CO_2 equivalent per year (Curtis et al., 2002; Froelich et al., 2015; Gahagan et al., 2015; Bernal & Mitsch, 2012; Khalil et al., 2020). The value of this service alone is between $2800-$8000 per year.

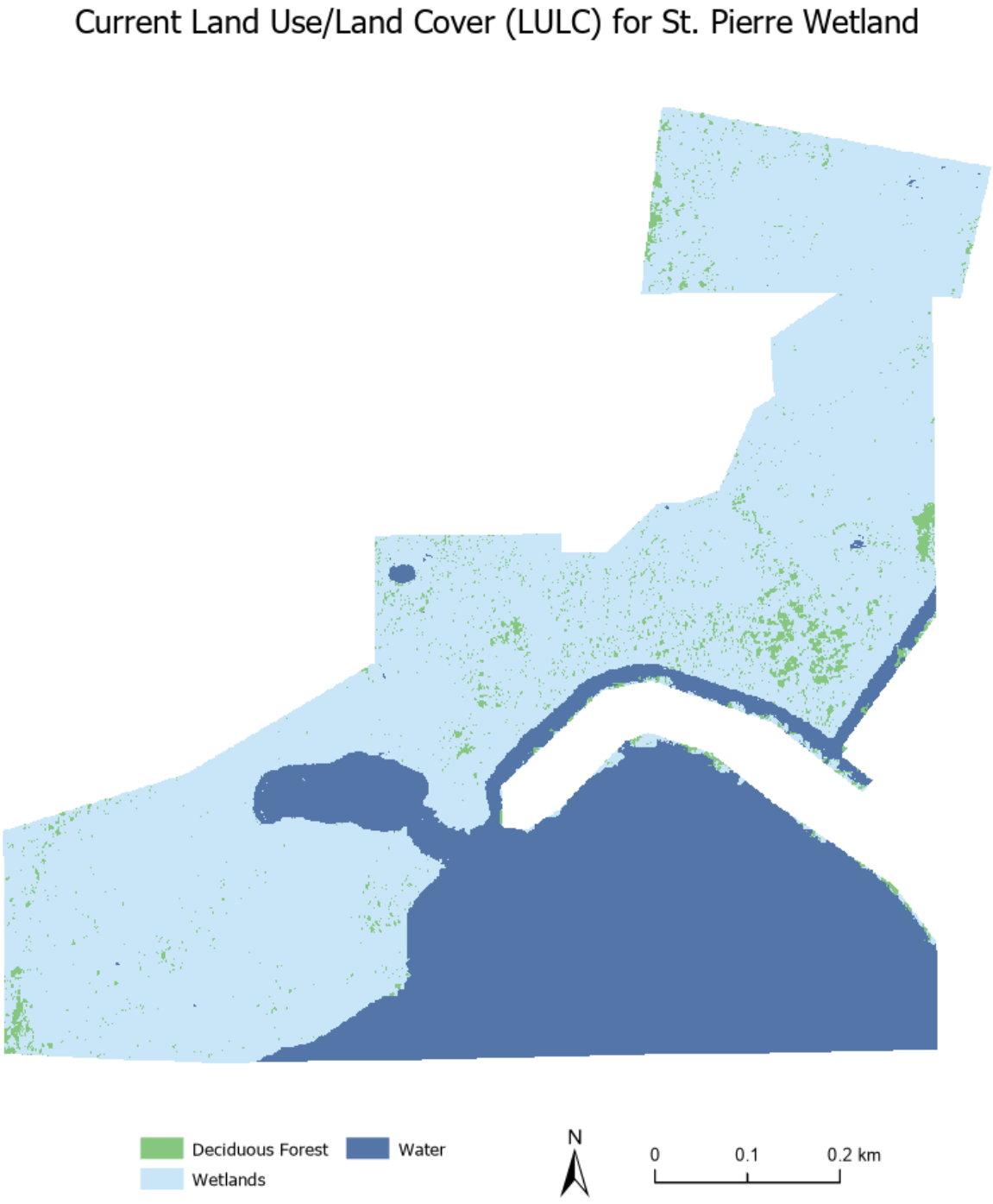


Figure 4-16. Current LULC for St. Pierre Wetland.

Stakeholders:

- Cordley Lake Association
- Portage-Base-Whitewood Owners Association

Future Vision/Recommendations:

St. Pierre Wetland is a vastly underutilized SEAS property. In order to increase the use of St. Pierre, there needs to be an increase in awareness about the property, as many individuals in the SEAS community do not know that the school owns a nearby wetland property. St. Pierre offers pristine habitat for wetland restoration and aquatic ecosystem research; thus, recommend that SEAS updates its website with greater information about St. Pierre, its needs, and its resources. This increased awareness is especially important with the influx of new faculty and students, who should be given the opportunity to understand the full scope of resources that the school can offer their classes and research.

Current conditions do not allow for easy access to the property, which limits its use for a class or lab teaching site. In this light, we recommend that accessibility on the property is expanded. Trails off of the Lakeland trail could make it more accessible to students and faculty for research and class activities. Drone imagery can be an effective tool in creating virtual tours of the property as well. St. Pierre has limited accessibility due to the nature of a wetland. A virtual tour can give people some base knowledge of resources and site conditions without the need to hike in with waiters off the Lakeland trail or access the property by boat. Additionally, signage is needed off the Lakeland trail to designate SEAS property from the publically accessible trail. St. Pierre is not open to the public and currently there is not adequate signage depicting the extent of SEAS' property. Increasing signage also increases University presence within communities. It is important to show the neighboring community that SEAS owns and cares for the neighboring property.

Part of showing the community that the university is a valuable neighbor is having active use and engagement with the property. Currently, the wetland property has many woody invasive species throughout the property. The school had Cardno (https://www.cardno.com/) quote the removal of these invasives, but the cost was outside of the current budget for the property (in excess of $30,000). One method to accomplish invasive removal at a lower budget is the use of community volunteers. The local Portage Lake Chain community is extremely active; residents care for the lake, and have investment in the condition of the wetland. Residents on the lake look directly out at the wetland from their property or from the water as they use the lake for boating, and have expressed great interest in helping maintain the St. Pierre property, including assisting with invasive species removal. Community workdays would be led by university staff, students, or caretakers from other SEAS properties.

Community involvement stems not only from volunteer workdays, but also through community education. A key insight from our social research is a strong local desire in the community for education in the care of wetland and lake ecosystems. Residents want to learn about the management of invasive species and the best practices for their property.

The school has a unique opportunity to communicate the science of nutrient loading and wetland restoration within a lake community, especially as Portage Lake Chain residents want to protect their home lake ecosystems. Education can come from faculty or student-led talks during community meetings, in addition to workshops and through interactive signage along the Lakeland trail. Informational pamphlets could be also created and disseminated to help inform local residents about invasive species, use of fertilizers, and ways to minimize disturbance. By sharing knowledge, the university extends its presence, expertise, and broader research to a local watershed community.

Moreover, the most effective way of sharing information is not a top-down model. SEAS can learn from the community about the needs, history, and conditions of the lake and wetland. Our interactions and interviews with community members surrounding St. Pierre Wetland showed endless enthusiasm for local stewardship action - a profound interest in pursuing joint action with faculty and students at SEAS (if they are not already involved), as well as local stewardship organizations and land conservancies. As unaltered, undisturbed wetlands are becoming more difficult to come by in the region, Portage Lake Chain residents (as well as the broader "Huron River Chain of Lakes" community) are very committed to the preservation of regional ecology. Additionally, both the Cordley Lake Association and the Portage-Base-Whitewood Owners Association have offered data, advertising partnerships, and other resources to the school, and are willing partners in future university action in the area. Especially in light of the future master's project proposed in the region (see Section III, Subheading I), accessing these well-established social networks will be paramount for advancing stewardship, social capital, education, and university presence among residents and community members.

The final recommendation for St. Pierre is to investigate a collaboration with local landowners and conservation groups to create a larger corridor of preserved wetland habitat. This venture would include two wetland properties adjacent to St. Pierre Wetland that have recently been put on the market (Fig. 4-17). According to Bioreserve Assessments conducted by the Huron River Watershed Council in 2017, these properties are the last intact wetland prairie ecosystems in Hamburg Township that remain unprotected (see supplemental files). Our social research highlighted a particular enthusiasm among local realtors to secure the properties for preservation, rather than allow it to enter the market for residential development. Though this partnership fell outside the scope of this master's project, it is highly recommended that SEAS partner with conservation organizations, land conservancies, and neighboring communities (Appendix C) to help protect these wetlands from future development and degradation. Helping conserve and restore these vital ecosystems would benefit the entire watershed ecosystem and community. Similar to the recommendations for Stinchfield Woods, the protection of these wetlands provides an opportunity for collaboration with local land conservancies and/or local units of government in Livingston County.

