

Stewardship Plan & Policy Recommendations

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Executive Summary

The University of Michigan Biological Station (UMBS) expressed a need for a stewardship plan to ensure consistent, long-term stewardship of its 10,000 acres of diverse lands and waters and to ultimately advance research, education, outreach, and preservation. In response, we developed this report, which provides a set of recommended strategies, policies, and tools for UMBS to consider in future efforts to steward the property. Importantly, these findings are not meant to be comprehensive or prescriptive; rather, they serve as a set of guidelines on how land and water stewardship values could be embodied at UMBS. We believe our work will aid in the development of such plans as it compiles supporting information and recommendations across a broad range of stewardship responsibilities and considerations. Our documentation and guidelines are organized under the following categories:

- 1) Public Outreach & Communication,
- 2) Property Acquisition and Maintenance,
- 3) Public Use,
- 4) Timber Harvesting,
- 5) Existing and Emerging Ecological Threats, and
- 6) Preservation of Habitats and Species of Concern.

Though these categories vary widely, and each consist of a diverse set of related recommendations, they are all aimed at supporting one or more of the UMBS Core Values: Research, Education, Outreach, and Preservation. These four values are central to how we conceptualized stewardship at UMBS and how we approached the development of these recommendations and tools. See **Table 1** for detailed descriptions of each value.

Public Outreach and Communication strategies are needed to facilitate public use consistent with UMBS principles, as well as to ensure the continued value of UMBS by strengthening the University's relationship with the local community. The guidelines in this report are primarily aimed at improving outreach and education and include recommendations related to informative and rule communication signage, K-12 educational opportunities, and survey design.

Property Acquisition and Maintenance are vital for increasing opportunities for research and education as well as preserving and restoring UMBS lands and waters for public, student, and researcher use. Information provided is geared at documenting existing processes for UMBS property acquisition and property maintenance to strengthen all aspects of UMBS stewardship. Further, we recommended and constructed a maintenance schedule. The schedule provides a matrix for staff to list key items and tasks on a monthly, annual, and 2-5 year basis; instructions for carrying out the tasks; their priority level, anticipated costs, materials, and staffing requirements; and planned dates and location(s).

Public Use, engagement with public users, and promoting sustainable use can better assure that the natural features of UMBS are preserved for scientific discovery, enhance safety, increase capacity for data collection, and build relationships and respect for UMBS. This section lists a set of recommendations for managing land uses and access for the public, specifically for hunting and trapping and Off-Road Vehicle (ORV) use. For hunting and trapping, we offer a set of recommendations aimed at improving rules and regulations for preserving UMBS habitats, ameliorating the communication of rules and regulations along with best practices, optimizing wildlife management and administrative actions, and building relationships with local hunters and trappers. For ORV use, we recommend a series of best management practices associated with ORVs, aimed at protecting sensitive ecosystems and species.

Timber Harvesting optimization is key for minimizing adverse ecological and social impacts from timber sales. We offer recommendations for administrative, technical, and safety measures for these sales. Moreover, we developed a case study on the timber sale that occurred on Pellston Hill in 2019. This case study is then used to inform a general SOP for UMBS staff to ensure efficient, consistent, and high-quality timber sale operations on the property.

Existing and Emerging Ecological Threats will be of increasing concern under future climate change scenarios, and any land management plan must explicitly address strategies to adapt to these dynamic realities. This section contains a set of best practices and recommendations for responding to some specific, common ecological threats, which include Woolly Hemlock Adelgid, Beech Bark Disease, Oak Wilt Disease, Zebra Mussels, and Emerald Ash Borer.

Preservation of Habitats and Species of Concern is vital for maintaining the intrinsic ecological value of biodiversity at UMBS, as well as assuring research and educational opportunities for generations to come. This section includes recommendations for establishing management zones based on ecosystem sensitivity and preservation value that are to be managed accordingly for use by UMBS and/or the public. This section also contains recommendations more narrowly focused on preserving threatened and endangered species, namely Michigan Monkey-Flower and Hungerford's Crawling Water Beetle. Due to limited existing knowledge of the distribution and sensitivities of UMBS populations, preservation efforts should be experimental and conducted alongside life history research projects.

Throughout the report, orange Toolboxes call out tools the team has initially developed to address specific stewardship needs. While the majority of these tools remain incomplete for the purposes of this report, they provide starting points for UMBS to further develop if desired. Case Study and Standard Operating Procedure (SOP) boxes document past stewardship activities and established protocols when available.

Introduction

UMBS Mission: *The University of Michigan Biological Station (UMBS) has been home to scientific discovery since its founding in 1909. Our core mission is to advance environmental field research, engage students in scientific discovery and provide information needed to understand and sustain ecosystems from local to global scales. In this cross-disciplinary, interactive community, students, faculty, and researchers from around the globe come together to learn about and from the natural world and seek solutions to the critical environmental challenges of our time.* (UMBS, 2023)

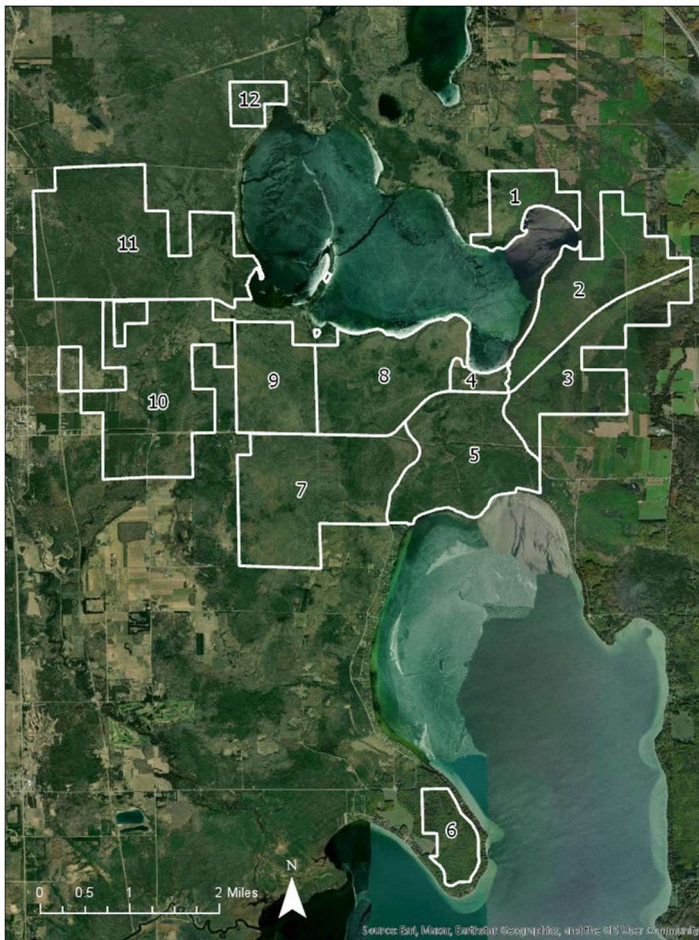


Figure 1. Map of UMBS Property Units

The land features a wide array of natural communities, including but not limited to bogs, boreal forests, mesic northern forest, dry-mesic northern forest, dry northern forest, emergent marshes, hardwood conifer swamps, northern shrub thicket, sand and gravel beaches, and vernal pools (see Figure 2 below). These natural communities host a diversity of flora and fauna, including many rare species with designations ranging from State special concern (American Goshawk, Bald Eagle, Woodland Vole) to State threatened (Red-Shouldered Hawk, Common Loon) and even Federal and State endangered (Michigan Monkey-Flower, Hungerford's Crawling

The University of Michigan Biological Station (UMBS) located in Pellston, Michigan has a long history of biological research and education in Northern Michigan. The property features approximately 10,000 acres of land primarily around and between Douglas and Burt Lakes, including miles of undeveloped lakeshore on Douglas Lakes and a small portion of Burt Lake. For administrative management purposes, UMBS divides its property into 12 units, which can be seen in Figure 1.

UMBS property falls within the Obatawaing Biosphere Region. Its designation as a unique Biosphere Region is part of the UNESCO Man and the Biosphere (MAB) Programme, which seeks to establish a scientific basis for mutually beneficial relationships between people and their environments (Fernandez Mendez Jimenez and Frederickson 2022).

The land features a wide array of natural communities, including but not limited to

Water Beetle) (Pearsall, 1995; University of Michigan Biological Station [UMBS], n.d.). In addition to UMBS’s ecological value, the land is also home to significant cultural sites. Remote sensing techniques, namely light detection and ranging (LiDAR), have unveiled at least 69 Native American food storage pit groups (cache pits) created by mobile hunter-gatherers in the upper Great Lakes during Late Precontact (ca. AD 1000–1600) (Howey et al. 2016).

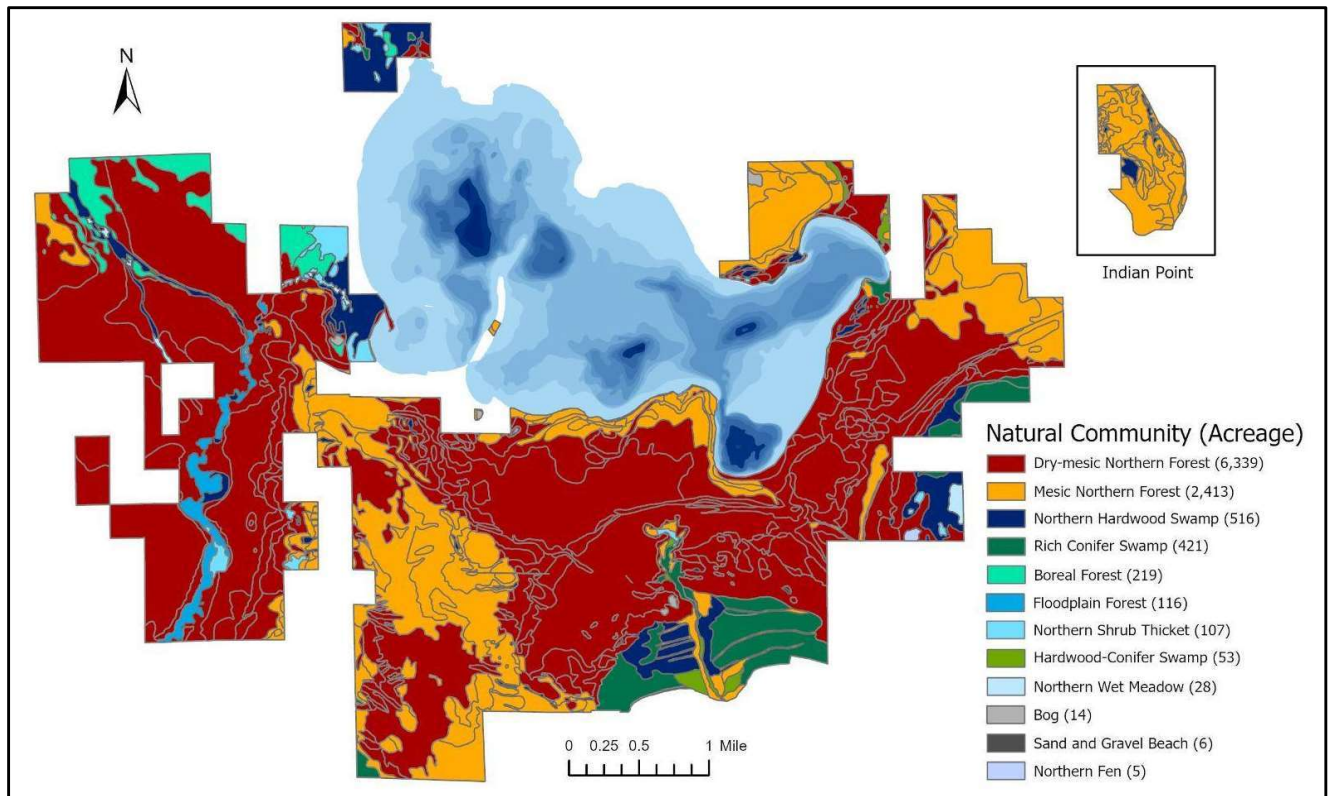


Figure 2. Map of UMBS Natural Communities

Stewardship at UMBS

The extensive biodiversity across 10,000 acres makes UMBS a unique asset to the University of Michigan to serve as a hub for research and field-based higher education. UMBS states its core mission is “to advance environmental field research, engage students in scientific discovery and provide information needed to understand and sustain ecosystems from local to global scales. (UMBS, 2023). In order to preserve the function of UMBS to realize this mission long term, UMBS understands that preservation and stewardship of their lands and waters are essential. Thus, the idea for a UMBS Stewardship Plan that would outline specific management strategies, tools, and policies aimed at stewardship of UMBS’s lands and waters was born.

Past students who have worked with UMBS identified some challenges associated with stewardship as well as short- and long-term stewardship goals. Among them were gaps in detailed

organizational procedures for dealing with recurring tasks such as property maintenance, violation reporting, and managing impacts from public use and ecological threats. They also recognized the need for better outreach and communication strategies with the public to build local support for UMBS and to better educate members of the public on UMBS policies.

With these challenges in mind, we developed this report to compile existing information and provide a novel set of recommendations to support the development of a comprehensive UMBS Stewardship Plan. We note that developing a comprehensive stewardship plan should be an ongoing, multiple year process, and thus we framed our work and report around identifying needs and making subsequent recommendations pertaining to plans, policies, and norms as well as developing some specific tools related to stewardship at UMBS. It draws on information collected via literature search and meetings with UMBS staff and administration, as well as information collected and observations made on-site in Pellston to make a series of recommendations and provide some specific tools that serve as a basis for UMBS to build on for future stewardship goals.



Image 1. Mark and Ruth Paddock (left), Trail Dedication at Carp Creek Gorge Trailhead (right); Chrissy Billau 2023

Mark and Ruth Paddock are integral figures in the history of stewardship at UMBS. Mark served as Associate Director from 1971 to 1991, during which he fought to protect the old-growth hardwood forest of Indian Point and keep the Douglas Lake shoreline undeveloped. He also founded the Bug Camp Stewards, a volunteer group that builds and maintains the trails of the station to this day. He leaves behind a legacy of community-led stewardship and conservation.

UMBS Core Values

Through our conversations and interviews at UMBS, we identified the following four core values that encompassed the range of perspectives on “stewardship” we heard repeatedly from staff and community members: Research, Education, Outreach, and Preservation. These values were used to guide our collection of information and organize our recommendations for this report.





Value	Icon	Description
Research		“Aim to increase the amount of science created, the ability of people to use that science and the capacity for natural scientists, social scientists and modelers to work together and connect the science. Specifically, we aim for UMBS to become an internationally recognized research station through the data and research that it produces, the scientists that it helps to develop and the connections that it helps to create” (UMBS Self Study, 2023).
Education		UMBS allows students “the ability to conduct, understand and communicate science, and perceptions of science belonging, or the extent to which students feel accepted, valued and included in the scientific community” (UMBS Self Study, 2023). Utilize the diverse environments of UMBS for on-the-ground learning outside of the classroom. Get students and community members engaged in science and interested in natural spaces with the unique experience of applied science.
Outreach		Engagement of the northern Michigan community to advance UMBS goals and values. Specifically, build public respect for UMBS land and public engagement in preservation and research efforts; educate the public about ecosystem services and habitat preservation; and listen to local communities to foster strong relationships and meet local needs.
Preservation		Preserve UMBS land for its own intrinsic ecological value as well as for supporting research, education, and outreach at UMBS for decades to come.

Table 1. UMBS Core Values

The central purpose of the University of Michigan Biological Station is to provide world-class opportunities for today’s educators and scientists to conduct classes and cutting-edge research in field biology, ecology, and environmental sciences, without compromising future use or degrading the property’s habitats. All four values must be kept in balance through careful consideration and management decision-making. An ideal stewardship of the property would consist of all values working together in harmony rather than in hindrance to each other. Look for these icons throughout the report to signify how specific management practices connect back to the UMBS core values.

Findings & Recommendations



Public Outreach & Communication

Recommendations related to public outreach and communication are given with the purpose of improving UMBS' relationship with the greater Pellston community, ensuring UMBS visitors are properly informed about property rules and regulations, and collecting information from members of the public, students, and researchers on how they interact with UMBS. Subsections include recommendations related to signage for rule communication, kiosk and educational signage, K-12 educational opportunities, and gathering information from UMBS stakeholders.



Signage for Rule Communication

UMBS land holds a unique classification. Despite being owned by the Regents of the University of Michigan, it is also classified as “MI Government Lands” on the popular hunting app, OnX, used by hunters, anglers, ORV users, and outdoor recreationists to find public land access. Land access and land use laws on UMBS property are regulated differently than other Michigan State Lands. The University of Michigan Regents Ordinance outlines baseline laws on University property (Regents of the University of Michigan, 1995). The University and UMBS have the ability to set additional policies and restrictions such as restricting ORV use, hunting, access, etc. on the property. This unique land classification has created some confusion. UMBS grants access to the public as a courtesy to the local community; however, there have been some issues of land use inconsistent with UMBS policies. UMBS signage is dated and varies widely in appearance and format across the property. This creates an opportunity to replace some aging infrastructure with new signage that better communicates UMBS land use restrictions to the public, protecting UMBS land to further research, education, and preservation.

Goals

The purpose of signage improvements is two-fold: first to ensure that members of the public accessing UMBS land are aware of and adhering to the land use rules and regulations, and second, to take the opportunity to standardize the appearance of signs across the property. These signs can provide the public with more information about UMBS and foster better adherence to UMBS policies as well as a better relationship between UMBS and members of the public.

Recommendation: New & Updated Signage



Image 3. Existing Boundary Signs on UMBS Property; Sara Thiessen 2023

1. Property boundary signs against trespassing must be compliant with Michigan State Law to be enforced by the state. Language from Michigan’s Natural Resources and Environmental Protection Act requires that “The property is posted in a conspicuous manner against entry. The minimum letter height on the posting signs shall be 1 inch. Each posting sign shall be not less than 50 square inches, and the signs shall be spaced to enable

a person to observe not less than 1 sign at any point of entry upon the property (MI Legislature, 1995).”

2. Signs should be standardized, consistent, and easily recognizable as marking UMBS property boundaries.
3. Property boundary signs should be posted at select access points where UMBS wants to restrict access, such as along public roads adjacent to UMBS property, near research infrastructure, adjacent to sensitive habitat such as wetlands and restoration areas, and adjacent to public trail systems.

Recommendation: Designing and Posting New Land Use and Rule Signs



Image 4. Existing UMBS Land Use and Rule Signage; Sara Thiessen 2023

Existing signage is effective in getting the bottom-line message across; however, based on observations and conversations we had at UMBS, this type of signage may be more effective if the formatting is standardized and signs are posted consistently across UMBS. A standardized sign would be easily recognizable and may avoid confusion amongst land users unfamiliar with UMBS. We suggest the following possible elements of rule signs:

1. Standard sizes and dimensions, standard font and text size, standard color, and University of Michigan logo as pictured in one of the existing signs above. The exact dimensions, font and text size, and color are at the discretion of the university, but standardizing these elements will make signs easily recognizable. It should also be noted that the University

has a published Brand Identity Style Guide that should be referenced in this process (University of Michigan, 2022)

2. Rather than having separate signs prohibiting individual activities, consider having icons for a variety of land uses on the single standard sign. These could include icons such as ORVs, bikes, campfires, tents, rifles, dogs, etc. In an area where a given activity is prohibited, that activity would have a red circle around it and line through it. In an area where a given activity is permitted, it would have a green circle around it.
3. The sign could contain a brief statement containing the most pressing information applicable to UMBS land. This could include a reminder to respect the local ecosystem by staying on trails, keeping dogs leashed, and leaving the place as you found it.
4. The sign could contain a QR code to direct users to more information about the specific area the sign is located in. This would allow for individual signs to contain site-specific information in addition to just the variety in which land use icons are struck in red. The QR code could link the user to a page on the website that contains more detailed information about the site's natural history, justification for land use restrictions, a map of the area, and a list of alternative areas where activities prohibited at that site may be done. Providing alternate routes where people can snowmobile was an example raised in our meeting with Facilities Manager Scott Haley. Scott cited conversations with snowmobilers around Douglas Lake who were unaware of the rules regarding snowmobiling on UMBS property and said he is always asked where they can go instead. He said having a list of alternative places to send them, perhaps even off UMBS property, would be a helpful deterrent to ORV use in restricted areas. Additionally, conversations with Associate Director Karie Slavik and Director Aimée Classen focused, in part, on forging a better relationship with the public. This raised the idea of educating, rather than simply prohibiting certain public activities. The team believes a QR code that educates users on the land and provides justification for UMBS land use policies can strengthen this relationship and thus be more effective in changing behavior.



Kiosks & Educational Signage

Certain parts of UMBS are very popular destinations for outdoor recreation such as hiking, boating, and fishing. UMBS sees these areas as opportunities to engage with the public to educate people about UMBS land and to improve the overall relationship with members of the Northern Michigan Community. Some of these heavily trafficked areas also contain sensitive species and habitats, so finding ways to educate the public about these issues at these sites can also raise awareness of the importance of these ecosystems. In conversations with UMBS staff, we discussed possibilities for in situ interactions and educational opportunities with the public at these sites. Ultimately, we settled on recommending the development and placement of educational kiosks and brochures at select sites on UMBS property.

Educational kiosks can give an area a welcoming feel by sending the message that UMBS is happy to have visitors and can enhance the visitor's experience by providing educational information about the natural history and biodiversity of the area. Kiosks are utilized on a variety of public land types ranging from county and state parks to national parks and monuments to inform land users about rules and regulations, to collect user feedback, and to provide users with information about what they can expect to see on their hike.

The website matchinggrants.org is a private initiative by the Torrey Pines Rotary Club, District 5340, to help the clubs and districts worldwide to do matching grants with The Rotary Foundation. The initiative published a comprehensive guide to planning a trailhead kiosk and introduced the merit of a kiosk as follows:

“They formalize the setting of a Trailhead and serve as the first and last impression. Trailheads indicate arrival, welcome visitors, and provide them with information that may be essential to their safety and enjoyment on the Trail. It offers the opportunity to educate and communicate a variety of information as a means of helping to solve management problems associated with visitor use. The value of informed visitors is less waste, more reverence, and an understanding of volunteer efforts...A Trailhead kiosk is best placed in a location where we want to say to the public: “Come on in! This is the Appalachian Trail, it’s here for you, and here’s what you need to know to enjoy it and protect it!” (matchinggrants.org, 2012).

Goals

Similar to other public outreach recommendations, the goals of implementing kiosks are twofold: strengthening UMBS relationships with members of the public, something multiple leaders at UMBS have expressed interest in, and informing visitors about the sites and UMBS research as well as UMBS institutional values and priorities (including mission, goals, and property rules).

Kiosks can be deployed at UMBS to make users feel welcome, enhance their enjoyment of the site, and ensure that they are respecting land use policies aimed at preserving ecosystems.

Recommendation: Educational Kiosks

We recommend the following options for Kiosk design and deployment to achieve the goals described above:

1. Location: In conversations with UMBS Resident Biologist, Adam Schubel, the team identified UMBS' main entrance, The Gorge trailhead, North Fishtail Bay (Township Beach), and Indian Point as four locations UMBS should consider placing kiosks. The Gorge, North Fishtail Bay, and Indian Point all host sensitive or unique natural communities and fauna or are of cultural and historical significance. These areas also receive substantial public traffic and are perfect places to achieve the dual purposes of public outreach and targeted preservation. For more information about these sites, please refer to the [Unit Profiles Toolbox](#).
2. Options for what information or interactive tools can be included on kiosks:
 - a. Rules summary specific to the area the kiosk is located in (e.g., hunting and trapping rules at trailheads of areas where the activities are allowed).
 - b. Information about the natural history, human history, and ecosystems of the site, including photos of flora and fauna users can expect to see. This can transition into a justification for why adhering to land use rules are crucial for the long-term preservation of UMBS.
 - c. QR code that links to UMBS website. UMBS should consider developing location specific information on their website that certain QR codes at those locations can link to.
 - d. Feedback box that can be used to administer surveys or collect general suggestions or information about what people saw on their hike. Another option is posting a guideline for using iNaturalist as a hub for users' observations on their hike.
 - e. Trail map.
 - f. Printed brochures that could feature trail maps and additional information to guide people along on their hike to enhance the experience. Information could be very similar to what is printed on the kiosk, but gives users the opportunity to take something with them on their visit and to take home to leave a lasting impression.
 - g. Contact information for UMBS.
 - h. Safety and emergency information (e.g., site coordinates, address, nearest hospital). Safety hazards (e.g. slippery boardwalks, poison ivy, wasps).
 - i. Some kind of fine print legal disclaimer might be appropriate.
 - j. UMBS events (e.g. open house, lecture series).



K-12 Education Opportunities

At present, UMBS opens events to the public such as the weekly speaker series in the summer and the Open House/Bioblitz. However, leaders at UMBS have expressed that there seems to be limited engagement from the public, and they would like to strengthen UMBS relationships with Northern Michigan communities. Several ideas have been discussed as part of a larger public outreach strategy but the primary gap we identified is the emphasis on one-off public events rather than an intentional and sustained relationship with the community. As a result, we suggest UMBS considers implementing programs aimed at involving the public in more sustained programs aimed at building a lasting relationship. More specifically, we identified the possibility of implementing programs that foster involvement from the next generation of researchers, conservationists, and leaders aligned with UMBS' mission. UMBS' core stewardship themes of Research, Education, Outreach, and Preservation could align perfectly with programs that help introduce students in the Pellston and surrounding public school systems to UMBS. Building relationships with local school systems has the potential to not only integrate UMBS with the local community but also to provide UMBS with a pool of future students, lab assistants, researchers, and engaged advocates for the land.

Goals

Better integrate UMBS with the local community as a part of UMBS's larger outreach and communication goals. Also has the potential to provide UMBS with a pool of future students, lab assistants, researchers, and engaged advocates for the land. The suggested partnerships would also benefit the community by encouraging their participation in the vast educational resources at UMBS and ideally inspiring future generations of scientists and conservationists.

Recommendations

To build up a sound relationship between UMBS and the local community via the school system we suggest the following programs:

1. **Guided hikes for kids of all ages.** UMBS could host regular events similar to those put on by many country parks and nature centers that take local kids and families on hikes to teach them about the land. Options could range from a tree identification hike to scooping for macroinvertebrates in the Gorge. Consider that this will require additional staff hours, possibly outside of normal M-F 9-5, when kids are in school.
2. **Field trips to UMBS.** Having a class out to UMBS for the day could be a great way to build relationships with kids, parents, and teachers. Activities could be very similar to those suggested for the guided hike and may get kids interested in becoming involved at UMBS in the future.

3. **Classroom visits.** UMBS staff could also take UMBS to the classroom, presenting information about what UMBS is and what they do during a science class at a local school. This could be an opportunity to bring awareness of the property to classrooms and advertise upcoming public events.
4. **Volunteer opportunities for credit.** UMBS could partner with local high schools to give students credit towards graduation for volunteering at UMBS. Volunteer work could include trail maintenance with the Bug Camp Stewards, assisting facilities management with property monitoring and maintenance, helping with other programs suggested here such as field trips and guided hikes for students interested in teaching.
5. **Summer internships.** UMBS could establish a summer internship program for local high school students. Students could work in labs, do their own research, or do work similar to what has been proposed under volunteer opportunities.
6. **UMBS scholarship program.** UMBS could establish a scholarship program for local high school students who have worked with UMBS in a volunteer or internship capacity.

Considerations:

Before developing any of these programs, UMBS' communication department should reach out to local school systems to gauge interest in such programs. Recognizing that all of these options involve either additional staff or more responsibility and hours from current staff, we also recommend that the adoption of any of these options be in conjunction with increased staffing. There would also be a need for planning and coordination to realize such programs, including level of effort estimates to inform staffing and hiring decisions. Any implementation of internship programs involving minors from local k-12 schools would also require high levels of staff supervision, which may be beyond UMBS staffing capacity. This is a substantial undertaking so we do not make these recommendations lightly, however we do feel such programs could benefit UMBS and their public outreach goals.



Gathering Information: Surveys

People have various relationships with the property at UMBS - as a location for ecological research, a workplace for staff, a hands-on classroom for students and teachers, a place for outdoor recreation for the public, and a valuable natural asset to neighboring communities. As a result of this broad functionality, a robust community has inherently formed within and around the biological station who are impacted by the management and stewardship of UMBS property. When considering future and current land stewardship practices, understanding the values, priorities, and uses of the land across the UMBS community will be a valuable asset. To guide UMBS decision makers in future land/water stewardship operations, information from all UMBS stakeholders should be considered in order to better uphold the values of Research, Education, Outreach, and Preservation. One efficient and effective way of reaching out to UMBS stakeholders is surveys. This method of communication allows for UMBS staff to directly ask for input on topics of interest, can be tailored to specific stakeholder groups, and can be formatted for long-term or short-term data collection.

Goals

The following recommendations are for two survey types: an Internal Survey and a Public Survey. The broad goals of both surveys are to provide lines of communication from both public and internal stakeholders directly to UMBS staff. The Internal Survey has a specific goal of acquiring insights/opinions/narrative content from those closely affiliated with the University. The Public Survey has a specific goal of gathering data on land usage by the public over time.

Recommendation: Internal Survey

An internal survey would produce insights on what the people who are directly affiliated with UMBS (i.e., faculty, researchers, staff, students, alumni, and former faculty and researchers) prioritize when considering their use of UMBS property and resources. By design, this survey should represent specific groups of people (e.g., Research, Education, Stewards)- some of which are critically important to the UMBS values of Research and Education. Other groups included in this survey - such as the stewards or staff - may represent the UMBS values of Preservation or Outreach. Land management practices for the preservation of UMBS property (such as combating the effects of climate change or natural diseases) and the goals of observational research and education (such as researching and observing the effects of climate change and natural diseases) are often at odds with one another. This survey may inform which of the UMBS values (Research, Education, Outreach, and Preservation) are currently prioritized by each of these groups.

Considerations:

Result Bias:

Due to the different communities surveyed, a significant bias in the answers is to be expected. For instance, a question referencing the accessibility of certain areas of the property may directly relate to on-going research, which may have consequences for the data collected there. The submitter's response may reflect their personal bias due to their relation to the area in question, and should be interpreted with this understanding. In anticipation of this, the language of the questions should be chosen carefully, and the results should be interpreted accordingly.

Selection Bias:

By design, this survey will be distributed only to individuals who are directly affiliated with UMBS, the University, and the greater scientific community, and therefore excludes the opinions of the greater public that interacts with UMBS. This lack of external group representation should be considered.

Furthermore, within UMBS groups their representation will be unequal. For example, the number of students that could be sampled for this survey will likely outweigh the number of researchers that could be sampled, since the student population is much larger. When choosing the sampling populations, it is important to consider how large the populations of each group are, and how many of each should be sampled. Furthermore, how this selection is decided should be randomized as much as possible, in order to avoid bias towards any other subgroupings that may be present (researcher/faculty fields of interest, student majors, staff roles, etc.).