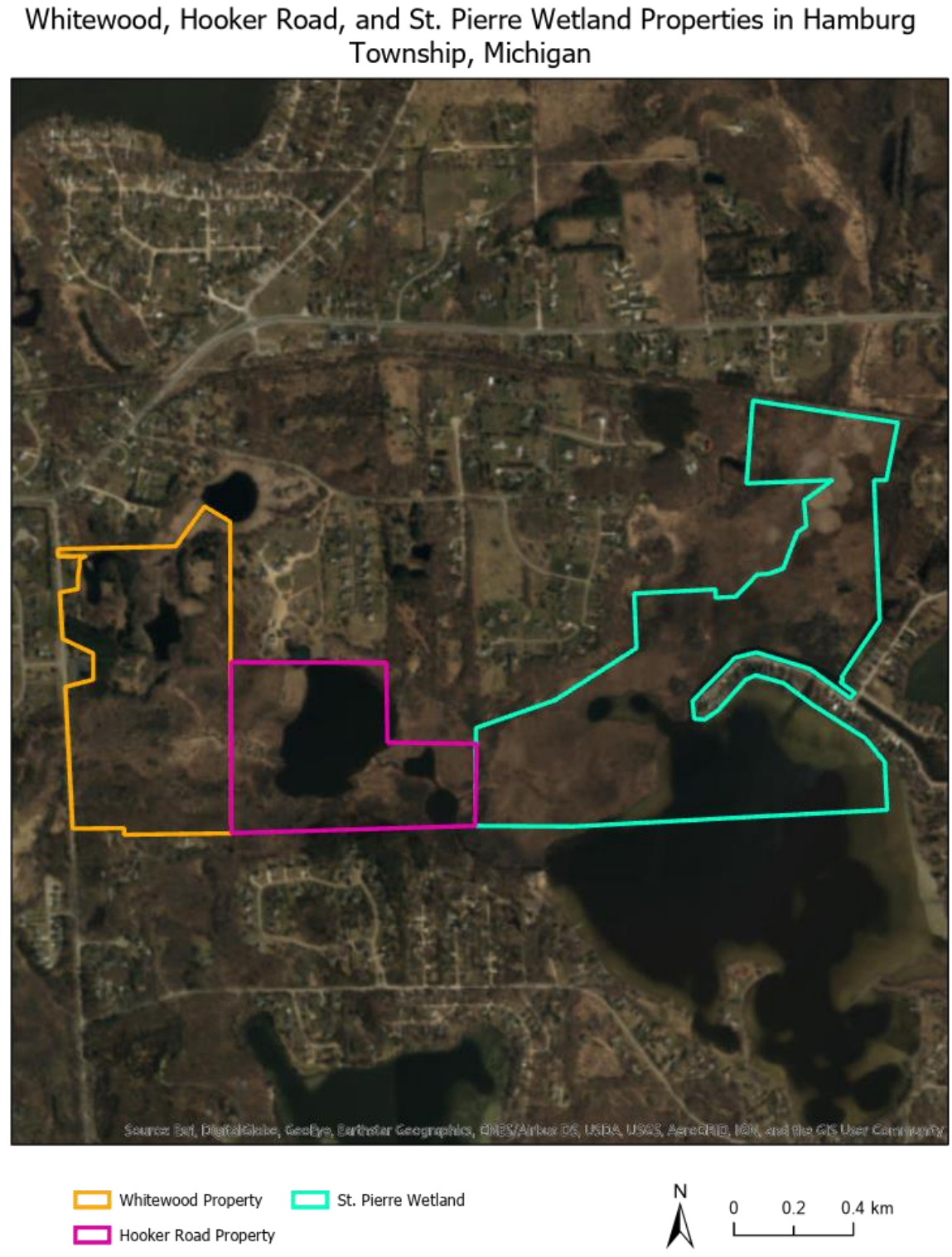


Figure 4-17. Proposed "wetland corridor" adjacent to St. Pierre Wetland.

E. HARPER PRESERVE

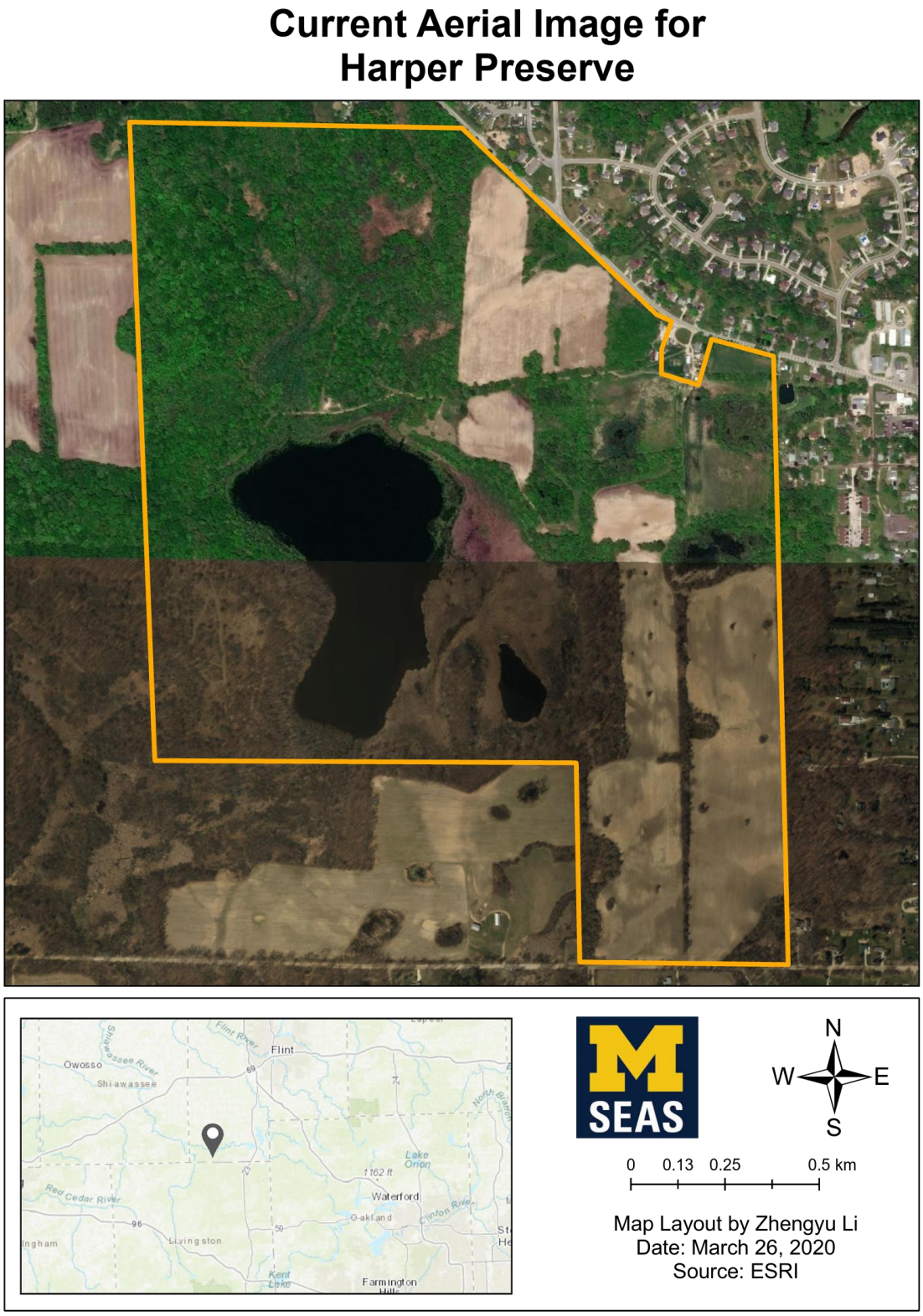


Figure 4-18. Current aerial image of Harper Preserve.

Figure 4-19. Murray Lake and agricultural land at Harper Preserve (Photos by U-M SEAS Staff).

Historical Uses:

Harper preserve was donated to the School of Natural Resources by the Hoyt family in 1974 in memory of William Albert Harper, Mrs. Willabelle Hoyt's father, to be used by the school for teaching and research. At one time almost half of the property's 375 acres were converted to farmland, and the property is currently under lease to a farmer who grows crops on about 80 acres.

Beginning in 1959, Richard Wolverton (the current property farmer) began farming the property after his father, who had rotated corn, oats, hoyt beans, and wheat through 240 acres since 1940. Over time, the planted land has decreased to between 60 and 90 acres; currently, the only crops planted and rotated are corn and soybeans, and are farmed by Dennis Corey and his son Sean (local generational farmers).

Over time, there has been very little academic activity at Harper. Historically the only class to use the preserve has been the Aquatic Ecology course, though there is interest from faculty in agroecology and GIS. There is no record of any research at the property, and the property has not been managed as a natural area while owned by SEAS.

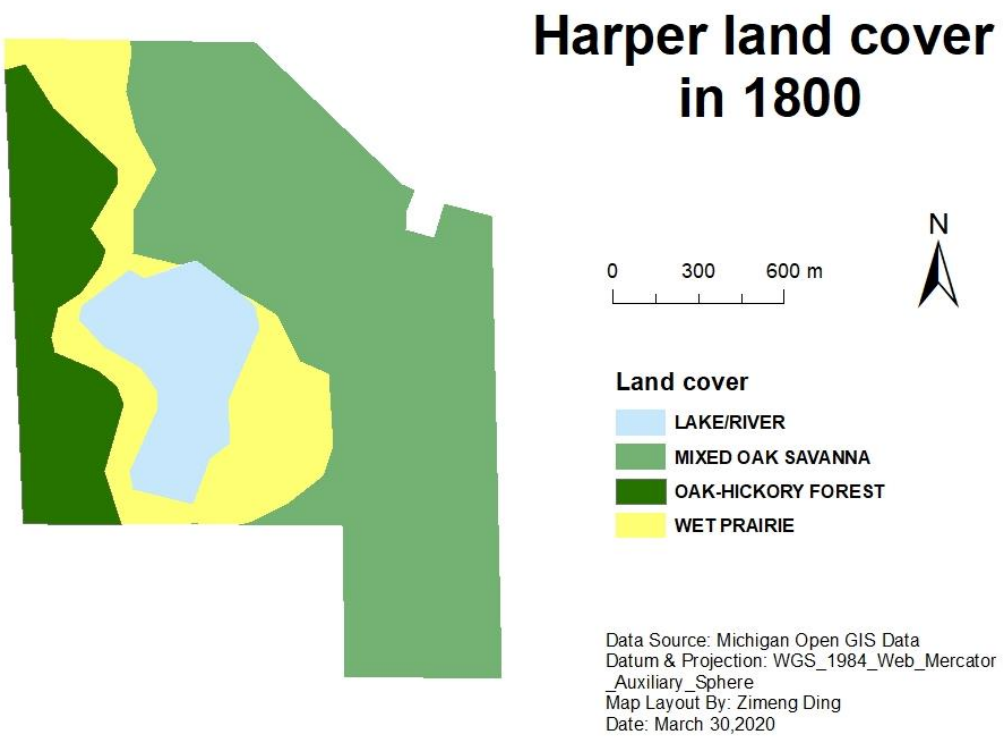


Figure 4-20. Harper Preserve land cover in 1800.