Interpretation of Results:

The results of this survey would include both qualitative and quantitative data. Though the quantitative questions (non-narrative, multiple-choice questions) can be analyzed statistically, caution should be taken when performing these types of analyses due to the targeted audience of the survey and the potentially low sample size. For instance, analysis on a question addressing the submitters opinion of restricted activities on UMBS property may show biases towards favoring restriction when analyzing the data as a whole. When breaking the data down into the groups represented (Students, Researchers, etc.), the data may show that one group has skewed the analysis towards this result, and other valuable interpretations may arise as a result.

Qualitative results (open-ended text responses) should also be interpreted with the understanding of inherent biases due to the audience of the survey. Since this survey is sampling specific groups, and the questions are mostly opinion-based ('What UMBS values do you prioritize?', 'Do you think certain activities should be restricted?', etc.), even quantifiable data should be seen with a qualitative lens.

Recommendation: Policy Survey

A public survey would gather insights on the ways in which the property is used by the public, as well as gather information on how outreach activities by UMBS are perceived. For instance, at trailheads visitors may be asked the reason for their visit (hiking, running, education, hunting, etc.), the time of year they are visiting, or whether or not they are aware of restricted areas, on-going research, or UMBS resources. These insights may inform UMBS decision makers on areas that are in need of more or less restrictions, signage, and/or other resources, as well as inform UMBS on fundraising needs and opportunities. Additionally, it may also inform UMBS on the public perception of UMBS and guide future strategies on public outreach that ensure a healthy and working relationship with community members while working towards UMBS missions and goals.

The Public Survey would serve as a long-term survey available to the public in which multiple-choice questions about property use and UMBS communication are presented. This survey would collect land use data at different points of UMBS property. This survey may be distributed physically (mail, in-person), or virtually (on website, with QR code at kiosks). The survey would ideally take no more than 1-2 minutes to complete and would avoid narrative or opinion-based questions.

Considerations:

Location Bias: The location of where the survey is distributed is an important factor to consider. For instance, if the surveys are only present at kiosks near trailheads, land use questions may skew towards exercise or education, and may not include a population using the property for hunting or fishing. When choosing the locations in which the survey can be accessed, it is important to attempt to include all areas that would be relevant for the types of land use in which you are expecting.

Physical vs Digital Surveys: The way in which the survey is distributed may also lead to biases. Choosing to only distribute surveys by mail to surrounding communities will exclude out-of-town or seasonal visitors. Choosing to only distribute the surveys via QR code at kiosks, or through the website, may exclude visitors who do not have access to the internet or who would not be inclined to answer the survey online. A combination of these types of distribution may yield results from all types of visitors and reduce bias.

Question Formatting: The results of this survey would be intended for quantitative analysis and should therefore be formatted as yes/no or multiple-choice questions. The audience of this survey will ideally represent one category of the population (public visitors), and therefore question language should remain broad and include all relevant answers in order to reduce bias. For instance, a question referring to the type of activity the respondent is engaging in should list more broad options to encompass as many activities as possible (i.e. 'exercise' vs 'running', 'hiking',

‘walking’). If more information is deemed important for specific answers given, conditional questions may be a way to collect further information.

Additionally, the length of this survey should be intended to take no more than 1-2 minutes to complete. This is an important consideration, especially if the survey is distributed within UMBS property - a longer survey will likely be abandoned or ignored as respondents may be on their way to their chosen activity. Questions should remain short and concise, with answers being non-narrative and relevant. If this survey is also distributed via mail or in-person, a shorter survey will also likely yield higher amounts of responses.

Findings & Recommendations



Property Acquisition & Maintenance

Property Acquisition & Maintenance activities are ongoing at UMBS and essential to all of its functions and core themes of stewardship. This section is presented as case studies that can serve as Standard Operating Procedures (SOPs) for current and future UMBS staff to reference when engaging in the acquisition of new property or routine maintenance of existing property. It closes with a maintenance schedule recommendation that can be used by current and future maintenance staff.



Property Acquisition

There are properties surrounded by University of Michigan land at the U-M Biological Station (UMBS) that the University may be interested in acquiring. This document was developed as a general guideline for UMBS staff to follow for future land acquisition efforts using a case study related to a 2023 acquisition.

Case Study: New Property Acquisition (2023)	
By tracing the 2023 process of acquiring a 40-acre parcel of land, this serves as a case study that can be used as a guide for future UMBS land acquisition as well as a set of recommendations to help UMBS establish criteria for identifying new properties to target in the future.	
Step	Action
1	The landowner contacted the U-M Real Estate Office to inform them of intent to sell.
2	The U-M Real Estate Office contacted the UMBS Associate Director, Karie Slavik through email to gauge UMBS interest in acquiring the 40-acre parcel.
3	The Associate Director acquired maps and specifications from UMBS Resident Biologist, Adam Schubel and Data Manager and Research Specialist, Jason Tallant.
4	The Associate Director informed the U-M Real Estate Office they would like to visit the property.
5	The U-M Real Estate Office contacted the landowners to inform them that UMBS staff would investigate the land. The land visit consisted of a habitat assessment, land use assessment, and general observations of the land to determine if there is trash, structures, etc.
6	The Associate Director contacted the Dean of the College of Literature, Science, and the Arts (LSA) to get approval to pursue acquisition of the parcel.
7	The Dean of LSA reported back with no major concerns and approved the request to move forward with the land acquisition.
8	The Associate Director passes on the Dean of LSA's approval to the Real Estate Office.

9	UMBS paid for an appraisal request through the U-M Real Estate Office.
10	UMBS compared the appraisal to the asking price.
11	UMBS decided to pursue it.
12	UMBS requested the U-M Real Estate Office to make an initial offer.
13	The U-M Real Estate Office negotiated with the landowner to set terms and conditions of purchase.
14	The offer was accepted by the landowner.
Next Steps	
<ol style="list-style-type: none"> 1. Work on closing documents. 2. UMBS prepares a statement detailing why the property is important and how its acquisition helps with the UMBS mission. The statement will be delivered to the Regents for approval. A Regents meeting will also be attended by UMBS staff. 	

Recommendation: Establish Criteria in Identifying Properties to Acquire

UMBS is always open to considering new property acquisitions that advance their goals of research, education, and preservation. At present, UMBS does not have specific criteria for evaluating whether an available property should be pursued. UMBS should develop criteria to identify which properties should be pursued and to rank these properties by priority.

Establishing criteria for properties to acquire would help to identify desirable properties easily and consistently, to prioritize purchases, and to raise and allocate funds.

Suggested Criteria:

1. What are UMBS’s immediate needs/wants and potential future needs/wants that new parcels could satisfy? If UMBS’s current needs change over time, UMBS should build in a process for revisiting and revising criteria they establish as priorities change.
2. Some possible criteria for assessing and ranking prospective properties.
 - a. UMBS Goals & Values - How do the property’s features potentially help further UMBS goals or align with UMBS values?
 - i. Opportunity to steward/protect a piece of land/sensitive ecosystem
 - ii. Opportunity to use in UMBS educational programs
 - b. Current Needs - How does the prospective property address current needs of UMBS
 - i. Particular ecosystems
 - ii. Ecosystems of conservation or research value

- iii. Ecosystems or areas of educational value
- c. Location Value
 - i. Adjacent to UMBS central campus
 - ii. Adjacent to other properties
 - iii. Minimum size
- 3. UMBS should consider ranking its goals and needs in order to establish criteria to rank potential properties to acquire.

Considerations: There are multiple factors that should be considered in the property acquisition process. For example, it is ideal if the landowner reaches out first. However, if the station knows the landowner well, there can be exceptions. UMBS can also acquire property through donations. Likewise, the Real Estate Office and UMBS work together throughout the donation process. The donated lands can be subjected to a designation and deed restrictions on the land regarding modification of the property. For example, a donator may choose that the donated property is exempt from physical human infrastructure. UMBS should inquire about possible designations and restrictions for prospective land to determine if the acquisition makes sense according to UMBS's goals. Lastly, If UMBS decides a given property does not fit a particular need, however the land is threatened by potential use/development by another buyer, UMBS should consider contacting the Little Traverse Conservancy to gauge their interest in acquiring the land for preservation purposes.



Property Maintenance

Natural and human influences like weather, natural disturbance, motorized vehicles, hiking, biking, horses, vandalism, and normal wear and tear impact the integrity of various infrastructure on UMBS lands. Damaged natural and human infrastructure can cause hazards for both humans and the natural environment and hinder community engagement, research, and education. As a result, property maintenance is essential for responsible stewardship of UMBS property.

Property maintenance helps to ensure that the Station's infrastructure and trails are maintained across the twelve units. Maintenance is becoming increasingly important considering anticipated impacts from global change (e.g., more extreme weather events and new forest pests and pathogens) and anticipation of increased UMBS property use from improved communications and growing human populations.

The following describes a case study of repairing stairs and bridges at the Mark and Ruth Paddock Trail at Carp Creek Gorge (Unit 5), which we participated in during our summer visit. This case study informs the general Standard Operating Procedure (SOP) for property maintenance on UMBS lands to facilitate the assessment and implementation of maintenance operations. We hope that this SOP will assist with ensuring that maintenance activities are carried out in a consistent and proper manner by current and future staff. Additionally, we articulate a recommendation for a property maintenance schedule. Lastly, we provide tools for property maintenance including a property maintenance schedule template (if UMBS ever decides to pursue a schedule), unit profiles, and ArcGIS online features.



Image 8. Bug Camp Stewards Repair Gorge Trail Bridge; Sara Thiessen 2023

Case Study: Gorge Stairs (2023)

In previous years, UMBS had observed and received reports of erosion, wood rot, and subsequent trip/fall hazards on the Carp Creek Gorge stairs in Unit 5. UMBS initiated discussions about addressing the issue and what kind of staff and material allocations would be involved. The Resident Biologist discussed the project with the Facilities Manager, the Bug Camp Stewards Coordinator, and other Stewards. The Resident Biologist and the Bug Camp Stewards Coordinator decided to put the project on the schedule for summer 2023, since they would have additional assistance from our team. The Resident Biologist, the Facilities Manager, and the Bug Camp Stewards Coordinator made a list of required equipment and materials. The facilities staff delivered approximately one ton of Afton stone to the Carp Creek Gorge parking area. The Resident Biologist gathered necessary tools and materials including shovels, power saws, power drills, buckets, rakes, lumber, and screws and delivered them to the site. Additionally, Stewards brought their personal tools to assist with the project. The Resident Biologist and volunteers inspected the steps to identify safety hazards such as damaged wood and eroded gravel fill that could lead to trips and falls. Volunteers organized into groups to repair stairs, shovel gravel into buckets, haul buckets to damaged steps, fill and grade steps, and repair bridges along the Carp Creek Gorge Trail. After completing the repairs, a final inspection was carried out by the volunteers to ensure that all needed repairs were adequately carried out before dismissal. Volunteers reported back to the Resident Biologist.



*Image 9. Steward Repairs Gorge Bridge;
Sara Thiessen 2023*

SOP: Property Maintenance

To ensure the resilience of maintenance operations in the face of staff turnover and to increase efficiency and consistency of operations, we developed a general SOP for property maintenance.

Step	Action
1	Resident Biologists, maintenance staff, and Bug Camp Stewards will conduct regular inspections across the property. These inspections will occur in the spring and on an ongoing basis along with opportunistic inspections if the need emerges.
2	During the growing season (April 15th - May 31st), an information/report processing meeting will occur on a bi-weekly basis based on reports gathered over the past two weeks. These include reports from staff, students, and researchers along with public reports made via phone calls, email, or online form on the UMBS website. This meeting will involve the Resident Biologist and/or Facilities Manager in consultation with the Associate Director and/or Bug Camp Stewards Coordinator to decide management priorities as a function of the significance of the repairs and associated costs. The decisions made encompass those related to what infrastructure needs to be improved, what infrastructure should be repaired immediately and what can wait, and what specific improvements need to be made. More significant and comprehensive planning and reporting meetings will occur with a major property planning meeting in the spring and reporting/review meeting in the fall. From these meetings, a checklist of items (and features of those items) will be developed and disseminated to relevant parties.
3	Following identification and prioritization of infrastructure in need, UMBS staff develop a plan for conducting the repairs in collaboration with Bug Camp Stewards and/or UMBS Maintenance Staff. This plan involves acquiring relevant permits and approvals, drafting work and construction plans, creating materials lists, coordinating volunteers, and scheduling maintenance tasks.
4	Relevant materials will be acquired and transported to their respective sites prior to the beginning of maintenance work by facilities staff.
5	Scheduled maintenance tasks will be carried out by maintenance staff and/or volunteers in accordance with previously established work and construction plans.
6	A final inspection should be conducted by the volunteers and/or maintenance staff to judge the adequacy of the repairs prior to dismissal.
7	The volunteers and/or maintenance staff report back to the Resident Biologist with remaining improvements (if any) or notification of completion.

Goals

The following recommendation aims to institutionalize a schedule for UMBS staff for the monitoring, upkeep, and preservation of research sites, deer exclosures, trails, natural habitats, and other property infrastructure and resources with a focus on sustaining a safe and productive environment for ecological research, education, and public recreation.

Recommendation: Maintenance Schedule

There is a consistent and significant need for property maintenance at UMBS to advance stewardship. However, the Station relies only on one full-time staff person and volunteers to monitor and maintain the 10,000 acre property. As a result, attending to off-campus infrastructure is rather challenging. UMBS maintenance staff expressed concern of feeling “stuck” on campus. Additionally, property maintenance is currently reactive in nature which creates issues for budget control and can be time consuming due to a lack of adequate planning. We believe that a maintenance schedule can institutionalize a “commitment” per se for maintenance staff to attend to issues outside of Bug Camp and to enhance the proactiveness of operations. Further, a schedule could be a helpful tool for UMBS to justify the need for additional maintenance staff.

Considerations: All maintenance activities listed in the schedule may not be financially feasible to carry out during its associated timeframe due to budget constraints. Moreover, UMBS should consider the environmental impact of maintenance tasks and thus, the use of eco-friendly products and practices whenever possible. For instance, avoiding the raking of leaves to protect habitat for small species or using electric leaf blowers to minimize emissions if removing leaves is deemed necessary. Depending on the level of costs and/or risks associated with a maintenance activity, consulting with the Associate Director may be beneficial. Consider formulating a cost and/or risk threshold that would require this consultation to keep operations consistent. In addition, UMBS should consider keeping administrators continuously informed about maintenance tasks and that certain tasks will require immediate attention or need to be performed more frequently than on a monthly basis or outside of 2-5 years.

Toolbox: Property Maintenance Schedule Template

We propose the following property maintenance schedule template, which provides a matrix for items and tasks to be carried out and their respective costs, staffing and material needs, planned dates, locations, and priority levels (low, medium, high) along with step-by-step instructions for each task. The items and tasks are organized on a monthly, annual, and 2-5 year basis.

The Property Maintenance Schedule can be found here: [UMBS Property Stewardship Schedule - Google Sheets](#).

Annually											
Items	Task	Planned / Anticipated Date	Location(s)	Priority Level (Low, Medium, High)	How many people will be needed?	Materials (if applicable) & Instructions	Anticipated Costs (\$)	Complete	Date Completed	Initials	Notes
1.1.	Inspect property for out-of-season blinds and tree stands							<input type="checkbox"/>			
1.2.	Draft annual property maintenance and improvement plans (possibly focus on one unit or system)							<input type="checkbox"/>			
1.3.	Spring property stewardship planning and prioritization meeting.			Medium				<input type="checkbox"/>			

Figure 3. Screenshot of Property Maintenance Schedule

Toolbox: Unit Profiles

For administrative management purposes, UMBS property is divided into 12 units by roads and property edges. The unit delineation map can be seen in **Figure 1**. As part of our project, the team worked with Resident Biologist Adam Schubel to begin developing Unit Profiles detailing the administrative concerns and ecological considerations specific to each unit. Each profile contains information on location and access, unit description, unit statistics (including total acreage, watershed, mileage of roads and trails, mileage of shoreline, and date(s) of acquisition), ecological profile, natural and human history, past and current research projects, current and potential class engagement opportunities, public use, infrastructure and easements, management considerations, ecological and infrastructure monitoring, and maps (showing natural communities, major and minor landforms, and existing infrastructure). These profiles, when completed, will be valuable resources for property maintenance and stewardship.

Unit Profiles are currently located in the following Google Drive folder: [Property Units](#).

UNIT 1: North Fishtail Bay

LOCATION
Munro Township, Cheboygan County, MI
Township 37N, Range 03W, Section 22

UNIT DESCRIPTION
Unit 1 is located in the northwest of UMBS property on North Fishtail Bay within the Douglas Lake watershed. It includes a public access site on Douglas Lake known as Munro Township Beach adjacent to the former site of a Methodist summer camp. Unit 1 includes the North Fishtail Bay trail system which transects private property in the westernmost trail section.

Unit 1 includes the following water features: Douglas Lake's North Fishtail Bay, Beavertail Creek, the Sedge Point ponds, and an unnamed seasonal creek. It includes the Douglas Lake shoreline features Sedge Point, Deer Point, and Hook Point. Gate's Bog is located in the northwest portion of the unit.

HOW TO GET THERE
Unit 1 is most easily accessed by boat or via Bonnett Road, but the northwest portion including Gates Bog is most easily accessed via Heilman Rd. Dotski Road to the north is normally in poor condition and not recommended for travel, but there is two-track access into the unit and to the trail system from Dotski Rd.

UNIT STATISTICS

- Total area: 370.88 acres
- Watershed: Douglas Lake
- Roads & trails: 3.54 mi
 - Trails: 2.63 mi
 - Two-tracks: 0.91 mi
- Stream length: 0.62 mi
 - Beaver Tail Creek: 0.31 mi
 - Other: 0.31 mi
- Dates of acquisition: 1910-1940; Camp Knight portion 1990+

Figure 4. Screenshot of Unit 1 Profile

Toolbox: ArcGIS Online Features

Physical infrastructure was mapped over the summer of 2023 using the Field Maps application within ArcGIS Online. Spatial features include the locations of [Signage](#), [Gates](#), [Fences](#), [Bridges](#), [Stairs](#), [Benches](#), and [Trash Bins/Dumpsters](#), as well as [Miscellaneous](#) or temporary features such as hunting blinds, bird boxes, and trail cameras. Feature attributes include Status (Proposed or Existing), Repair Needs, Material, and an image of the structure. The [Field Sites](#) layer locates and describes points of interest around the property such as Greenstar Meadow, Grapevine Point, Bryant's Bog, and the Sedge Point beach pools. The [Property Units](#) polygon layer designates the boundaries of station units.

Additional point features were created in ArcGIS Online to support property maintenance activities. The [Violations](#) layer pinpoints locations of documented violations (e.g., off-roading, camping, campfires, trash, theft). The [Hazard Trees](#) layer identifies hazard and fallen trees across roads and trails. Both of these feature layers serve as dynamic tools for the property management team. Regular updates to these layers can help determine areas requiring more frequent maintenance and potential surveillance.

The [Natural Communities](#) feature layer, derived from the Landscape Ecosystem designations by Pearsall et al. (1995), was expanded to include newly acquired parcels, including a substantial portion of Unit 12. Aerial imagery, as well as observed understory and overstory vegetation and soil characteristics, was used to draft an updated map of Natural Communities.

Due to extensive pre-existing spatial data and the focus of this report on land and water management outside of the immediate campus area, Unit 4 (UMBS Campus; Fig 1) was excluded from the field survey. All features were separated in ArcGIS Online, so they can be individually downloaded or used to create unique map products.

Ownership of all ArcGIS Online features has been transferred to Data Manager Jason Tallant and features are available for future property maintenance or resource visualization projects. All features and data points can be seen in the [UMBS UnitProfile Infrastructure](#) map.

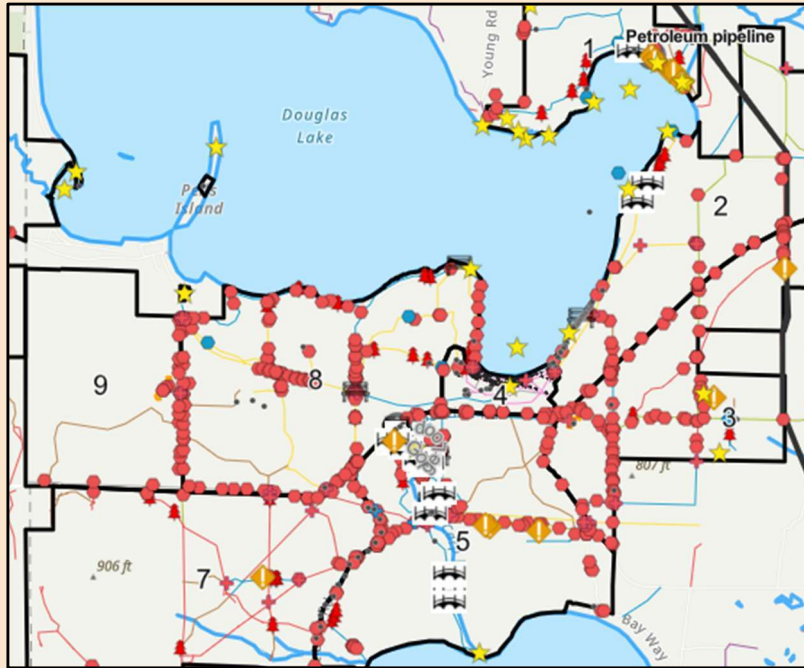


Figure 5. Screenshot of UMBS Infrastructure Map (Desktop Version)

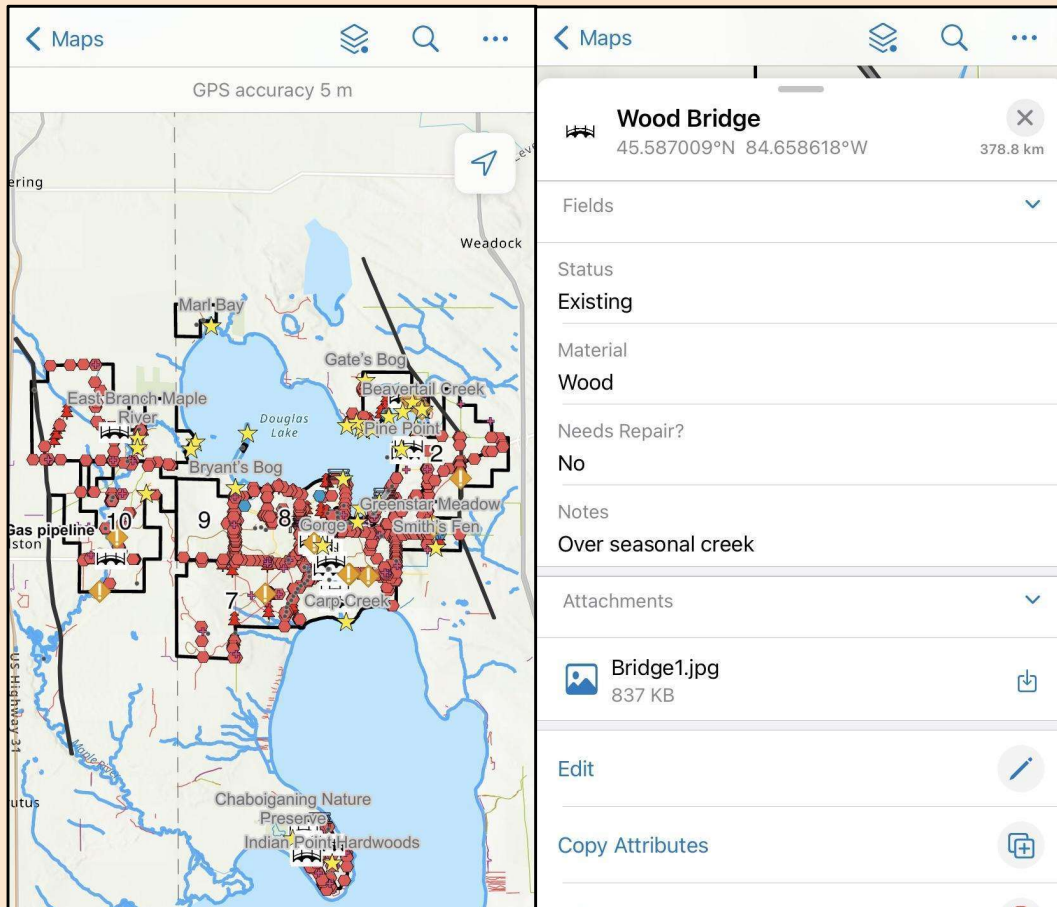


Figure 6. Screenshots of UMBS Infrastructure Map (Mobile Version) & Feature Attributes

Findings & Recommendations



Public Use

Many of the visitors at UMBS are members of the general public who use the property for recreation. UMBS property offers various outdoor recreation opportunities as a courtesy for the public including hiking, biking, hunting, trapping, off-road vehicle use, horseback riding, fishing, cross-country skiing, and kayaking. However, these multiple uses can occasionally conflict with the mission and goals of UMBS and present public relations and ecological concerns. In consultation with UMBS staff, we focused on two public uses that need more policy and management consideration at UMBS - hunting and trapping and off-road vehicle use. In response, the following section outlines a series of recommendations that may assist UMBS in managing these activities in a safe and ecologically sustainable manner while advancing the core themes of stewardship.



Hunting & Trapping

Hunting and trapping has been practiced on UMBS lands since prehistory and as long as the Station has operated. UMBS offers these recreational and subsistence opportunities as a courtesy to the public and has historically provided minimal oversight. Hunting and trapping are allowed on about two-thirds of UMBS property. **Appendix D** lists the game species found on the property. Where these activities are permitted, state rules and regulations apply but UMBS can implement rules that are more stringent. Hunting and trapping function as a form of ecological manipulation that can support and conflict with the goals and mission of the Station. UMBS's primary concerns related to hunting and trapping are safety and the effects on ecology and wildlife (e.g., poaching, destruction of natural features, etc.), specifically as they relate to ongoing research and educational activities. In addition, hunters and trappers are often not familiar with relevant UMBS rules and regulations and there is a lack of engagement with these groups. There have also been cases where internal and external researchers have been unaware of hunting and trapping on the property and where activities are allowed. Furthermore, UMBS staff are not well informed about what to do when encountering hunters and trappers suspected of violating rules and regulations.

When guided by informed strategies, hunting and trapping can contribute to land and water stewardship at UMBS. It is with this understanding that we present a set of recommendations aimed at improving communication of rules, fostering sustainable harvesting of game species, preserving the quality of UMBS habitats, ameliorating administrative actions, and minimizing safety concerns. Additionally, a portion of the recommendations aim to increase opportunities for advancing community engagement and research. The recommendations are categorized into six sections: (1) rules and regulations, (2) safety, (3) administration, (4) communication, (5) wildlife management, (6) outreach/relationship building. Relevant considerations are addressed for each recommendation.



Image 11. Father and Son Beaver Trapping in Michigan; Michigan DNR

Goals

The following recommendations aim to help achieve multiple goals through improving management of hunting and trapping on the property. These include better preserving the property from adverse ecological impacts of the activities, enhancing safety, building relationships with hunters and trappers, utilizing the activities to assist with wildlife management and data collection, optimizing administrative actions, communicating rules and regulations, and encouraging use of best practices.

Rules & Regulations

Recommendation: Permission system with mandatory reporting

Unit-specific permission to hunt or trap on UMBS lands should be obtained by the completion of a form on the UMBS website, in-person, or by mail to be reviewed by decision-makers for approval. This process could be modeled after the programs in the [Little Traverse Conservancy \(LTC\)](#), [Bangor Land Trust](#), [University of Minnesota](#), [Miami University](#), [Hollow Oak Land Trust](#), [Brunswick-Topsham Land Trust](#) and/or [Cornell University](#). It would be greatly beneficial to require reporting for any permittees. Harvest reporting ensures that data is collected, allowing for decision-makers to make timely assessments and adjustments to wildlife conservation efforts (Gasaway, 2022). Requested information for the report forms could include location of harvest, species, sex, and count. Appropriate deadlines and clear instructions for reporting will be essential for its success. Complementing this mandate with a deterrent where those who fail to report will be ineligible for permits for a period of time will likely enhance compliance.

Considerations: There are a handful of considerations for implementing this policy. These include resources and personnel for monitoring and enforcing compliance, administrative burden to review any submitted reports and permit applications, staff training and time for managing the new permit system, resources for effective communication about the new system to the public, and frustration among hunters and trappers. Due to the possibility of inaccurate reports, it may be beneficial to provide high quality photos of the game species found on UMBS lands on report forms or asking permittees to submit photos of their harvests to be checked by UMBS biologists (Ahlers & Miller, 2019). Similarly to the Cornell University's Deer Management Program, an online test that must be passed to demonstrate that applicants have read and understand rules, regulations, and expectations before applying for UMBS permits could be implemented (Cornell University Deer Management Program, 2023). Consider implementing an Earn-a-Buck (E-a-B) program where deer hunters must document the harvest of one or two does within a particular time frame before they can obtain a buck permit to manage local deer overabundance. Local deer overabundance can lead to overbrowsing which poses negative implications for research. Boulangar et al. (2012) found that an E-a-B program for lands owned by Cornell University was effective in increasing doe

harvest and improving adult sex ratio. Other considerations consist of “permit-required” signage and penalties for violating permits. Finally, contemplate requiring DNR trapping education certificates for applicants to be eligible for permits to trap at UMBS. Those with certificates are more likely to be knowledgeable on regulations, ethics, safety, and avoiding non-target species.

Recommendation: Hunting blind restrictions

Multiple types of hunters use blinds to conceal themselves to increase their chance of harvesting game. However, some hunters destroy vegetation to build their blinds or use permanent blinds which undermine preservation. Similar to the Leelanau Conservancy in Michigan, UMBS should prohibit permanent blinds and allow only Type 1 and Type 2 ground blinds (Leelanau Conservancy, 2023). A type 1 blind (Image 16) is a portable ground blind and a type 2 is a dead natural materials ground blind. These blinds



Image 12. Type 1 Hunting Blind

should not penetrate any trees. Similar to the provisions for blinds on public land in Michigan, require that the user’s name, address, and DNR number are attached (Michigan Hunting Regulations Summary, 2023) to help with enforcement.

Considerations: UMBS could consider a timeframe where blinds can be placed and when they must be removed. For example, the LTC requires that blinds can only be placed within 7 days before the hunting season and must be removed by the end of the hunting season (Little Traverse Conservancy, 2023). If a hunter fails to do so, consider stating in the rules that it will be seized and become property of UMBS. Moreover, a penalty may be appropriate for retrieving blinds as it will require staff time to do so.