Current Uses:

According to our supervised LULC classifications (Fig. 4-21) and data from the National Wetlands Inventory (USFWS, 2018), the 375-acre property is comprised of a 40 acre lake (Murray Lake, named after James Murray, the first white settler of the area), 130 acres of deciduous forest, 45 acres of freshwater emergent wetland, and 35 acres of freshwater forested/shrub wetland. There are also 33 acres of herbaceous land, including old fields undergoing succession back to forest, and 90 acres of conventional agricultural land (corn and soy). Mr. Wolverton, the lessee of the property, farms the cropland and keeps an eye on the property as a whole.

Our analysis of carbon storage at Harper Preserve showed that the equivalent of 200,000 tons of CO_2 are currently stored in the forest and soils of the property. Because of the history of agriculture, the forested portions of the property accounted for only 20% of total carbon storage, while the lake and wetland soils accounted for about 75% of the carbon stored at the property. Based on the current price of carbon in the California Market of \$15/metric ton CO_2 there is the equivalent of about \$3.0 million of carbon currently stored in the trees and soils of Harper Preserve. Every year this property sequesters the equivalent of between 530-1130 metric tons of CO_2 (Curtis et al., 2002; Froelich et al., 2015; Gahagan et al., 2015; Bernal & Mitsch, 2012; Khalil et al., 2020), the equivalent of between \$8,000 and \$17,000 worth of CO_2.

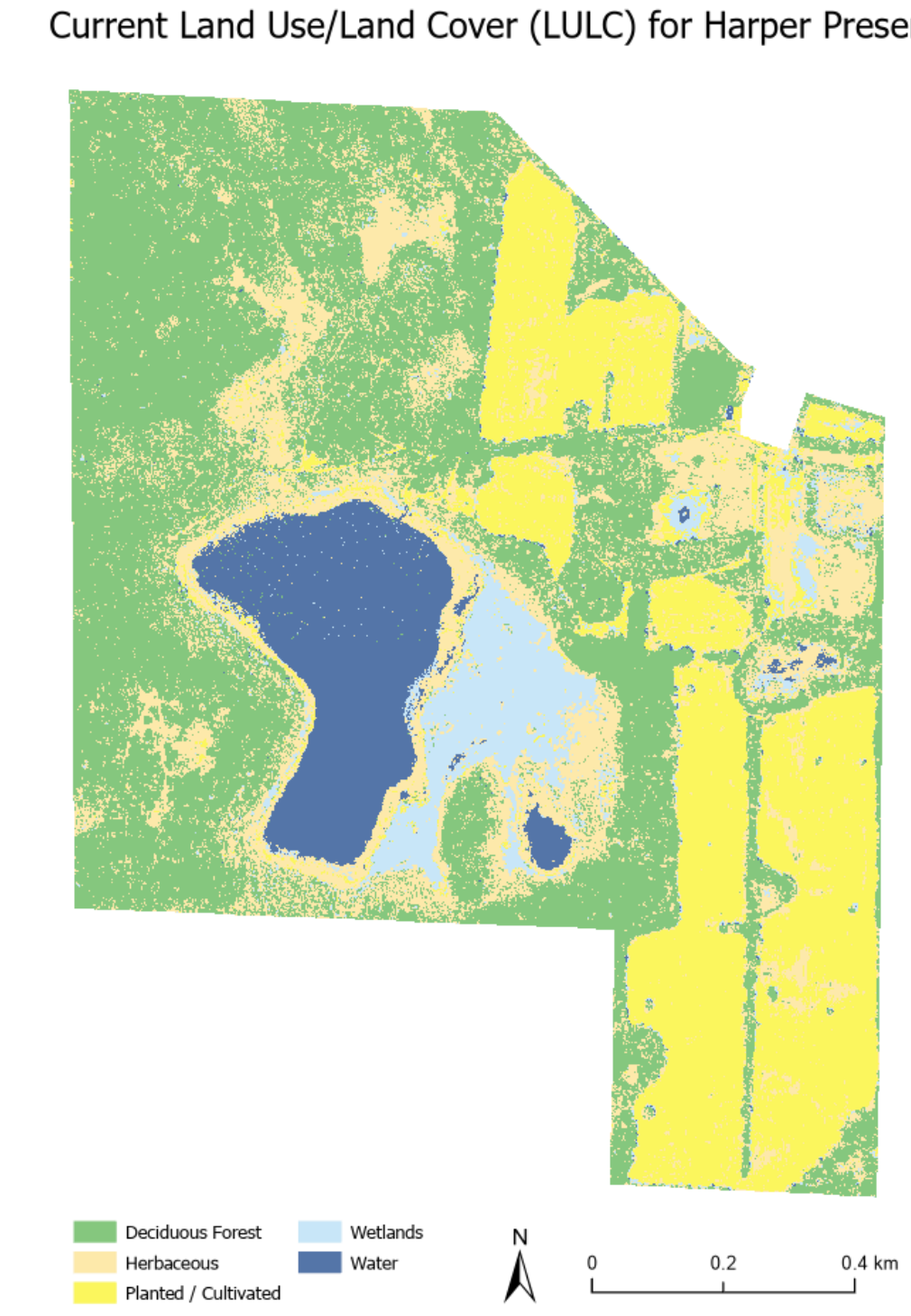


Figure 4-21. Current LULC for Harper Preserve.

Stakeholders:

- Richard Wolverton (property lessee) and family
- Dennis and Sean Corey (current planters)

Future Vision/Recommendations:

The region surrounding Harper Preserve has a rich agricultural history, and is built around a culture of generational farming. While some of the generational farming community is in decline (with many smaller farms being bought out by larger farms and housing developments), the potential for sustainable agriculture, cooperative farming partnerships, and the exploration of renewable energy is promising. Though only about ten large farms remain, the social ties in the farming community are still very strong, and would provide a strong foundation for future sustainability efforts in the region.

In our interview with Richard Wolverton, he expressed that the decline in generational farming seems to be due to interest changes between generations, in addition to the expenses and difficulties of establishing a farming lifestyle at later stages of life (typically, farms need to be passed down through families in order for them to have a chance to be financially viable). As a result, many local farms who do not have the capacity to look after the entirety of their land lease acreage out during the growing seasons to other farms, who can potentially secure land for themselves in the future should these partnerships remain constant. In this way, the land can continue to stay in agricultural rotation, rather than being sold off to developers. Locally, there has also been a slow transition from cattle and dairy to crop farming, which leaves a fair amount of local acreage out of livestock rotation. In the midst of this surrounding cultural and economic landscape, Harper Preserve is in a unique position to be utilized in the future due to its ties with the university, particularly in terms of research, partnership, and potential experimental uses.

There are over 80 acres of agricultural fields and 33 acres of herbaceous cover at Harper Preserve that can be converted into a renewable energy demonstration area. There have been many recent studies that have shown that solar fields can be placed over agricultural production or herbaceous prairie without significantly impacting the growth of the plants underneath (Barron-Gafford et al, 2020). Such solar farms can produce electricity at about 150kW/acre (https://newlook.dteenergy.com), though agrivoltaic systems are constructed at a slightly lower density of solar panels than a traditional solar farm. If all available agricultural and herbaceous land was converted to solar, the property could potentially produce 16.95 MW/year which would be the second largest solar farm in Michigan. At 18% efficiency this would produce $2.7 million dollars worth of electricity (assuming $0.10/kWh) per year. SEAS can be at the forefront of this research by converting some of these areas to solar farms and encourage faculty in the Sustainable Food Systems Initiative and ecosystem services to conduct research at the property. There could also be agricultural partnerships with local farmers at the property, while allowing for faculty and students to conduct research concurrently. This approach would also create income for

SEAS, which could be used to further promote use of the research properties, and possibly fund property management by hiring land managers.

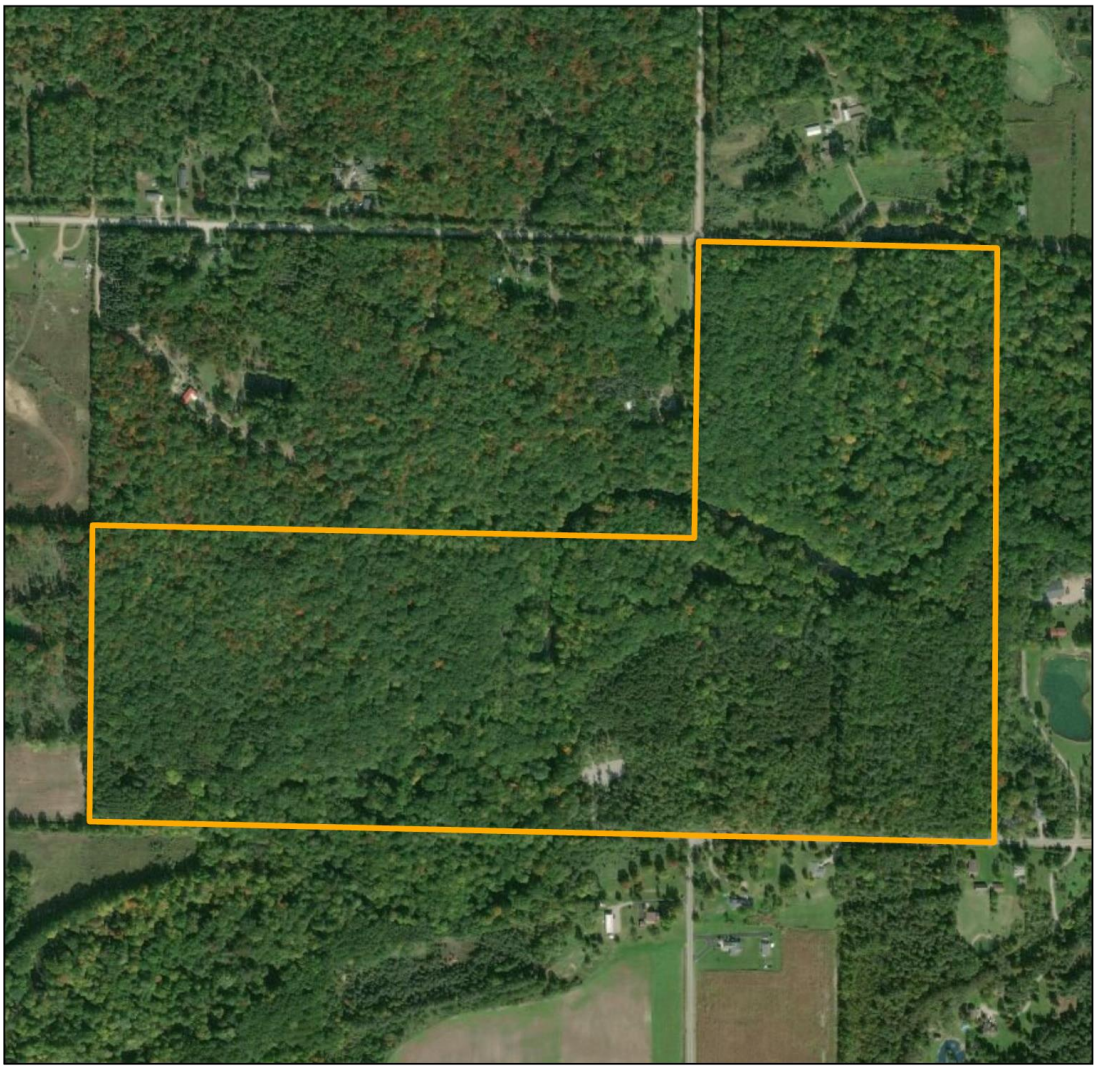
In this light, the potential for sustainable agriculture at Harper is extremely auspicious. In our interview with Mr. Wolverton, he stated that the university was doing a fine job with the property currently, and recommended being in touch with Dennis and Sean Corey, who would be a wealth of information. This undertaking could benefit from reclaiming the 70 or so acres that have currently entered early succession, and though this land has not been farmed in over forty years, Mr. Wolverton expressed an interest in seeing it planted again. Thus, we see the promising beginnings of a dual-use partnership for the property: research in sustainable energy and agriculture, in conjunction with overlaps with the local farming community to help manage the property's potential. As there are very few avenues into the community other than local farming networks, this approach would be an encouraging model for students to take part in, leading to powerful insights into generational farming.

Additionally, Harper can be used as a research and teaching site for topics of sustainable agriculture. SEAS has a growing interest in sustainable agriculture and Harper can serve as an experimental farm for the exploration of many unique farming practices. The school should examine the potential of Harper for perennial crops, cover cropping, and rotational grazing. Cattle grazing could also serve to establish a connection with MDining (https://dining.umich.edu/about-us/sustainability/) who has been looking to build partnerships in the production of local beef. Harper could also be used for smaller scale research or class projects. A simple project could be monitoring soil health as sustainable and regenerative farming practices are implemented. All new farming practices would be in conjunction with the implementation of solar. This would allow for the exploration of mixed-use farm properties. Harper could also look to partner with local farmers who are interested in the sustainability themes of U-M researchers and who would want to provide food to the Flint and Ann Arbor campuses and the Flint, Brighton, and Ann Arbor markets. Partnerships with local farmers could be explored through the Flint Fresh Food Hub (https://www.flintfresh.com/) and the Flint Farmers' Market (https://www.flintfarmersmarket.com/).

Finally, Harper Preserve is located less than a half-hour drive from U-M Flint. SEAS should partner with U-M Flint and provide access to the property to faculty and students for research and learning purposes. Currently, the Wildlife Biology program and others at Flint currently have no access to university-owned research properties, and a partnership would help increase educational use of the property and increase the university presence at Harper Preserve and the surrounding community. A partnership with U-M Flint would also encourage and increase collaboration across the larger University of Michigan community.

F. RINGWOOD FOREST

Current Aerial Image for Ringwood Forest



SEAS

N
W E
S

0 0.13 0.25 0.5 km

Map Layout by Zhengyu Li
Date: March 26, 2020
Source: ESRI

Figure 4-22. Current aerial image of Ringwood Forest.

Figure 4-23. Ringwood Forest (Photos by U-M SEAS Staff).

Historical Uses:

Originally part of the great old-growth pine forests of Michigan, Ringwood Forest was first logged in 1862 by Eleazer J. Ring, an early owner of the land. The cleared land was opened up for farming, however, in 1883, after it was made evident that the land's sandy soil was not suitable for crops, Eleazer's eldest son, William Lee Ring, decided to plant areas of red and white pine. Sections of these pine plantations still remain and are considered some of the oldest in the state of Michigan and the entire country. Land that was not planted with pines or used for farming was left to undergo primary succession to hardwoods, including oak, beech, elm, ash, maple, and walnut. In 1920, The Ford Motor Company purchased all of the hardwood stands for clear cutting (Vandendriesche, 1982).

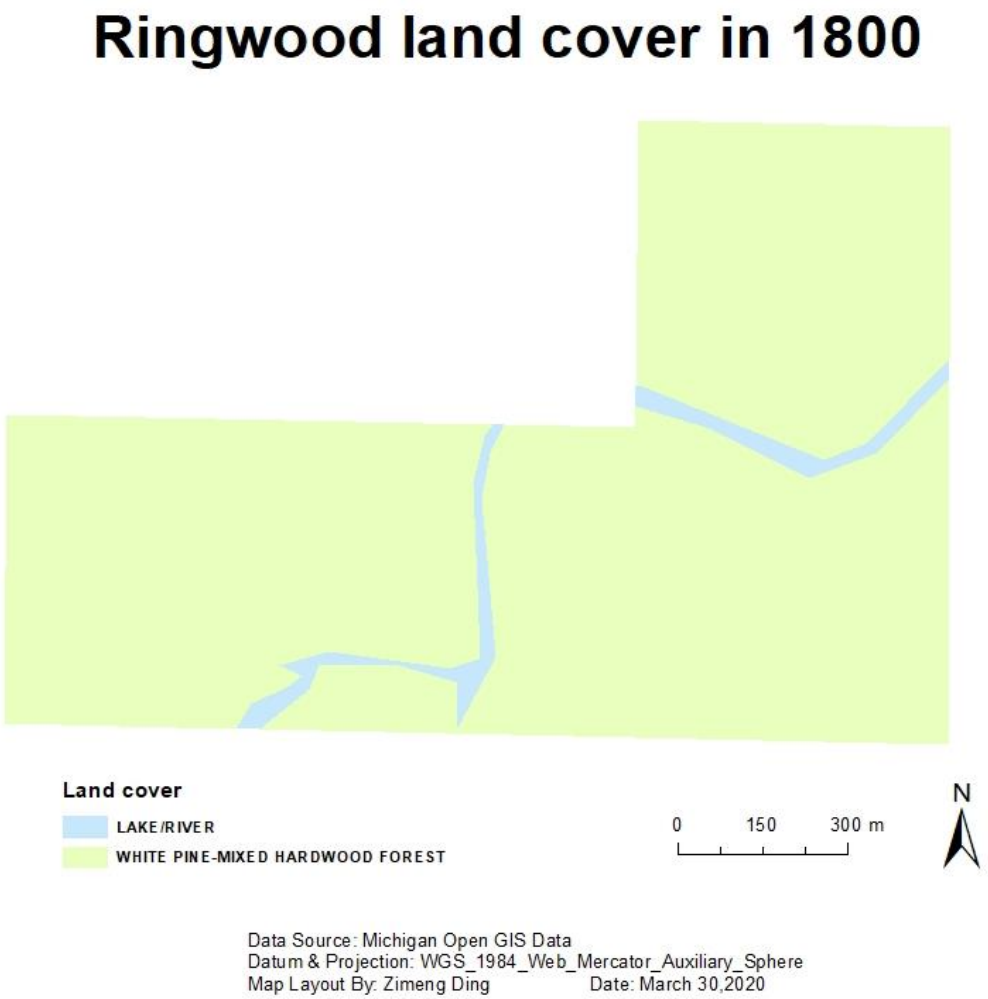


Figure 4-24. Ringwood Forest land cover in 1800.

In 1930, Ringwood Forest was donated to the University of Michigan by Clark L. Ring, the youngest son of Eleazer, in memory of his brother William, on the condition that the University use the property for "instruction, demonstration, and research in forestry". After acquiring the land, the University of Michigan's School for Natural Resources began managing the area and initiated an extensive planting program that lasted until 1941. Forest management research was also conducted and fire lanes were constructed. Several timber sales took place during this time with the last occuring in the mid 1950's (Vandendriesche, 1982).