Recommendation: Tree stand restrictions

Similar to blinds, tree stands (Image 17) are commonly used by hunters to give them an advantage when harvesting game. However, some tree stands penetrate trees, which can allow harmful insects and disease to enter into the tree. As a result, like numerous institutions that allow hunting on their property, UMBS should create a rule where all tree stands must be portable, not penetrate trees with nails, pegs, or screws, and are clearly labeled with contact information (Leelanau Conservancy, 2023; Cornell Deer Management Program, 2023; Grand Traverse Regional Land Conservancy, 2023; Little Traverse Conservancy, n.d.; Bangor Land Trust, n.d.; Kennebec Land



Image 13. Tree Stand

Trust, n.d.). Currently, this rule only applies to public lands in Michigan (Michigan Hunting Regulations Summary, 2023).

Considerations: UMBS should consider a timeframe when tree stands can be placed and when they must be removed. For instance, the hunting policy of Hollow Oak Land Trust states that a hunter can only put up a stand within two weeks before hunting season and must remove it within two weeks after the season is over (Hollow

Oak Land Trust, n.d.). If a hunter fails to do so, consider stating in the rules that it will be removed and become property of UMBS. A penalty may be appropriate for retrieving stands as it will require staff time to facilitate.

Recommendation: Prohibit shooting and access lanes

It is rather common for hunters and trappers at UMBS to cut trees, brush, and other vegetation to create access lanes to their traps or stands or shooting lanes which cause ecological damage. As a result, UMBS could prohibit these activities on the property like the Grand Traverse Regional Land Conservancy and Leelanau Conservancy. Currently, these regulations only apply to public lands in Michigan (Michigan Hunting Regulations Summary, 2023).

Considerations: Consider a financial penalty for violators to compensate UMBS based on the market value of the damaged features.

Recommendation: Prohibit the blazing and marking of trees to locate trails, traps, blinds, or hunting stands

Similar to the hunting policy for the Leelanau Conservancy and Sleeping Bear Dunes National Lakeshore, develop a rule that prohibits the blazing of trees and use of materials (e.g., spray paint, reflective tacks, flagging tape, flags, etc.) for marking trees to locate trails, traps, blinds, or stands (Leelanau Conservancy, 2023; Sleeping Bear Dunes National Lakeshore, 2019).

Considerations: Provide a statement with the rule that mentions alternative methods that are less invasive for marking such as using natural landmarks or GPS devices. Furthermore, it will be difficult to determine if a detected blazed or flagged tree is or was for the purpose of research.

Recommendation: Field dressing restrictions

Prohibit field dressing, gutting, cleaning, and other processing activities of game animals on UMBS lands within a certain number of feet of a stream or other natural bodies of water. Currently, the Grafton Land Trust requires field dressing to be 150 feet away from these features while Miami University requires 50 feet (Grafton Land Trust, 2013; Miami University Deer Management Program, n.d.).

Considerations: If implemented, consider inserting a description explaining the rationale in the rules and regulations. The rationale could mention being precautionary about the spread of emerging diseases like bovine tuberculosis via waterways especially since the property is located in a county that borders DMU 487 (which is a hotspot of concern for the disease). This will help to create understanding amongst confused hunters.

Recommendation: Prohibit lead shot on UMBS property

Establish and communicate a new rule that only non-lead ammunition can be used for hunting on UMBS lands. Other properties like the Skagit Land Trust in Washington have implemented this rule (Skagit Land Trust, n.d.). Further, the phasing out of lead ammunition at numerous refuges owned by the U.S. Fish & Wildlife Service will begin in 2026 (Klein, 2023). Research has found that lead shot has been associated with population declines for species like scavengers, raptors, and other terrestrial species (Pain et al. 2019; Arnemo et al. 2016; Green et al. 2022).

Considerations: Provide a scientific rationale for ensuring the policy is well understood by hunters. Be aware that some hunters will simply just hunt somewhere else that does not have this restriction in place which can lead to lower capacity for cost effective “checking” of populations for species like white-tailed deer (*Odocoileus virginianus*). This is important to consider given that less harsh winters from climate change is expected to increase populations for the deer species in the Midwest (Weiskopf et al. 2019). Furthermore, it will be difficult to get buy-in and enforce. Consider promoting the availability of lead-free ammunition at nearby stores (which likely has a larger profit margin than other ammunition).

Safety

Recommendation: Address safety concerns

Safety is a prominent concern for UMBS, especially related to hunting and trapping on UMBS property. The following is a list of potential strategies that UMBS can implement to minimize safety concerns surrounding hunting and trapping:

- Establishing trapping and hunting safety buffer zones on trails and roads. This would also include the prohibition of shooting (with a firearm and bow) across trails and roads.
- Post hunting and trapping warning signs.
- Encourage other land users to wear blaze orange when in the field during hunting season.
- Require blaze orange on deer blinds. For instance, the Wisconsin DNR requires that a deer blind possesses a minimum of 144 square inches of solid blaze orange visible from all directions (Wisconsin DNR, 2023).
- According to state law, traps must have the owner's name and address or Michigan driver's license or DNR number attached (Michigan Furbearer Harvest Digest, 2023). To better ensure the safety of any enforcers on UMBS property, this information should be visible without having to move the trap.
- Require signs around traps if it poses a threat to humans (Bangor Land Trust, n.d.).
- Require tree stands to be a certain amount of feet away from a trail. For example, the hunting policy of Kennebec Land Trust states that all tree stands must be at least 300 feet away from any trails (Kennebec Land Trust, n.d.).
- Set restrictions on the practice of deer driving.
- Limit hunting and trapping seasons on UMBS property to periods when classes are not in session and visits are low.
- Mandate that hunters must yield to researchers, hikers, and other land users (Brunswick-Topsham Land Trust, 2023).
- Require that arrows be in a quiver when on trails (Brunswick-Topsham Land Trust, 2023).
- Demand that firearms must be unloaded when crossing lands to shorelines for waterfowl hunting (Brunswick-Topsham Land Trust, 2023).

Considerations: With limited capacity, UMBS will have difficulty in enforcing any safety rules and regulations unless relationships are developed with university, state, and local law enforcement. If stands are ever required to be away from trails and/or safety buffer zones are implemented, creating maps with respective buffers for guidance will help enhance compliance.

Administration

Recommendation: Annual hunting and trapping policy reviews

Incorporate formal UMBS hunting and trapping policy reviews into the annual cycle of operations. Policy reviews should involve a collaborative and evidence-based approach involving experts, internal and external stakeholders, and the public. The outcomes of these reviews should be communicated to all stakeholders and the public to ensure transparency and understanding.

Considerations: A review could generate conflict from participants who disagree with proposed policy changes. Importantly, an effective review will require awareness of changes in science,

laws, and loopholes along with time and resources for modifying relevant signage, policy documents, and webpages if policies change. Consider hosting the reviews virtually on software like Zoom as travel costs may be a major barrier for interested parties and documenting recommendations and findings from each review for future reference.

Recommendation: Create a SOP for what staff should do when encountering hunters and trappers violating rules or interfering with research

From our interview with Research Coordinator and Lab Manager, Helen Habicht, we learned that faculty is generally unaware of what to do when encountering hunters and trappers on UMBS lands. We propose that a SOP is developed that informs staff on how to go about consulting and reporting hunters and trappers who are suspected of violating rules or interfering with research. This should include a list of well-articulated statements and questions that can be asked to facilitate a thorough investigation and respective and productive consultations. Moreover, procedures for reporting should list relevant MDNR contacts and key information that should be shared to government officials.

Considerations: When designing the SOP, consider involving stakeholders such as UMBS staff, hunters and trappers, and local authorities (e.g., conservation officers). Lastly, the SOP could outline procedures for documenting encounters with hunters and trappers to track trends and address recurring issues (e.g. staff log).

Recommendation: Off-trail cameras for monitoring

It would be in the best interest of UMBS to implement additional off-trail cameras and utilize current off-trail wildlife cameras to monitor hunting and trapping activity. This footage should be reviewed on a regular basis especially during periods of high activity such as deer firearms season which typically occurs in the middle of November. The cameras will have the capability of informing UMBS about which units experience the heaviest hunter and trapper use and detect illegal activity.

Considerations: Acquiring and implementing additional cameras will require funds and commitment from a staff member to review the footage on a regular basis, time to decide on effective camera placement, maintenance of cameras, and reviewer awareness of what constitutes rule-breaking both at the state and UMBS level. There is also a chance that the cameras can be stolen or vandalized, especially by poachers.

Communication

Recommendation: Dedicated UMBS hunting and trapping webpage

During our interview with Research Coordinator and Lab Manager, Helen Habicht, we discovered that there is general unawareness amongst recreationalists regarding UMBS's hunting and trapping regulations. As a result, a downloadable UMBS's no hunting boundary (Figure 7) and hunting and trapping regulations (that are additional to local, state, and federal) should be posted on its own webpage on the UMBS website. This webpage could also remind hunters and trappers of UMBS-wide rules including but not limited to: open or contained fires are prohibited, no camping, and that dogs must be on a leash at all times. Emphasize other important factors such as that UMBS is mainly used for education and research purposes and thus, hunters and trappers should respect and not interfere with these operations.

Considerations: If the recommendation is implemented, it will require staff time for updating the webpage when relevant policy or boundary changes occur.

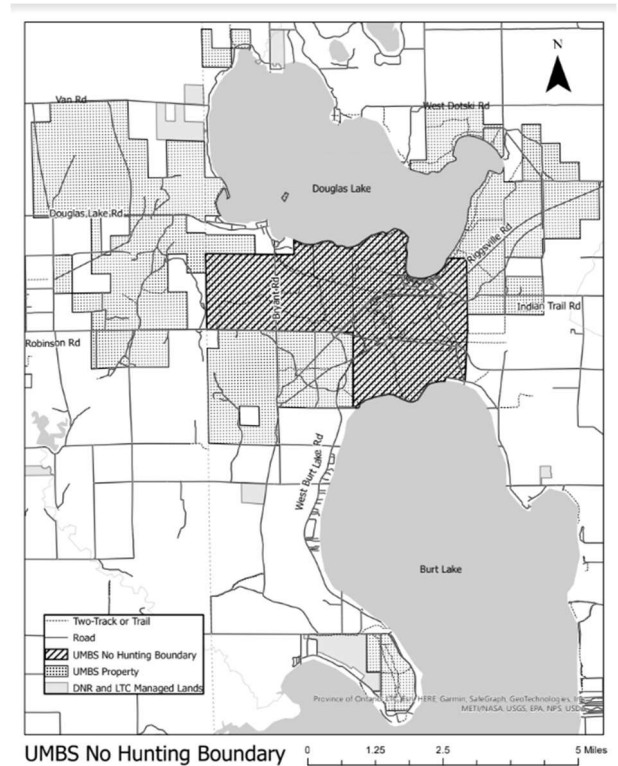


Figure 7. Map of UMBS No Hunting Boundary

Recommendation: onX Hunt modifications

Currently, when UMBS is selected in the popular onX Hunt app, there is a clear need for additional information. Specifically, UMBS should consult onX staff to add notes conveying important information such that UMBS has rules and regulations that extend beyond that of the state and a link to those regulations and the station's No Hunting Boundary.

Considerations: This will require consultation with the organization if the notes need to be modified or links ever change. Furthermore, even though the application is popular, not every hunter and trapper uses it. There will need to be other public outreach strategies to fill the gap for hunters and trappers who view UMBS as government-owned land.

Recommendation: Ensure that researchers are aware that UMBS allows hunting and trapping and where

Some researchers in the past have been unaware that hunters and trappers use UMBS lands. As a result, UMBS should develop and implement mechanisms to help ensure that researchers are aware that hunting and trapping occurs on UMBS property and where. One potential strategy is making an explicit statement and attaching the No Hunting Boundary in research application forms on Mfield.

Considerations: If the No Hunting Boundary ever changes, research application forms will need to be updated. Furthermore, this action may discourage researchers from conducting work in areas outside the no hunting boundary due to concerns over personal safety or interference with their study.

Recommendation: Poaching-related signage

Through our conversations with UMBS staff, poaching has been a recurring issue on the property. One strategy for deterring poachers is to install signage. Potential text for signs includes “No Poaching, Area Patrolled” and “Security Cameras in Use.” Another strategy is to advertise on signs at trailheads that those who report a poaching incident on UMBS lands to the DNR may be rewarded with thousands of dollars from the department if they supply information that leads to the arrest and conviction of one or more poachers. As of April 1, 2023, the reward is \$6,950 (MDNR, n.d.). Complement the signage with the DNR poaching hotline number (800-292-7800) and a QR code to the MDNR’s [online Report All Poaching \(RAP\) form](#) to streamline reporting.

Considerations: As it is likely that poachers may tear down the signs, consider hanging the signs high on trees to prevent losing them. Another consideration is administrative costs to install, maintain, and replace signs along with ensuring the signs follow criteria from the MDNR. Finally, there could be false reporting which results in a waste of law enforcement resources.

Recommendation: Encourage traps that are compliant with Best-Management Practices (BMPs)

One major concern in the scientific community about trapping is the possibility of non-target harvests which can injure or kill non-game species. Considering this information, UMBS should encourage trappers to use BMP-compliant traps. This could entail inserting the following statement on the UMBS website and in relevant documentation: “Traps should be designed to the extent possible to trap only the targeted species. Information on BMP-compliant traps can be found by referring to the current BMP documents developed by the Furbearer Conservation Technical Work Group of the Association of Fish & Wildlife Agencies (AFWA). These documents are available

on AFWA's [official website](#)". Trapping practices are evaluated based on animal welfare, efficiency, and selectivity.

Considerations: It is likely that some trappers will not have the interest or ability to obtain BMP-compliant traps. For instance, a BMP-compliant trap may be too expensive. UMBS may also want to consider mandating BMP-compliant traps, but this will pose significant enforcement challenges.

Wildlife Management

Recommendation: Special hunting zones

Development of zones/parcels outside the No Hunting boundary open to either unrestricted hunting or limited to a mix of bow, shotgun, muzzleloader, and/or waterfowl only like the [Little Traverse Conservancy \(LTC\)](#). Other organizations that employ similar management approaches include [Bangor Land Trust](#) and [Skagit Land Trust](#). These zones can be adapted to specific ecological and safety considerations on UMBS lands. Apply where applicable on UMBS lands outside of the sanctuary zone with an adaptive management approach.

Considerations: The following issues should be considered: logistical challenges (e.g., defining clear boundaries), increased administrative burden for monitoring, enforcement, and rezoning, and potential conflict between UMBS and hunters. Clear communication about the purpose and guidelines of these zones will be crucial for understanding and compliance.

Recommendation: Apply for deer management permits from the DNR

If population surveys ever find that current antlerless harvests are inadequate on UMBS lands, consider applying for the MDNR's Deer Management Assistance Permits (DMAP). Other research properties like Black Rock Forest in New York have utilized a similar version of these permits. Landowners with this permit open their land to hunters who receive special tags for harvesting antlerless deer on their property during open season (MDNR, n.d.). DMAP is property-specific which allows for building relationships with the DNR. If overbrowsing occurs outside of hunting season, consider applying for Deer Damage Permits where UMBS may designate hunters to harvest on the property outside of open season (MDNR, n.d.). Give preference to hunters who have demonstrated compliance with UMBS policies.



Image 14. White-tailed Deer (*Odocoileus virginianus*); Michigan DNR

Considerations: Potential considerations include allocation of funds and time for applying for and purchasing permits, coordination with the DNR, increased hunter density during open season which can negatively impact safety and interfere with research, and establishing mechanisms for monitoring and evaluating the effectiveness of the permits.