In 1983, the University of Michigan entered into a 30-year lease agreement with the Saginaw County Parks and Recreation Commission that allowed Ringwood Forest to be used by the Commission for public forestry education and recreation. That lease was recently renewed in 2013 for another ten years. The park was officially opened to the public in June 1987. Facilities include 3.5 miles of trails for hiking and cross-country skiing, educational displays, a canoe launch which accesses the Bad River, a children's play area, and a picnic pavilion.

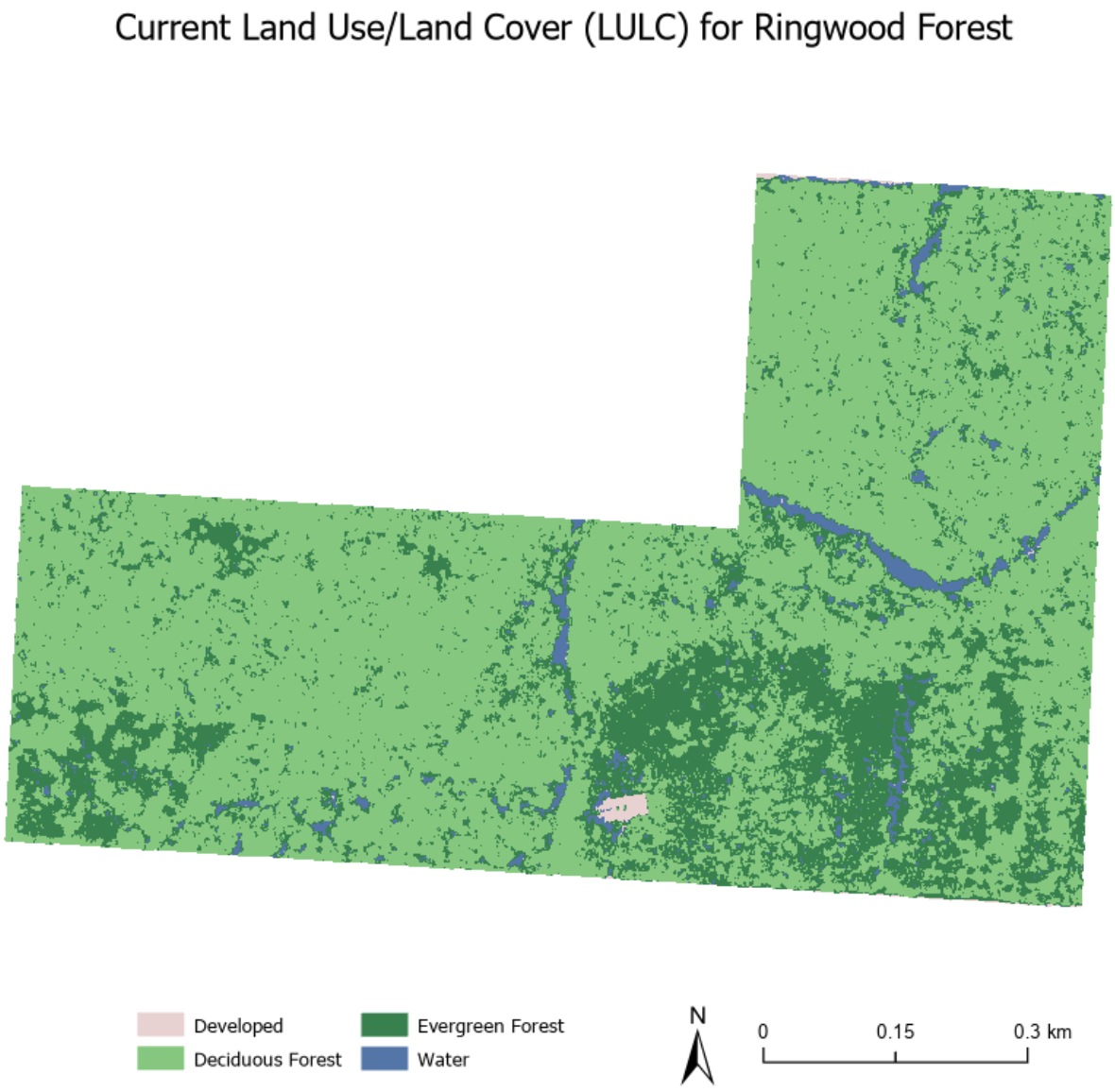


Figure 4-25. Current LULC for Ringwood Forest (Note that the small area of developed land cover is the parking lot and bathroom area of the park).

Current Uses:

According to our supervised LULC classifications (Fig. 4-25) and data from the National Wetlands Inventory (USFWS, 2018), 160-acre property consists of approximately 70 acres of deciduous forest, 27 acres of coniferous forest, and 63 acres of freshwater forested wetlands.

Our analysis of carbon storage at Ringwood Forest shows a stock of the equivalent of 108,000 metric tons CO_2. Aboveground and belowground woody carbon stocks account for a majority of the carbon stored on the property. Every year this property sequesters the equivalent of between 380-807 metric tons of CO_2 (Curtis et al., 2002; Froelich et al., 2015; Gahagan et al., 2015; Bernal & Mitsch, 2012; Khalil et al., 2020), primarily occurring in woody plant growth. Based on California Carbon Market prices in 2020, the value of this sequestration is roughly $5,700-$12,000 per year.

Ringwood Forest is currently managed by Saginaw County Parks & Recreation under a long-term lease from SEAS. The Parks department conducts all management and maintenance at the property, which is open to the public as a county park (https://www.saginawcounty.com/departments/parks__recreation/ringwood_forest.php) . There is a parking lot with space for about 50 cars. There are a few miles of trails that visitors use for hiking and cross-country skiing and a boat/canoe launch into the Bad River. There is also a public restroom, playground, grills, and a pavilion that visitors can rent out for events.

Stakeholders:

- Saginaw County Parks & Recreation
- Local residents and landowners
- Seasonal visitors and recreationalists

Future Vision/Recommendations:

Because of the distance from all U-M campuses, the project team recommends that Ringwood Forest continue under the current lease arrangement with Saginaw County Parks & Recreation, which has done all management and maintenance of the property and trails since 1983. Nevertheless, some steps could be taken to increase U-M presence, including adding signage and providing opportunities for students and faculty to visit the property.

Saginaw County Parks staff are very open to the possibility of working more closely with SEAS and there are potential opportunities for faculty and student research in forest ecology, soil ecology, fluvial ecology, and other fields. The property is also located much closer to U-M Flint than Ann Arbor, and could provide another avenue for partnership similar to that of Harper Preserve. Ringwood may be a perfect location for students and faculty in Flint to conduct research on university landholdings.

APPENDIX A - METHODS

I. Remote Sensing and GIS Analysis

Method 1: (Supervised LULC Classifications)

To analyze the current land use and land cover (LULC) for the six SEAS properties, we conducted supervised LULC classifications for each property. We first acquired GIS data and imagery files, including property boundary shapefiles, high resolution aerial imagery from Nearmap, and 2018 color infrared imagery from the USDA's National Agriculture Imagery Program (NAIP). Using the NAIP imagery and ArcGIS Pro software, training samples were created for the seven main land cover types from the National Land Cover Database 2011 (NLCD2011) - developed, deciduous forest, evergreen (coniferous) forest, herbaceous, planted/cultivated, wetlands, and water. Nearmap (natural color, leaf-on) and the ESRI Basemap: World Imagery (natural color, leaf-off) were also used to help interpret the different land cover types.

Once a sufficient number of training sample polygons were created to represent the full spectral range within each class (e.g. darkest to lightest areas of water), a supervised classification was run using the Support Vector Machine method to create the final LULC outputs. To calculate the area (in hectares) of each of the classified land cover types, the LULC raster was transformed into a polygon feature class. A new field was then created in the attribute table to calculate the areas and summarize the results.

Accuracy assessments for the forested LULC classifications were conducted by comparing the supervised LULC classifications with field data from five of the SEAS properties (See Appendix A, Section II). Using NAIP 2018 imagery, the GPS points from the field were plotted and 10 m x 10 m polygon squares were drawn for each vegetation survey plot. Training samples were created for the polygons, which were designated as either deciduous or evergreen forest based on the field data and a majority rules method. Accuracy assessments were then run with the ground truthed training samples as the reference dataset to create output confusion matrices.

In order to explain the results, we utilized ggplot (Wickham, 2016) to visualize the final accuracy assessment. The first graph (Fig. A-1) shows the user accuracy and producer accuracy for each property in different land cover types. User accuracy is computed by dividing the n of correctly classified mapped pixels in each class by the total number of pixels (row total) that were classified into that class. It indicates the probability that a pixel classified into a given mapped class actually represents that class on the ground. Producer's accuracy is computed by dividing the n of correctly classed mapped pixels in each class by the n of testing set pixels (column total) used for that class. It tells how well the testing set pixels of a particular class are classified.

Figure A-1. User accuracy and producer accuracy for LULC classifications.

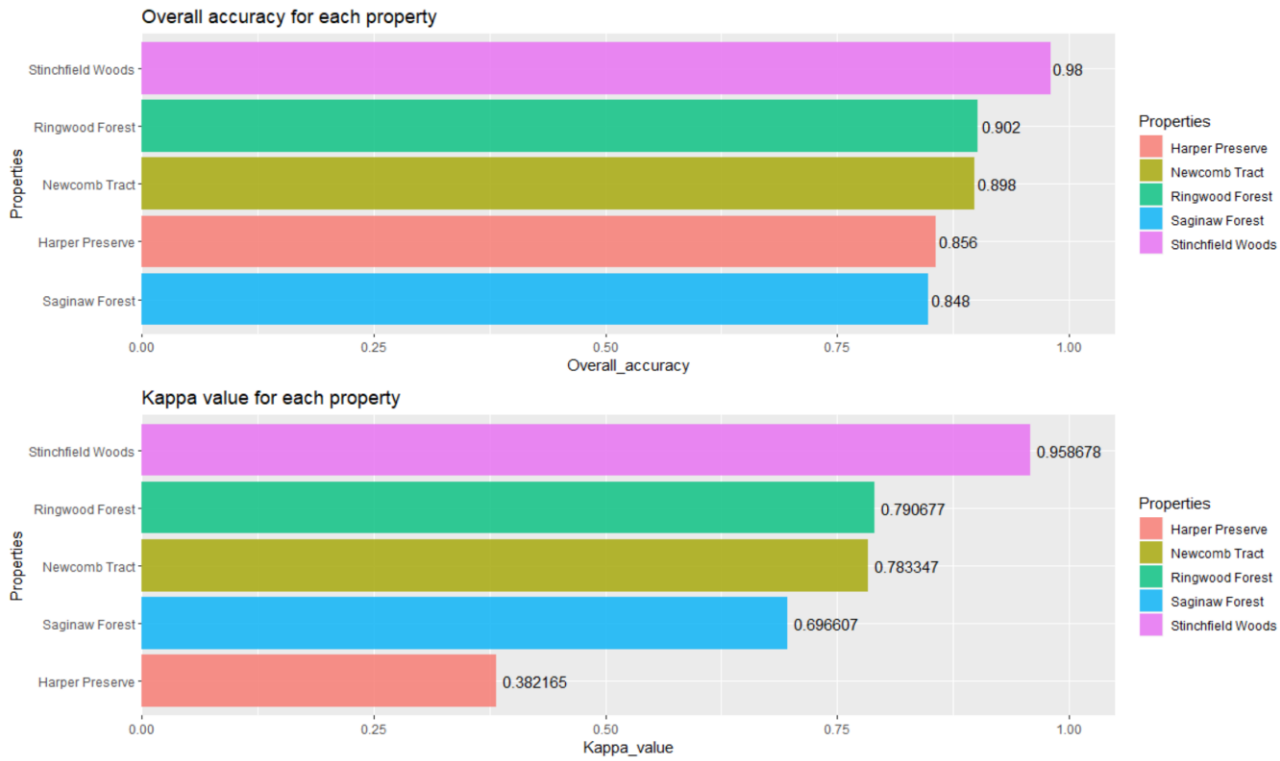


Figure A-2. Overall accuracy and kappa values for LULC classifications.

The second graph (Fig. A-2) explains the overall accuracy and kappa value for each property. Other than overall accuracy, kappa statistic is an indicator of the extent to which the percentage correct values of an error matrix are due to true agreement versus chance agreement. For example, with Newcomb Tract, the land cover classification for deciduous forest had a 98% user accuracy. Evergreen or coniferous forest had a 79% user accuracy as it contained more mixed vegetation. Overall, accuracy was 78%, which indicates that this method is valid and can be applied to other natural areas.

Method 2: (Combining LULC with National Wetlands Inventory data)

Unlike forested land cover, supervised LULC classifications for wetlands do not have a high accuracy rate as there is a high probability that forested wetlands will be classified as forest and emergent wetlands will be classified as herbaceous. Therefore, to get a more accurate assessment of the wetlands land cover area for each of the properties, the supervised LULC classifications were rerun without the training samples for wetlands. The latest data from the National Wetlands Inventory (USFWS, 2018) was then downloaded and clipped to the individual property boundary polygons.

After converting the supervised LULC raster files to polygons, the wetlands polygons were erased from the LULC polygons. In the LULC attribute table, a new field was created to calculate the area in hectares for each cover type and summarize the results. The same was done for the wetlands polygons to find the area of each wetland type (freshwater forested/shrub and freshwater emergent).

II. Field Data and Carbon Storage

Field data for carbon storage within woody biomass were collected at each of the forested properties. There were no plots established at St. Pierre Wetland because there were not enough large trees to warrant the use of woody biomass calculations. Within each property, a series of 10 m x 10 m plots was established in order to cover a representative sampling of cover types across each property (Fig. A-3 to A-7). Before each site visit, rough placements of the plot locations were selected from aerial imagery. Each property contained 8 - 12 plots divided between deciduous and coniferous cover types. In the field, plots were randomly established by blindly throwing a flag to establish the southwest (SW) corner of the plot. The location of the SW corner was recorded with a Garmin GPS unit. Within the plot, every tree larger than 10 cm in diameter at breast height (dbh) was counted. Species and dbh were then recorded. Field data collection took place between November 2019 and February 2020.

Figure A-3. Field sample plots for Saginaw Forest.

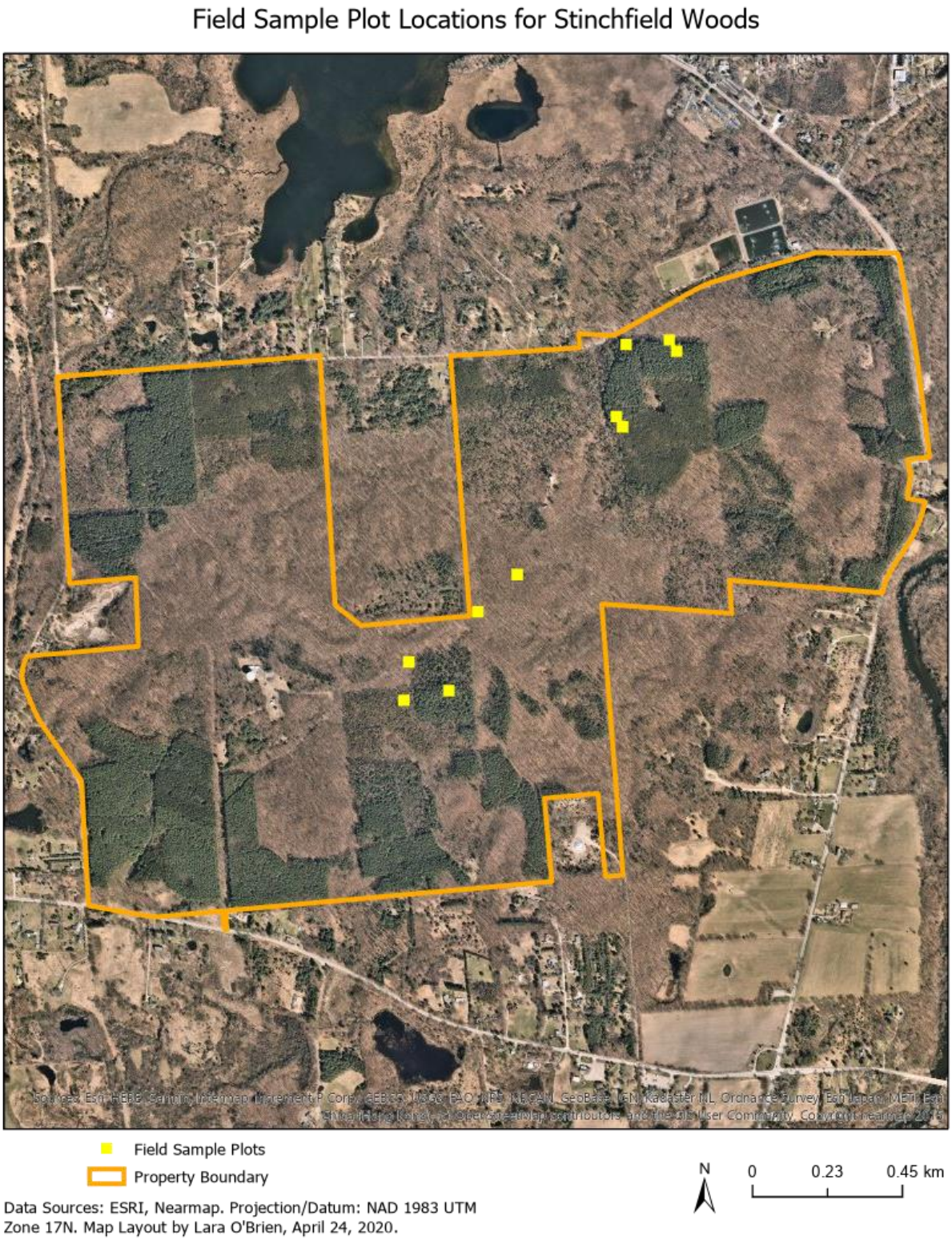


Figure A-4. Field sample plots for Stinchfield Woods.

Figure A-5. Field sample plots for Newcomb Tract.