Recommendation: Flexible no hunting and trapping boundary zone

Make the No Hunting Boundary flexible where invited hunters and trappers can harvest inside of the zone for a certain period of time if appropriate ecological conditions emerge (e.g., too many deer). This will allow for management of issues like overbrowsing within certain units that are traditionally excluded from hunting and trapping.

Considerations: Safety concerns should be greatly considered. For instance, consider only adapting the zone during the winter season where the human population at UMBS is low. Other major considerations include time and resources for planning and communicating the modification. Inviting experienced hunters and trappers who will have a greater chance of harvest during the time period will increase the effectiveness of the temporary adaptation. Consulting local sportsmen clubs and organizations like the Michigan Trapper & Predator Callers Association may assist in finding these experienced hunters and trappers.

Recommendation: Temporary restrictions on buck hunting

Antlerless harvests are being encouraged by the MDNR to mitigate deer overabundance across the state. This overabundance can lead to impacts on future research at UMBS through reducing species diversity, species density, and basal area. To address this issue, UMBS should implement temporary restrictions on buck hunting to sway hunting pressure towards does.

Considerations: Issues associated with monitoring to determine effectiveness along with enforcement as UMBS has a low number of staff, hunter opposition as deer hunters regularly prefer bucks, and administrative burdens associated with public communication. Implementation will also require regular check-ups on MDNR goals to ensure that temporary restrictions align with broader statewide deer management goals.

Outreach/Relationship Building

Recommendation: Become an active partner in special state hunts

UMBS could become an active partner in the Independence Hunt, Liberty Hunt, Youth Waterfowl Hunting Weekend, and/or Veterans and Active-Duty U.S. Military Personnel Waterfowl Hunting Days. These are special hunts that offer hunting opportunities for youth, military, and disabled hunters. The LTC is currently an active partner in the Independence Hunt and provides a deer-camp experience (Little Traverse Conservancy, n.d.).

Considerations: Hosting these events will require staff time and resources. For instance, the LTC provides hunters with large tent-blinds, meals, food plots, shooting sticks, and deer processing fees for the Independence Hunt. However, requesting donations may help to circumvent some financial costs. Like the LTC, these initiatives could be coordinated through local sportsmen clubs (Little Traverse Conservancy, n.d.).

Recommendation: Leverage hunters and trappers for wildlife research

UMBS should involve local hunters and trappers as citizen scientists. Cretois et al. (2020) and DeCesare et al. (2023) have found that leveraging hunters as citizen scientists can provide a rigorous and cost-effective approach for monitoring wildlife dynamics through methods like direct and indirect observations, camera traps, donating carcasses, questionnaires, and interviews for aspects like diseases detections, and monitoring non-target species. For instance, the University of Minnesota operates a program where deer hunters set up game cameras after field dressing to help researchers understand scavenging of deer gut piles (University of Minnesota Extension, n.d.; Candler et al. 2023). Similarly, the state of Minnesota encourages voluntary submission of wings or tail feathers to study habitat change and behavior influencing sharp-tailed grouse expansion into the range of prairie chickens (Minnesota DNR, 2023). Trappers can be leveraged to train wildlife biologists in capture techniques, provide carcasses for study, capture species for radio collaring, secure bait, and offer intimate knowledge of their trapping areas amongst other benefits (Webb & Anderson, 2016).

Considerations: Hunters and trappers may have biases in their observations and reporting influenced by their interests, preferences, or the specific wildlife they target. This may potentially

skew analyses. Furthermore, low participation rates in forums like surveys can make interpretation of findings difficult. An additional limitation is inconsistent data quality as the level of expertise and commitment amongst hunters and trappers will vary. As UMBS is familiar with iNaturalist, consider encouraging hunters and trappers to use the application for reporting observations of species. Another mechanism for capturing species observations is a survey that inquires about the type and number of wildlife observed.

Recommendation: Invite local hunters and trappers to relevant summer lectures and/or open house events

Ask local organizations such as the Emmet and Cheboygan County Sportsmen Clubs, Michigan United Conservation Clubs (MUCC), and the Michigan Trappers & Predator Callers Association to notify their members about summer lectures hosted by UMBS focusing on relevant topics of interest (e.g., lectures on game species) and open house events.

Considerations: Given the lectures occur at a specific time and place which limits participation, consider live streaming them via Zoom or organizing repeated lectures in other locations.

Recommendation: Voluntary Deer Check Station

Invest in a deer check station (Image 20) where hunters can voluntarily bring their harvested deer for UMBS staff to record sex, antler points, dressed weight, age, and check for disease. Effectively communicate to hunters about the benefits and procedures as lack of awareness and understanding could hinder participation. Staff should be present on heavily hunted days (e.g. first day of deer firearms season). When staff cannot be present, a self-service drop box where tools are provided for hunters to remove one half of the lower jaw or whole heads will be beneficial. During deer hunting season, Black Rock Forest operates a station for 12 hours a day for 23 days which demands 276 staff hours per season.



Image 15. Deer Check Station

Considerations: Implementing this recommendation will require the purchase of appropriate tools (e.g. weight scale). It will also require adequate training, oversight, staff, and regular check-ups on the dropbox during open deer season. Furthermore, to avoid stepping on the toes of the MDNR, share any obtained data with bureaucrats. Importantly, there will be an administrative burden for communicating about the new station to the public, potential public frustration towards wait times, and hunters interested in taxidermy will likely not use the self-service box. Similar to Cornell

University's deer management program, consider providing harvest and deer-sighting forms at the self-service stations (Bouglander et al. 2012).

Recommendation: Annual buck pole

Implement an annual buck pole where hunters can voluntarily bring their harvested deer to UMBS to exhibit their harvests and hunting skills.

Considerations: A buck pole will require infrastructure, materials, and staff to display the deer. Also, there is a possibility of resistance from stakeholders who view the event as unethical. Other considerations include incentivizing hunters to participate through a small cash prize contest for whoever brings in the first and/or biggest deer. UMBS should also consider hosting the pole on the first weekend of deer firearm season as it will increase the likelihood of participation.



Off-Road Vehicle Use

UMBS has experienced frequent issues with Off-Road Vehicle (ORV) traffic across the property. The University has indicated this is a priority issue and Resident Biologist, Adam Schubel has also cited complaints from local county board representatives, conservancies, non-profits, and the DNR regarding ORV traffic around Pellston. Recently, Adam Schubel has been working with the U-M Real Estate Office and Consumers to get permission to install a fence across a powerline right-of-way to restrict ORV traffic, however other than restricting use via fencing and road closures, UMBS is looking for ideas involving best practices for how to approach restricting ORV traffic on the property. Ultimately, the main goal is for UMBS to develop a comprehensive strategy for ORV management that reduces ORV traffic to a level in accordance with UMBS's overarching priorities of Research, Education, Outreach, and Preservation.

These recommendations are formatted as best practices followed by some considerations. These best practices are not meant to be prescriptive but to provide UMBS with options to consider. ORV use policies are fairly well documented for US public lands. Despite being a public institution, UMBS has the ability to restrict public access on UMBS property without public input or review. Much of what has been written regarding ORV use takes into account the legal context and political implications of restricting an activity undertaken by the public on public lands, where ORV users' input is a factor in the decision-making process and where state and federal legislation must be adhered to. As such, the following recommendations are given under two possible scenarios: first, UMBS attempts to prohibit ORV use on its property, where possible, by closing roads and second, UMBS decides to direct limited ORV use in certain areas.

Goals

To provide a set of best practices for how to approach restricting ORV traffic on the property. Ultimately, the main goal is for UMBS to develop a comprehensive strategy for ORV management that reduces ORV traffic to a level that UMBS finds in accordance with its overarching priorities of Research, Education, Outreach, and Preservation.

Recommendation: UMBS prohibits ORV use on property

Considerations: In theory, this option is straightforward as UMBS has the authority to unilaterally prohibit ORV use on the property, however in practice UMBS will still face the same enforcement challenges it already faces. UMBS cannot restrict ORV traffic that occurs on public two-tracks and has trouble restricting traffic on utility corridors, in practice. If UMBS were to adopt this option, the following should be considered:

Fencing off access points in conjunction with new standardized signage, as recommended in the "Signage and Rule Communication" section of this report, could aid in discouraging ORV activity.

However, given the size of the property this would take a substantial amount of time and resources with an unclear picture of how effective it would be in eliminating ORV use in accordance with UMBS' goals.

Recommendation: UMBS limits, but directs ORV activity along selected public routes

Considerations and Suggested Best Management Practices:

This option may be more practical as ORV restrictions would only need to be enforced in select parts of the property. Further, providing the public with some alternate locations that are actively managed for ORV use may be a better deterrent to ORV use in sensitive areas. In conversations with Facilities Manager, Scott Haley, this past summer, Scott expressed that he has spoken to ORV users and his sense is that they are going to go somewhere, so it would be helpful to notify them of alternative locations where they can use their ORVs outside of areas where the activity is restricted. Thus, UMBS should consider designating select areas as ORV friendly in an attempt to concentrate activity to areas where there are limited ecological concerns and limited conflict with other public uses and with UMBS research or educational activities.



Image 16. Example ORV Route Sign; Michigan DNR

The following are a select list of best management practices for ORV use on forestlands, taken from a guide for designating and managing ORV routes prepared by the Wild Utah Project and Wildlands CPR (Wildlands CPR and Wild Utah Project, 2008).

Protect Forest Soils

ORVs have well documented detrimental impacts on soil health, which has cascading effects on the ecosystem as a whole. ORV activity can compact soil (Nakata et al. 1976), which reduces the soil's ability to absorb water and reduces the fertility of the soil (Dregne, 1983; Wilshire et al., 1977). This can lead to increased overland flow, as the soil's water holding capacity is reduced,

resulting in high concentrations of surface water that contribute to erosion and sedimentation (Misak et al. 2002). Studies have also directly linked ORV to increased erosion and stream sedimentation, damaging riparian habitat (Chin et al. 2004). The following best practices were developed with these issues in mind (Wildlands CPR and Wild Utah Project, 2008):

- Locate routes in areas with stable soils; avoid highly erodible soils, if possible.
- Locate routes the minimum distances from water bodies and wetlands specified below (USDA, n.d.):
 - Fish-bearing streams and lakes – 300 ft.
 - Permanently flowing non-fish-bearing streams – 150 ft.
 - Ponds, reservoirs, and wetlands greater than one acre – 150 ft.
- Avoid designating any routes that require stream crossings and prioritize closure, re-routing or creating bridge crossings for existing routes that have stream crossings. See the [US Forest Service Riparian Area Management Guide](#) for more details on riparian protection best practices.



Image 17. Erosion impacting tree roots (left) and a small stream (right)

Native Plant Protection

Aside from the direct detrimental impacts ORV use can have on vegetation from trampling plants, there are also cascading effects on plants that have been documented. Large shrubs and trees 15-20 ft. tall have been killed by root exposure caused by adjacent ORV traffic (Wildlands CPR and Wild Utah Project, 2008) and plants that survive direct trampling or root exposure are weakened and prone to disease. Studies have found that ORV use can result in up to half as much vegetation present when compared to a comparable undisturbed site (Misak et al., 2002). Furthermore, this can result in substantial long-term alteration of the natural plant community at a given site via changes in species composition from direct trampling mortality or delayed seedling mortality (Leininger and Payne 1971; Stout, 1992). In addition to effects on native plant species, ORVs can serve as a vector for invasive plant species. With these issues in mind, we recommend considering the following BMPs when deciding where to permit ORV use and possibly establish ORV routes (Wildlands CPR and Wild Utah Project, 2008):

- Identify what sensitive, threatened, and/or endangered plants are in ORV use areas, as well as rare, fragile and/or unique plant communities. Record this information into a GIS database to guide any future decisions on ORV routes.
- Remove invasive non-native plants from routes when feasible.
- Identify areas where invasive plants are present and pose a problem and require that all ORVs using such areas wash vehicles when exiting such areas.
- Close and restore routes documented as contributing to the spread of non-native invasive plants into relatively weed-free areas.
- Adaptively manage by closing or mitigating a route if monitoring identifies that vegetation conditions are no longer in compliance with planning and decision-making BMPs.



Image 18. Michigan Monkey-Flower (Mimulus michiganensis)

Preventing Wildlife Disruption



Image 19. Ground Nesting Woodcock (Scolopax minor)

Unsurprisingly, the trampling effect of ORVs can also result in direct mortality of wildlife, especially amphibians, reptiles, small mammals, and ground nesting birds. The destruction of habitat for wildlife is also an issue, as is partly discussed in the ‘Native Plant Protection’ section above. The most widespread impact of ORV use on wildlife is disturbance, which mostly involves the impact that ORV noise has on wildlife behavior. Disruption of breeding and nesting birds is a well-documented problem that highlights the detrimental impacts of ORV disturbance. Potential

disruption of courtship activities, over-exposure of eggs or young birds to weather, and premature fledging of juveniles have all been documented as a result of ORV disturbance (Hamann et al., 1999). Repeated disturbance can eventually lead to nest abandonment and these short-term disturbances have been linked to long-term bird community changes (Anderson et al. 1990). Thus, it is essential to consider wildlife in the ORV decision making process. Below are a couple of essential BMPs to consider from Wildlands CPR and Wild Utah Project (2008):

- Locate new routes where they are unlikely to significantly affect the populations of important native wildlife species specifically regarding reproduction, nesting, or rearing.
 - Do not locate routes in areas with concentrated or particularly important ungulate fawning or calving areas.
 - Do not locate routes inside buffer distances for nesting sites, particularly of ground nesting bird species.

Avoiding Use Conflicts

Land use conflicts in the context of ORV management are often discussed in the context of managing multiple public recreation uses on state or federal land. For the sake of this report, we are less concerned with ensuring quiet spaces for hikers, hunters, and anglers but there are still multiple land uses to be considered where ORVs may be disrupted. UMBS should prioritize research and educational activities to shield from ORV conflict, but also give some consideration to members of the public looking to recreate quietly as described by the BMPs below:

- Do not locate ORV routes where they may directly interfere with research infrastructure, or indirectly interfere via noise pollution.
- Do not locate ORV routes where they may disrupt class activities at UMBS. Sites frequented by classes and students should be avoided in determining where to permit ORV activity.
- Designate motor-free Quiet Use Zones that prioritize wildlife needs and relatively low-impact recreational activities.
- Do not locate ORV routes on trails, areas, or watersheds primarily used by hikers, horseback riders, mountain bikers, hunters, birdwatchers, or other quiet recreationists and sportsmen.

Enforcement, Outreach, and Implementation of ORV Management Policies

Essential in achieving the desired outcomes of the BMPs described in this section is the ability for UMBS to adequately implement and enforce the ORV policies it chooses to establish. This is where UMBS can leverage the appetite of the University and local entities to take action to reduce

ORV traffic, along with the justifications provided here, to build momentum that can aid in the implementation and enforcement of new ORV policies. Below are a combination of BMPs from Wildlands CPR and Wild Utah Project (2008) and suggestions specific to UMBS, taken partly from other recommendations related to outreach and education provided in this report:

- Undertake proactive and systematic outreach to motorized and non-motorized visitors in order to facilitate mutual understanding of the preferences and desired experiences of public land visitors.
 - Could involve survey or feedback forms at kiosks as described in the ‘Signage and Rule Communication’ section.
- Establish a recreational working group with both motorized and non-motorized stakeholders that meet regularly with land managers. These groups should work cooperatively to identify and resolve conflicts in a manner consistent with agency policy.
 - At UMBS, this could take the form of attending county meetings, expressing concerns about ORV use, and listening to input from ORV users and other folks with a stake in the issue.
- Work with MDNR and local law enforcement to implement penalties and consequences for violating ORV regulations that will dissuade ORV users from such violations.
- Match ORV use to the available management and enforcement capacity (funding and staffing).
 - UMBS has expressed difficulty in capacity for enforcement and its ability to get local law enforcement to assist. Thus, ORV use restrictions should match this capacity to the extent possible while also adhering to BMPs. This is another reason why we feel that encouraging use along select routes that minimize ecological harm and disruption to UMBS activities, could be a better way to discourage use of less desirable routes. In other words, using carrots instead of sticks to give ORV users alternatives and hopefully reduce the amount of ORV use that needs to be forcefully restricted with limited capacity to do so.