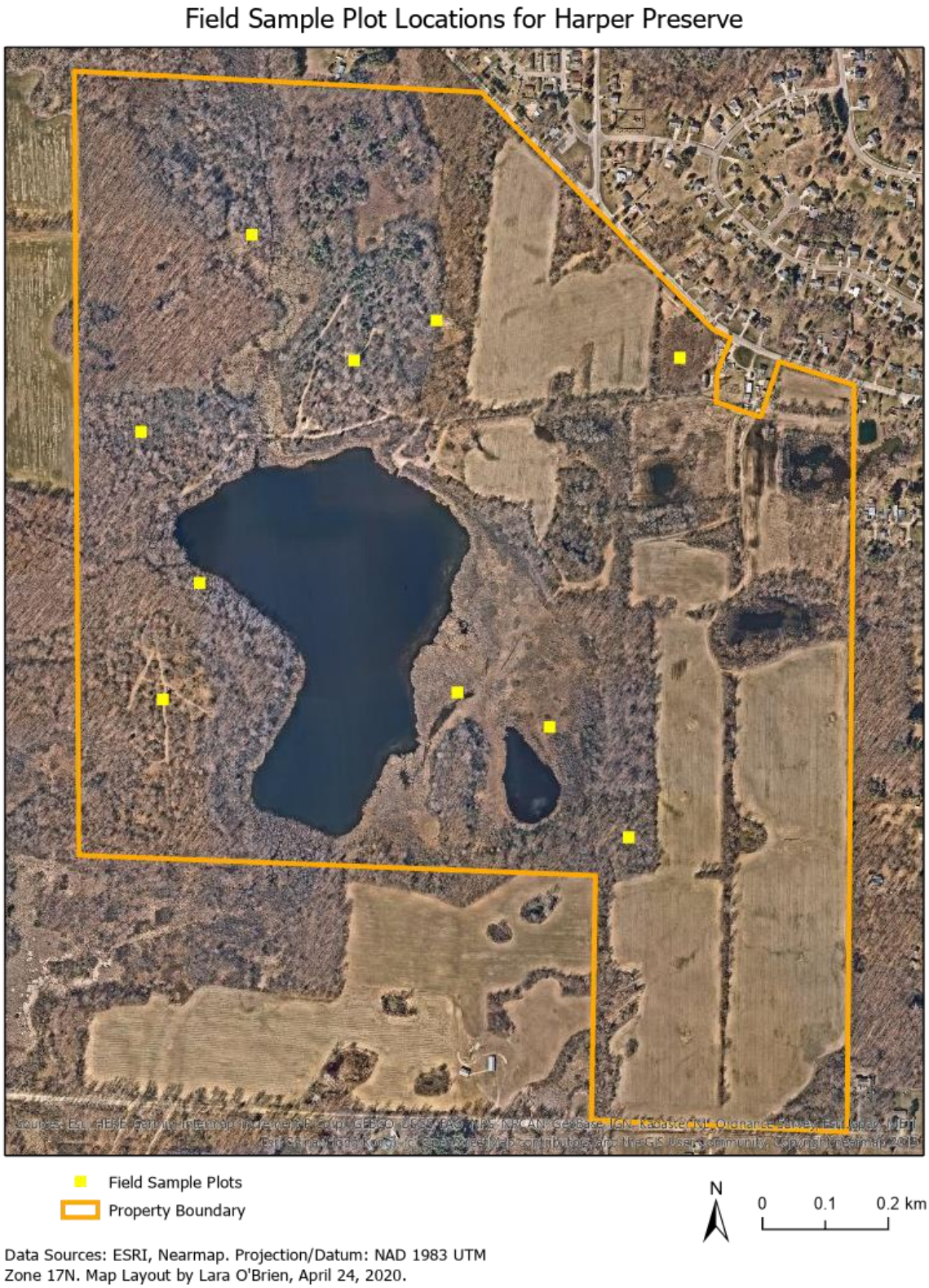


Figure A-6. Field sample plots for Harper Preserve.

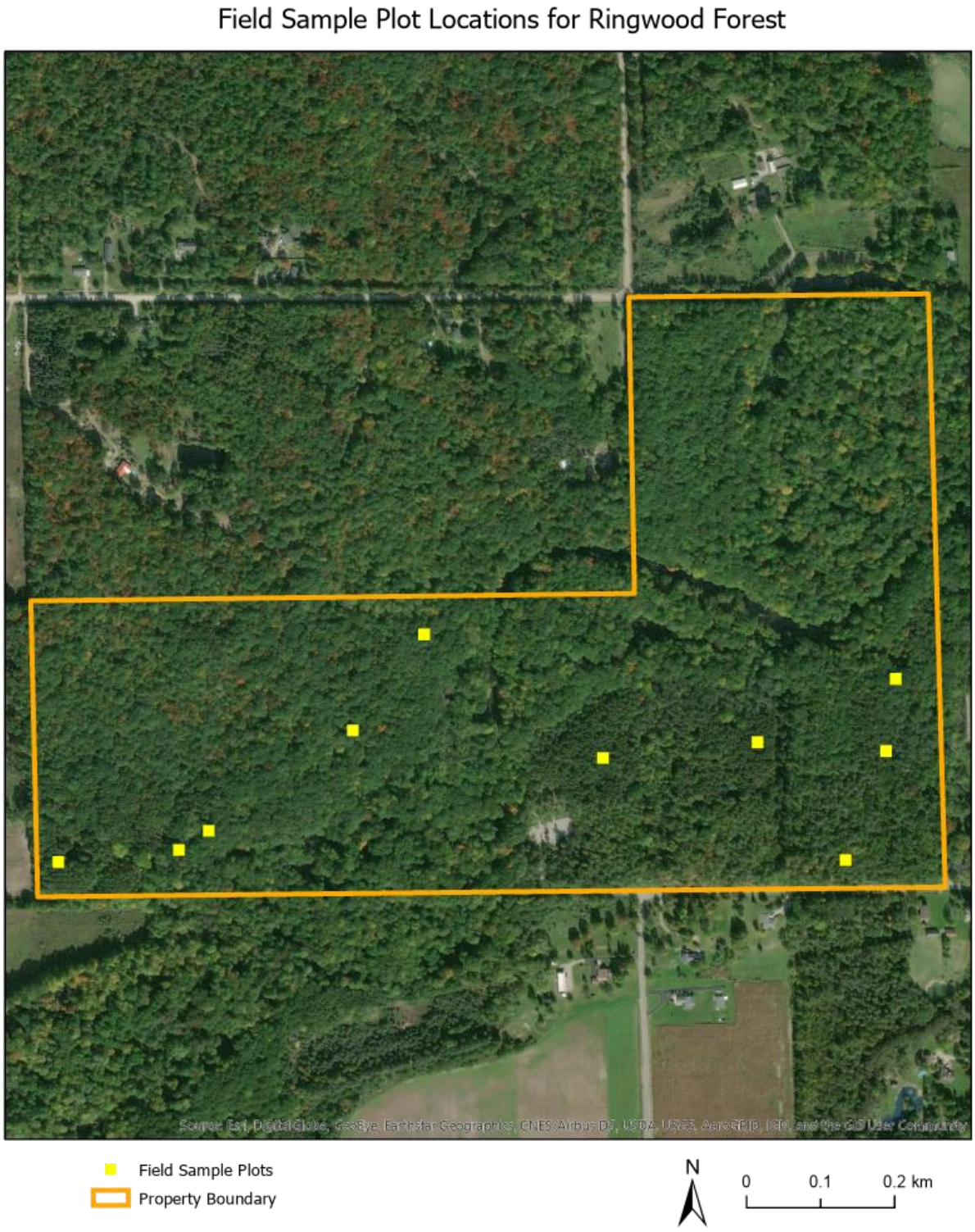


Figure A-7. Field sample plots for Ringwood Forest.

Species group and DBH were used to calculate the biomass of each tree using allometric equations (Jenkins et al 2003). Species groups were classified as Hard Maple/Oak/Hickory/Beech, Mixed Hardwoods, Soft Maple/Birch, Aspen/Alder/Cottonwood, Spruce, Cedar/Larch, and Pine. Root biomass was estimated through an allometric equation using the natural log of the aboveground biomass. Biomass was then converted to the carbon content in the trees using an estimate of carbon as 50% of woody biomass. Carbon content was then converted to mass of CO_2 using the molecular weight of C and CO_2.

The LULC classifications were then converted to polygons using ArcGIS Pro and the area of each cover type was calculated. When calculating the estimate of carbon storage on each property the summed total area of deciduous forest cover and coniferous forest cover were used to extrapolate the field data calculations to the property as a whole using the equation: $Ct = \Sigma Cf * (\Sigma At / \Sigma Af)$ where Cf is the carbon estimate calculated from field data, At is the total area of the given cover type present at the property, and Af is the area of the field sites. The total carbon stored in aboveground woody biomass was calculated by summing each of these cover types. Belowground biomass was calculated using the equation: $BGB = e^{(-1.0587+(0.8836*ln(AGB)+0.2840)}$ which was developed for use by the U.S. Forest Service by Cairns et al. (1997).

Soil carbon is a large percentage of carbon storage in natural areas. Using the USDA Web Soil Survey soil map layer, the team clipped the boundaries of each of the SEAS properties and recalculated the area of each soil type. Then the USDA Natural Resource Conservation Survey's soil lab results (National Cooperative Soil Survey) were analyzed and average soil carbon percentage and bulk density numbers were calculated to use for estimating each property's soil carbon. These data were converted to tons/hectare and multiplied by the total area, in hectares, of each soil type.

Minimum and maximum carbon sequestration rates for each property were estimated from published rates from the Great Lakes region (Tables A-1 and A-2). The lowest and highest published numbers were used and the carbon sequestration rate for each property was calculated using the areas of each land cover from the LULC maps for each property.

Habitat type	Literature-based sequestration rate range (MtCo2e/ha/y)	Citation
Forest, Coniferous	8.43	Gahagan et al., 2015
Forest, Deciduous	10.63	
Forest, Deciduous	6.60-11.73	Curtis et al., 2002
Forest, Mixed	7.11	Ma et al., 2020
Forest, Mixed	5.46-7.52	Froelich et al., 2015
Forest, Reforestation of Agricultural Land	8.8-18.33 for 20 years then 6.97-14.67	Niu and Duiker, 2006
Prairie	1.47-1.91	Khalil et al., 2020
Wetland	4.54-15.03	Bernal and Mitsch, 2012
Wetland	5.24	

Table A-1. Literature-based Carbon Sequestration Rates for different cover types present on SEAS Properties.