The management zone recommendations provided in this report can also be used as guidance for determining where to designate and prohibit ORV use at UMBS. Much of the BMP criteria described here, particularly those pertaining to sensitive plant species or habitat, could be used to classify land into management zones. If UMBS establishes a management zone based on the presence of sensitive habitat and species, then it would follow that disruptive activities like ORV use would be prohibited there. Thus, management zones can also be used as a guide to quickly narrow down where ORV uses might be most appropriate.

Findings & Recommendations



Timber Harvesting

Timber sales have occasionally taken place at UMBS primarily for research, ecological, and/or revenue generating purposes since 1979. The most recent timber sale at UMBS occurred in 2019.

Timber sales can result in massive disturbance of the ecosystem and liquidation of significant university resources, thus a clear set of guidelines about how to carry out timber sales would be helpful to the Station. However, there is not a documented standard operating procedure (SOP) for carrying out such sales. The following proposes a general SOP that can help to ensure that procedures related to timber sales are compliant, consistent, efficient, and in the university's best interest. Furthermore, a series of recommendations to enhance the safety and environmental stewardship of future timber sales are presented.

Timber Sales Standard Operating Procedure & Case Study

The following describes a general SOP that could be used by current and future staff. The goal of the SOP is to maintain consistent and compliant operations related to timber sales, improve efficiency, and serve as a checklist to reinforce proper performance. The most recent timber sale that occurred on Pellston Hill in 2019 provides a case study to inform the SOP. This sale was part of the [Adaptive Aspen Management Experiment \(AAME\)](#), which incorporated research, silvicultural, and revenue-generating goals (Nave et al. 2020). The sale consisted of 12,000 mature trees that were mostly bigtooth aspen trees (*Populus grandidentata*) occurring across four research units/treatments on 77 acres. Variables of this harvest are monitored and evaluated as part of the experiment.

Case Study: Pellston Hill Timber Sale (2019)

In 2018, Luke Nave collaborated with the Northern Institute of Applied Climate Science (NIACS) and UMBS staff and researchers to design an experimental timber harvest to study forest responses to different silvicultural treatments in a changing climate (Figure 8). UMBS then contracted consulting forester Dean Reid to help plan and administer the timber harvest, and Nave worked with Reid and U-M administration to develop a feasible harvest plan that included specifications for the experimental silvicultural

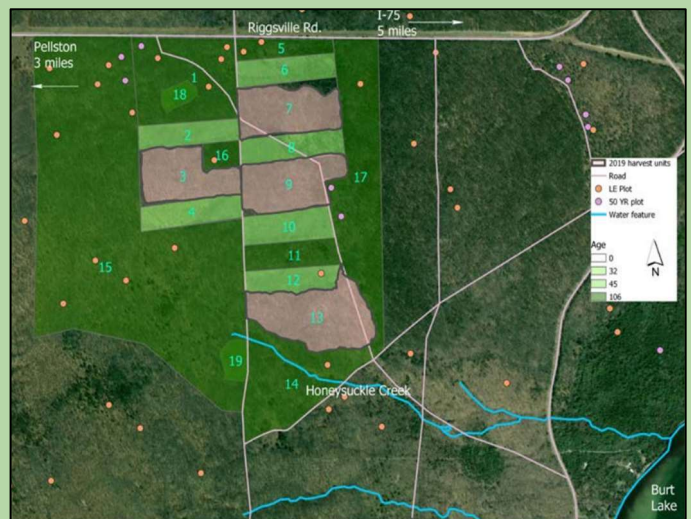


Figure 8. Map of Experimental Timber Harvest

treatments and met U-M criteria. Road improvements were identified such as those on S. Bryant Rd. and on relevant two-track roads. UMBS staff communicated with Mr. Brent Shank (Engineer and Manager at the Cheboygan Road Commission) who approved of these improvements. UMBS hired an excavating contractor to estimate the associated costs (Merchant Excavating of Cheboygan). A cutting specifications document that went out with request for bids was developed which detailed criteria for what is to be cut in each of the four research units, road improvements, vehicle access, restricted time frames for harvesting, restrictions when harvesting (e.g., no skidding of logs over 17 feet in research units, leave standing trees for wildlife unless hazardous to operations, etc.), and payment schedule. The document provided an illustration of a map that identified timber sale boundaries, research wells, vehicle access, and needed infrastructure improvements (Figure 9). Reid advertised the sale while the U-M Procurement Office administered the bidding process. Bidders, including a representative for the Louisiana-Pacific Corporation visited the timber-sale site in 2018 to estimate the amount of

usable timber and its associated market value (Erickson, 2019). UMBS selected the highest bidder, Louisiana-Pacific Corporation (American building materials manufacturer) for the timber sale. Reid then delivered payment to UMBS. Reid, with assistance from Nave and the UMBS Resident Biologist, marked the timber sale boundaries and individual trees with paint to be harvested or preserved from cutting. For instance, in research unit 7, all red pine and beech marked with orange paint were to be cut while all red painted trees were to be preserved.

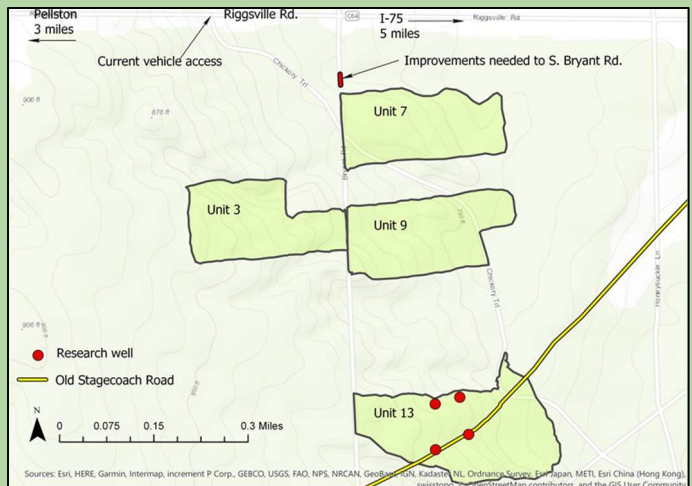


Figure 9. Timber Cutting Specifications Map

Afterwards, a license agreement was developed by U-M and UMBS representatives. The agreement included information on insurance, supervision, indemnification, vacation of premises, waste or nuisance, governing law, default, and notices amongst others. In addition, UMBS rules and regulations and a map illustrating the licensor's property and license area were provided as exhibits. The U-M Real Estate Office reviewed the documents and consulted with the Office of the General Counsel. This agreement was signed by the Executive Vice President and Chief Financial Officer for the Regents of the University of Michigan and the Resource Manager for Louisiana-Pacific Corporation. Reid and UMBS representatives met with the contractor on-site prior to the beginning of work to approve roads, landing locations, and review contract specifications. The contractor was responsible for notifying the forester at least 7 days prior to schedule this meeting.

The harvest was carried out in March of 2019 but paused in May for bird nesting season and student summer research. It was later completed in September of 2019 (Erickson, 2019). UMBS representatives and the forester periodically visited the site to evaluate progress and compliance with the contract. All timber and trash were required to be hauled out as soon after cutting as possible. A post-harvest review was conducted to ensure that the purchaser abided by the contract and no trash or timber was left behind. An ongoing long-term monitoring program is in place to test the three aspen management strategies that were applied in the Adaptive Aspen Management Experiment. A living report was developed by the project leader and shared on the Climate Change Response Framework website. This document provides a summary of the project, describes the management area and treatments, and lists associated research questions (Nave et al. 2020).

SOP: Timber Sales

The following describes a general SOP for timber sales on UMBS property. The purpose of this SOP is to ensure that timber sales on UMBS lands are carried out in an efficient and consistent manner. The scope of the SOP is to provide guidelines detailing step-by-step actions for facilitating the planning, implementation, monitoring, and reporting of timber sales. This will be beneficial given that the sales serve as an important mechanism for research and pose social-ecological impacts.

Step	Action
1	Contract with a professional forester who fits needs and preferences. Refer to the Michigan Department of Agriculture and Rural Development (MDARD) list of qualified foresters and/or Association of Consulting Foresters website to locate a consulting forester.
2	Develop a harvest plan in conjunction with the forester, relevant scientists, and U-M administration.
3	Coordinate with the forester to identify any road improvements. If improvements are needed on UMBS roads, engage an excavating contractor to estimate costs. For public roads, consult the Cheboygan Road Commission Engineer and Manager for approval. Note that for private roads, or in coordination with relevant government units for public roads, logging operators may handle road repairs and improvements as part of their post-cut restoration efforts.
4	In collaboration with the forester, develop a cutting specifications document to go out with requests for bids (see Appendix H).
5	The forester should mark trees to be cut and preserved with different colored paint in accordance with the cutting specifications document. If needed, UMBS should provide assistance.
6	Advertise and administer the bidding process. The forester will be in charge of advertising while the U-M Procurement Office administers bids.
7	Evaluate bidders based on the following criterion: magnitude of bid, business record and reputation, logging practices and equipment, and end products.
8	Develop a license agreement for the sale. Refer to Appendix G for an example of this document.
9	Authorized representatives for seller and purchaser sign off on the agreement.

10	Meet with the forester and contractor to approve roads, landing locations, and contract specifications. The contractor is responsible for notifying the forester ahead of time about this meeting.
11	The forester will administer the harvest acting as UMBS's agent.
12	UMBS representatives and Forester should periodically visit the harvest site to evaluate progress and contract compliance.
13	Carry out a post-harvest review with assistance from the forester to ensure that close-out activities were adequately conducted including that all timber was hauled out, trash was removed, and roads were repaired (if applicable).
14	Continuously monitor and evaluate the impacts from the sale.
15	Develop a living report and disseminate to relevant stakeholders through strategically identified forums (e.g., websites).

Timber Sales



Timber sales provide UMBS the opportunity to generate income to enhance research and education, facilitate research, support local economies, make its forest less vulnerable to climate change, and foster relationships with stakeholders in the timber industry (Climate Change Response Framework, 2020). However, timber sales can cause ecological damage (and thus threaten research and education) and pose safety concerns if not carried out sustainably. Past timber sales on UMBS lands have used many good practices including but not limited to: engaging a professional forester, developing a contract, requiring contractors to comply with state BMPs, site-visits, and mandating down payments and performance bonds. However, we identified areas for improvement. The following is a set of recommendations that may optimize timber sales on UMBS lands which can assist the Station in better achieving its land and water stewardship goals. The recommendations are categorized into the following three categories: (1) administration, (2) technical, and (3) safety. Relevant considerations are highlighted for each recommendation.



Image 21. Forwarder stacking Bigtooth Aspen logs during 2019 UMBS timber sale

Goals

The following recommendations aim to assist UMBS in improving administrative, technical, and safety measures related to timber sales on the property. Specifically, ensuring that UMBS is better prepared for future sales and maximizing the probability that adverse ecological and social impacts will be avoided.

Administration

Recommendation: Invest in a documented, comprehensive forest management plan

Develop a written property-wide forest management plan for UMBS. This plan can assist UMBS in deciding on what timber stands to sell and retain to improve its forests. Content of the plan should include goals and objectives, maps, property boundary descriptions, forest inventory data, management recommendations, and activity schedules (Utah State University Forestry Extension Service, n.d.). Utilize the UMBS zone management plans created by past student teams at Michigan Technological University to jump-start development of the plan.

Considerations: If a plan is developed, consider a timeframe for regular review to align with changes in science or institutional goals. Most importantly, a forest management plan will require a significant amount of staff time and resources for its development and implementation, especially considering the large size of UMBS and its variety of forest types. Hiring a consulting forester for management plan writing will likely be cost-effective. There are also two mechanisms in Michigan that can help cover costs for the development of a plan and assist in its creation: Forest Stewardship Program (FSP) and the Natural Resources Conservation Service (NRCS) (Leisen, 2017).

Recommendation: Communicate with neighboring landowners

After initiating interest in conducting the sale, UMBS should talk to adjacent landowners who may also be interested in selling timber (Utah State University Forestry Extension, n.d.). This would include State land and private landowners. Establish effective means of communication such as in-person meetings, phone calls, or written correspondence. Even if neighbors do not have interest in participating in a sale, they may have references for foresters.

Considerations: This communication will require time and resources for coordination between all involved parties to determine appropriate allocation of revenue and harvest parameters. Further, there is potential for disagreements regarding property boundaries. If this occurs, hiring a professional land surveyor will be beneficial.

Recommendation: Inquire about contractor's equipment

Inappropriate equipment can be a major threat to forests during timber sales. For instance, if a piece of equipment is too small, it may create difficulties for skidding thus leading to stand damages (Parker & Bowers, 2006). Depending on sale-specific characteristics such as timber size, soil types, and environmental concerns, specific equipment requirements to minimize erosion and impacts to water quality should be listed in the cutting specifications document.

Considerations: This inquiry will require personnel with a high level of knowledge and expertise to assess if the on-site equipment truly complies with the listed requirements.

Recommendation: Consult with an expert forester

Clarifying the goals of future harvesting initiatives will be critical to ensuring their cohesion with the core values of UMBS. Engaging one or more Expert Forester(s) would ensure a comprehensive understanding of harvesting options and sustainable best practices. This effort has the potential for substantial financial gains, as well as far-reaching implications for the future of research, conservation, and sustainability at UMBS. The significance of this endeavor necessitates careful consideration and expertise beyond the scope of this report to ensure its success and longevity.

Considerations: There is an opportunity here to collaborate with tribal organizations within the Obtawaing Biosphere Region, as an effort to both strengthen existing partnerships and embrace traditional silvicultural knowledge towards mutual land stewardship goals. Such a proposal aligns with the University's commitments to Diversity, Equity, and Inclusion (DEI) principles including indigenous representation.

Recommendation: Consult with a wildlife biologist

In conjunction with a consulting forester, require input from an accredited wildlife biologist on the harvest plan (USDA Forest Service, 2016). This biologist can be obtained through the University of Michigan, other universities, a consulting firm, or government agencies.

Considerations: The following should be considered when implementing this recommendation: Availability for consulting may be limited, associated financial costs for assessments and consultations, and potential delay of the timber sale process through having to redesign the harvest plan if an overlooked threat is highlighted by the biologist. Further, the MDNR wildlife biologist position that represents Cheboygan and Emmet County is currently vacant (MDNR, n.d.).

Recommendation: Standard Monitoring & Evaluation (M&E) plan

Development of a standard and consistent M&E plan that can be applied to most if not all harvests. One example is that from the [California Water Board](#). The duration of the Board's plan ranges from 1-5 years depending on needs (California Water Board, 2005). The following are general elements that should be included into a standard plan: monitoring questions, common parameters, frequency of monitoring and reporting, and highlighting who is involved in data collection, processing, and analysis. The USDA Monitoring Guide highlights three types of monitoring to be included in plans: implementation (i.e. did we do what we said we were going to do?),

effectiveness (i.e. are the standards and guidelines working?), and validation monitoring (i.e. is our understanding of the situation and information available correct?) (USDA, 2007).