Site Name	Developed	Deciduous	Coniferous	Herbaceous	Agriculture	Water	Wetlands	Total Sequestration Rate
SEAS Properties				Low Rate				Mt CO2e/yr
Harper Preserve	0.0	348.4	0.0	19.9	0.0	0.0	167.8	536.2
Stinchfield Woods	0.0	1276.0	624.8	4.1	0.0	0.0	9.1	1914.0
St. Pierre Wetlands	0.0	9.5	0.0	0.0	0.0	0.0	180.9	190.4
Ringwood Forest	0.0	187.3	59.3	0.0	0.0	0.0	133.7	380.3
Saginaw Forest	0.0	112.5	46.4	0.4	0.0	0.0	39.4	198.7
Newcomb Tract	0.0	381.3	127.2	1.1	0.0	0.0	78.1	587.7
Total	0.0	2315.1	857.7	25.5	0.0	0.0	608.9	3807.3

Site Name	Developed	Deciduous	Coniferous	Herbaceous	Agriculture	Water	Wetlands	Total Sequestration Rate
SEAS Properties				High Rate				Mt CO2e/yr
Harper Preserve	0.0	619.3	0.0	25.9	0.0	0.0	481.3	1126.5
Stinchfield Woods	0.0	2267.9	964.7	5.3	0.0	0.0	26.0	3263.9
St. Pierre Wetlands	0.0	16.9	0.0	0.0	0.0	0.0	518.8	535.7
Ringwood Forest	0.0	332.9	91.6	0.0	0.0	0.0	383.4	807.9
Saginaw Forest	0.0	199.9	71.6	0.6	0.0	0.0	113.0	385.1
Newcomb Tract	0.0	677.7	196.4	1.4	0.0	0.0	224.0	1099.6
Total	0.0	4114.7	1324.3	33.2	0.0	0.0	1746.5	7218.6

Table A-2. Minimum and maximum carbon sequestration rates per property.

III. Social Research

Our social research methods varied broadly throughout the project. Generally, we operated from a pre-drafted interview instrument, containing broad visioning questions in addition to property-specific inquiries. All interviews and focus groups were semi-structured, with team members choosing appropriate probing responses throughout each interaction in order to guide conversation towards meaningful data related to each property. Afterwards, interview data was analyzed by theme, and both repeated and novel insights were included throughout all stages of the final project report. In so doing, a primary focus of our mixed-methods approach was to arrive at holistic recommendations which supplemented our field work with socially-sourced data.

Primarily, the following approaches were used most often throughout the project's timeline:

1. Primary Stakeholder Interviews

   Much of our social data was sourced through in-person interviews, generally involving interviews with one to several stakeholders at a time. Given the variability in the properties themselves as well as their public/private positioning, we aimed to collect as much detailed information as possible from a broad spectrum of primary stakeholders throughout the project: local landowners, property users, current and former faculty, students, and university staff. Two properties specifically sourced their primary social data from stakeholder interviews, listed below:

   -Harper Preserve: Richard Wolverton
   -Newcomb Tract: Bill Brinkerhoff and Kathy Sample

2. Group Interviews

   Many stakeholders belong to broader organizations, "friends of" groups, and other social structures, many with previous or current ties to the university. Thus, it became most practical to meet with these groups in part or whole in order to streamline data collection. This type of interview utilized a similar interview document, but allowed for more space in participant responses. A group interview was utilized for the following property:

   -St. Pierre Wetland: Portage Base Whitewood Owners Association

3. Virtual Focus Groups (per COVID-19 concerns)

   Due to the suspension of in-person research and group gatherings in light of COVID-19 pandemic, two focus groups had to be held via video-conferencing (using the platform Zoom). Invite lists were constructed from pre-established property contacts, mutual connections, and previous focus group attendees related to property activities (the meeting link was also further disseminated by invited participants to other stakeholders). These took place towards the end of our data collection and analysis, and were recorded with the permission of the participants. These focus groups targeted public-use properties, drawing from the same interview document used for other interviews but adapted to fit specific use trends and needs. Virtual focus groups were employed for the following properties:

   -Stinchfield Woods (4/3/20) and Saginaw Forest (4/7/20)

APPENDIX B - HISTORICAL RESEARCH RESOURCES

The SEAS properties have a long and storied history of research, spanning many decades and cohorts of faculty, students, and researchers. As we look to move forward in the visioning process for each property, we would be remiss to overlook the catalogue of associated dissertations, theses, and publications that have contributed to our current knowledge and understanding of these natural areas - insights that have been instrumental in positioning the school to look towards future change.

Listed below are the two most comprehensive archives for research at each of the six properties; while it is beyond the scope of this project to detail each individually, our work would be incomplete without providing information concerning where these reports can be located. Our document is a next step in a long series of published works concerning the properties, and it is our hope that as future projects develop, both students and faculty alike can make use of the long lineage of scholarship centered in each of these six natural areas.

Archive I: SEAS Properties Webpage

https://seas.umich.edu/research/field_research_sites

For each property, the SEAS Properties webpage contains a deep archive of previous documents associated with each property (listed on each property's page). Naturally, certain properties have far more research associated with them due to their proximity to Ann Arbor (e.g., Saginaw Forest). However, all documents are pertinent and valuable in the broader scheme of the properties, and should be given continual attention in the future as more visioning develops.

Archive II: 2017 SEAS Properties Committee Report*

A similar document to this current report was put together by the SEAS Properties Committee in 2017 (the findings of which were presented to the school in December of 2016). This document was foundational for our work, and contains links to many important studies, figures, and literature surrounding the properties - both currently and as we look towards the future.

*A copy of this document has been included with our final report (see supplemental files).

APPENDIX C - FUTURE RESEARCH RESOURCES

Saginaw Forest

- *Existing partner:*
  - 2|42 Community Church (Ann Arbor Campus) (https://242community.com/ann-arbor/)

- *Possible partners:*
  - City of Ann Arbor Natural Areas Preservation (https://www.a2gov.org/departments/Parks-Recreation/NAP/Pages/NaturalAreaPreservation.aspx)
  - City of Ann Arbor Greenbelt (https://www.a2gov.org/greenbelt/Pages/greenbelthome.aspx)
  - Scio Township Land Preservation Commission (http://sciotownship.org/boards-commissions/land-preservation-commission/)
  - Washtenaw County Natural Areas Preservation Program (https://www.washtenaw.org/939/Natural-Areas-Preservation-Program)
  - Legacy Land Conservancy (https://legacylandconservancy.org/)
  - Three Sisters Trail Project

Stinchfield Woods

- *Possible partners:*
  - U-M, EEB/ES George Preserve (https://sites.lsa.umich.edu/esgr/)
  - Legacy Land Conservancy (https://legacylandconservancy.org/)
  - Dexter Township (http://www.twp-dexter.org/Portals/46/zoningordinancereview/2017/OpenSpacePreservation(07062017)G.pdf)
  - Washtenaw County Natural Areas Preservation Program (https://www.washtenaw.org/939/Natural-Areas-Preservation-Program)
  - Northwest Connector Trail (https://mail.google.com/mail/u/0/#search/stinchfield+woods+trail/FMfcgxwCgVSRcvPJzhvBvsNMrHjSLcQV?projector=1&messagePartId=0.1)

Newcomb Tract

- *Possible partners:*
  - U-M, EEB/ES George Preserve (https://sites.lsa.umich.edu/esgr/)
  - Legacy Land Conservancy (https://legacylandconservancy.org/)
  - Webster Township Farmland and Open Space Board (http://www.twp.webster.mi.us/farmland_and_open_space_board.aspx)
  - Washtenaw County Natural Areas Preservation Program (https://www.washtenaw.org/939/Natural-Areas-Preservation-Program)

St. Pierre Wetland

- *Possible partners:*
  - Portage, Base, and Whitewood Owners Association (http://www.pbwoa.org/)
  - Michigan Nature Association (https://www.michigannature.org/)
  - Legacy Land Conservancy (https://legacylandconservancy.org/)
  - Livingston Land Conservancy (https://livingstonlandconservancy.org/)
  - Livingston County Conservation District (https://www.livingstoncd.org/)
  - Huron River Watershed Council (https://www.hrwc.org/)
  - Livingston County (https://www.livgov.com/plan/Documents/landUseBooks/Natural-Features-Report.pdf)
  - Hamburg Township (http://www.hamburg.mi.us/)
  - Ducks Unlimited Michigan (https://www.ducks.org/Michigan)
  - Michigan United Conservation Clubs (MUCC) (https://mucc.org/)

Harper Preserve

- *Possible partners:*
  - U-M Sustainable Food Systems Initiative (https://sites.lsa.umich.edu/sustainablefoodsystems/)
  - Six Rivers Land Conservancy (https://www.sixriversrlc.org/)
  - Genesee Conservation District (https://www.geneseecd.org/)
  - Southeast Michigan Land Conservancy (http://www.smlcland.org/)
  - Saginaw Bay Resource Conservation and Development (http://www.saginawbayrcd.org/county_genesee.php)

Ringwood Forest

- *Existing partner:*
  - Saginaw County Parks (https://www.saginawcounty.com/departments/parks__recreation/index.php)

- *Possible additional partners:*
  - Saginaw County Conservation District (https://www.saginawcd.com/)
  - Saginaw Basin Land Conservancy (http://www.sblc-mi.org/)
  - Saginaw Bay Resource Conservation and Development (http://www.saginawbayrcd.org/county_genesee.php

APPENDIX D - BIBLIOGRAPHY

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