Considerations: Strongly consider incorporating citizen science approaches into the plan to minimize monitoring costs. This could include the Bug Camp Stewards going out post-harvest to look for any leftover waste. Furthermore, UMBS should contemplate implementing mechanisms for continuous improvement of the M&E plan based on feedback and results.

Recommendation: Staff review of best management practices (BMPs)

Before the start of harvesting, relevant UMBS staff should review the latest forestry [BMPs document](#) made by the MDNR. Since UMBS traditionally requires BMPs during timber sales, if staff possessed a strong awareness of the practices, then they can better assist with monitoring contract compliance when conducting site-visits, thus, acting as effective “watchdogs”.

Considerations: This review will be time intensive as the document is over 75 pages and at times uses technical jargon.

Recommendation: Timber sale advisory committee

It may be beneficial for UMBS to develop a voluntary timber sale advisory committee through a MOU consisting of a diverse set of experts to provide suggestions to decision-makers regarding harvest plans for timber sales. Potential members of this committee could include representatives from the Michigan State University Forestry Extension Service, conservation districts, MDNR, MDARD, timber associations, and local tribes amongst other groups. Since timber sales are not extremely frequent at UMBS, the work demand would be minimal.

Considerations: Ensure that any recommendations adhere to relevant laws and regulations and to schedule periodic meetings to maintain engagement given the rarity of the sales.

Recommendation: Establish quantitative measurement for residual damage in contract

Residual damage to trees and soils is almost inevitable when carrying out timber sales. As a result, UMBS should establish a standard quantitative threshold for residual stand damage (e.g., no more than 5%) in collaboration with the consulting forester. The contract should highlight penalties for exceeding this threshold such as financial costs for compensating UMBS (Belart & Bowers, 2021).

Considerations: Determining and quantifying residual damage can be a complex task, especially on large-scale sales. It will require sophisticated monitoring systems which could be costly and time-consuming. Referring to Palander et al. (2007) and the methodology in Kizha et al. (2021)

could provide beneficial insight on residual damage monitoring practices (e.g., systematic transect sampling). There is also potential for disputes between UMBS and contractors regarding the assessment of residual damage. As a result, clear and objective criteria for measurement are essential to minimize disputes and ensure fair enforcement. Collaborating with a consulting forester to develop these criteria will be beneficial to mitigate any chance of dispute.

Recommendation: Allow only bidders that are certified for sustainable practices

Allow only logging companies who possess credentials related to sustainable forestry to be able to place a bid. These credentials may include certification by the Sustainable Forestry Initiative (SFI) and/or Forest Stewardship Council (FSC), certification as a Michigan Master Logger, or are part of Michigan's Association of Timberman.

Considerations: This requirement for bidding will minimize eligibility which can exempt an organization who would have had the highest bid if the requirement did not exist. Moreover, this may overlook organizations that employ sustainable practices but do not have certification such as new and small businesses.

Technical

Recommendation: Mandate washed equipment

Similar to how the USDA Forest Service manages timber sales, depending on the size of the sale, require in the license agreement that equipment must be washed if it is coming from a recent operation or moving from a site known to have invasive species to another within UMBS lands (USDA, 2006). Given that washing may lead to environmental impacts if the wash water contains harmful substances, require that it is conducted off-site.

Considerations: Requiring the washing of equipment may potentially deter organizations from placing a bid. Additionally, it will require a dedicated UMBS representative to regularly monitor and inspect. Lastly, washing may be time-consuming and thus impact project schedules.

Recommendation: Spill response plan

As timber sales involve vehicles and equipment that contain hazardous materials like oil, UMBS should mandate that bidders must have a comprehensive spill response plan in the cutting specifications document. The plan should include clear steps for containing and maintaining any spills if they occur.

Considerations: Requiring a spill response plan may deter organizations from bidding if they do not already have one since it will require resources and time for its development and training staff.

Recommendation: Increase the amount of detail on maps

Based on the map made for the most recent timber sale, there are some areas for improvement. Maps in the cutting specifications document should illustrate all of the following: property boundary; harvest area boundaries; research wells; archaeological sites; critical habitat; stream crossings; Riparian Management Zones (RMZs); haul roads; slope; skid trails; log landings; and significant natural communities (Michigan Forest Management Best Practices, 2023). These maps should be given to all members of the timber harvest crew.

Considerations: Consider conducting a brief session with the timber crew to review the maps and address any concerns or uncertainties. Importantly, a map with this amount of detail will take significant staff time and resources to develop and may be difficult to digest.

Recommendation: Equipment servicing guidelines

Just like contracts for selling timber on National Forest lands, make it clear in the licensing agreement that the licensee must keep all their equipment in proper working condition to avoid leaks and require oil-absorbing mats beneath all stationary equipment or equipment undergoing maintenance (USDA, 2006).

Considerations: This will require oversight and may entail additional costs for licensees such as costs for oil-absorbing mats. Consider writing in the contract what licensees must do if a spill occurs from servicing equipment. For instance, requiring the licensee to remove all contaminated resources like soil and vegetation from UMBS property as soon as possible.

Safety

Recommendation: Safety SOP for UMBS representatives when visiting sale sites

Formulate a safety SOP for UMBS staff and researchers when they visit timber sale sites. This SOP may detail aspects like the acquisition of personal protection equipment (e.g., hard hats, safety glasses, hearing protection, etc.) and on-site protocols including site orientation, identification of hazards, and emergency procedures if injury occurs.

Considerations: Ensure that all staff and researchers are adequately trained in emergency procedures and provided with appropriate personal protection equipment. Also, UMBS could conduct regular inspections of personal protection equipment to ensure that they are in good



Image 22. 2019 UMBS Timber Sale

working condition. Consider implementing a clear protocol for reporting incidents or injuries to identify potential areas for improvement.

Recommendation: Traffic control plan

Develop a traffic control plan that outlines measures and strategies for managing and controlling traffic during a timber sale on UMBS property. Similar to the USDA Forest Service, certain elements of the plan could include

specific requirements for signage such as their text (e.g., warnings, speed, and directional information) and when and where they should be placed, minimum letter size, and the use of barricades (USDA Forest Service, n.d.). The purchaser and UMBS should sign off on the plan to ensure that both parties agree to its requirements.

Considerations: When designing the plan, conduct a thorough site assessment to identify any potential traffic hazards, critical intersections, and areas with limited visibility and consider topography, road conditions, and environmentally sensitive areas. Contemplate placing signage on adjacent roads and trails that are open for public use to warn them of the timber sale. Defining a system for monitoring and enforcing the plan may also be beneficial. Finally, consider outlining when and where barricades should be placed, taking access points and potential bottlenecks into account.

Findings & Recommendations



Existing & Emerging Ecological Threats

This section explores the ecological threats facing UMBS ecosystems, highlighting the impact of climate change and specific hazards like Hemlock Woolly Adelgid, Beech Bark Disease, Oak Wilt Disease, and invasive species such as the Zebra Mussel and Emerald Ash Borer. It underscores the indirect effects of climate change on UMBS, necessitating proactive management strategies. The pressing ecological threats prompt a discussion on various treatments and control methods. Additionally, the challenges posed by invasive species like Zebra mussels and Emerald Ash Borer require careful consideration of mechanical and chemical approaches for adequate control. The recommendations emphasize ongoing research, collaborative initiatives, and the development of an invasive species management strategy and an ecological threats watchlist to ensure the long-term sustainability of UMBS amidst evolving ecological challenges.



Existing & Emerging Ecological Threats

Climate Change

Given UMBS's longstanding dedication to environmental field research and its expertise in studying the impacts of climate change, it is imperative that we conscientiously address how climate change affects UMBS property and ecosystems. Drawing on decades of research and the expertise of UMBS researchers, we must assess why and how we respond to climate change threats—or choose not to respond—in an informed, justifiable, and intentional manner. Our responses, or lack thereof, express our understandings, goals, and priorities, conveying valuable lessons to our community and beyond. While a comprehensive response plan may be beyond the scope of this discussion, we recommended that UMBS consider this issue systematically, gather and summarize relevant information, make well-informed decisions, and translate those decisions into actionable measures. This section aims to assess the direct and localized effects of climate change dynamics on the particular ecological systems within this region.

Climate change will indirectly affect this area via increased risk of diseases, pests, and invasive species. As temperature rises in this cold system, new, but also native, parasites, pests, and invasive species will be able to establish and grow populations harmful to the local communities.

Forest Pests and Pathogens

*Hemlock Woolly Adelgid (*Adelges tsugae*)*

The Hemlock Woolly Adelgid (HWA), an aphid-like insect native to East Asia, emerged as a formidable threat to Eastern Hemlock trees in North America, starting in Virginia during the 1950s (Southeastern Naturalist, 2014). The geographic distribution of this pest extends from the southeastern United States to parts of New England and Michigan, with active populations in Allegan, Benzie, Ottawa, Muskegon, Oceana, and Mason counties in West Michigan (SOM, 2016). HWA spreads by birds and other wildlife, wind, gear, clothing, infected nursery stock, and other hemlock materials can all carry the hemlock woolly adelgid from tree to tree. HWA can transfer when diseased branches are cut and disposed of and when machinery or cars rub against them (SOM, 2016).

The destruction of the hemlock population is especially alarming since Eastern Hemlocks are essential for shade, maintaining the stability of streambanks, and providing habitat for a wide range of wildlife (Havill, Vieira, & Salom, 2016). As the HWA spreads, understanding and managing its impact on hemlock forests will become an urgent priority for conservation efforts across these afflicted areas.

The decline of hemlock trees is primarily attributed to HWA, prompting various suggested and researched treatments. Chemical treatments have been employed for smaller operations to save

individual Eastern Hemlock trees or small stands, although the efficacy of such treatments has yet to be thoroughly evaluated (Southeastern Naturalist, 2014). Experts recommend using the pesticide imidacloprid to control HWA, and applying it directly to the ground (Cowles, Montgomery, Cheah, 2006). In addition to chemical treatments, the USDA has explored biological control of HWA by introducing a specialized predator, such as *Laricobius osakensis*, to control the HWA population naturally (Havill, Vieira, & Salom, 2016).

Beech Bark Disease (Cryptococcus fagisuga and Neonectria spp.)

The introduction of Beech Bark Disease (BBD) poses a severe ecological danger to North American beech trees. The symbiotic association between the *Neonectria* fungus, a beech parasite, and the Beech Scale, a dispersal agent, gives rise to this disease (Cale, Garrison, Teale, & Castello, 2017). The disease primarily affects beech trees, valued for their hardwood and environmental significance as keystone species. BBD damages the bark of these trees, creating openings for opportunistic infections to enter the tree. Beech forests support a variety of animal species by providing food and habitat (Cale, Garrison, Teale, & Castello, 2017). BBD has spread geographically over the eastern part of North America, with concentrated effects most noticeably seen in the northeastern United States and southeast Canada. Furthermore, Beech Bark Disease has already severely impacted UMBS forests, with nearly all mature beech trees dead or dying (Barnett, 2022).

The most popular approach to controlling BBD has been preventing the spread of beech scales. Scales can be controlled with insecticides and insecticidal soaps. However, there might be more suitable or efficient methods for managing the disease in already affected forests (Cale, Garrison, Teale, & Castello, 2017).

Spraying buprofezin and administering yearly imidacloprid injections reduced beech scale infestation. However, chemical treatments are not feasible in natural settings (Roberts, 2016). Another successful BBD treatment is silvicultural practices that remove at-risk and diseased trees from a stand. Long-term selection cuts that eliminated diseased and infested trees decreased the infestation of the remaining trees (Leak, 2006). However, due to UMBS being an “aftermath forest,” or a stand that has already seen the effects of BBD, it is pertinent to retain trees that are free of scales and Nectria. This can be done through chemical treatments, as previously mentioned.

Oak Wilt Disease (Ceratocystis fagacearum)

The fungus *Ceratocystis fagacearum* causes Oak Wilt Disease, a serious ecological threat to oak trees and forest ecosystems (Jagemann, Juzwik, Tobin, & Raffa, 2018). Although Oak Wilt Disease is found throughout the United States, it is most prevalent in the Midwest and East, where oak species (*Quercus* spp.) are more abundant (Jagemann, Juzwik, Tobin, & Raffa, 2018).

This destructive disease primarily affects oak trees, leading to wilting, defoliation, and eventual mortality. The systemic spread of the disease occurs via sap-feeding beetles and the linked root systems of trees, frequently resulting in rapid tree death. The consequences include substantial losses of wood and ecological services, such as water management and habitat for wildlife.

One treatment developed to manage Oak Wilt Disease utilizes the antifungal microbe *Streptomyces blastomycetica*, which reduces the non-conductive region linked to the illness and successfully stops the pathogen's growth (Lee, 2018). The fungicide Alamo has been a well-known and often-used remedy in the United States. Propiconazole, the active component in Alamo, is effective in reducing the symptoms of oak wilt disease. Administered via techniques like ChemJet trunk injection, Alamo dramatically lowers the disease's non-conductive region, offering a practical way to reduce the effects of the disease and making it an essential part of oak wilt management plans (Lee, 2018).

Invasive Species

The state of Michigan defines an invasive species as “one that is not native and whose introduction causes harm or is likely to cause harm to Michigan's economy, environment, or human health.” Strategic management is necessary because invasive species may jeopardize ecosystem stability and biodiversity. The most prolific are the Zebra Mussel and the Emerald Ash Borer (Tobin, 2018).

Zebra Mussel

The spread of Zebra Mussels into the Great Lakes Region's water bodies poses a danger to these aquatic ecosystems. Zebra Mussels routinely restructure food webs through an ecosystem engineering process termed “benthification.” Benthification alters habitats within aquatic ecosystems by augmenting benthic production and escalating the flow of energy and materials between the pelagic and benthic subsystems. Therefore, ecosystem engineering by these nonindigenous species is changing the fundamental physical nature of an entire category of ecosystems (Karatayev, 2013). Notably, Zebra Mussels have proved very harmful to unionid clams, a freshwater mollusk. These clams are critical to preserving water quality and the general health of aquatic habitats. This decrease in unionid clams can result in lower water quality, altered nutrient cycling, and general imbalances in the aquatic environment, all of which can have far-reaching ecological effects (Hollandsworth, Lowe & Badra, 2011).

Controlling the proliferation and effect of Zebra Mussels in aquatic habitats has proven challenging. Several approaches have been used to regulate their numbers and reduce environmental harm. Mechanical controls, such as installing barriers and filters on water intake systems, have efficiently prevented Zebra Mussels from clogging infrastructure such as pipelines and screens (Lund, Cattoor, Fieldseth, Sweet, & McCartney, 2017). Chemical management approaches, including molluscicides, have also been used, with Zebra Mussels targeted in certain

regions. However, non-target species may be harmed by these chemical treatments, making them unsuitable for broad usage in fragile ecosystems (Thompson & Hofmann, 2019).

Emerald Ash Borer

Since its unintentional arrival, the Emerald Ash Borer (EAB) has destroyed millions of ash trees in North America. The first identification of the Emerald Ash Borer was in Detroit, Michigan, in 2002 (USDA APHIS), with the first reports at UMBS in 2016. EAB's distribution is stratified between natural and human-assisted spread, and much work has been done on developing survey techniques. A significant factor in the failure of early eradication attempts was how hard it was to identify and distinguish between infestations.

To reduce ash mortality rate, high-value trees are currently under pesticide protection and biological control (Herms & McCullough, 2014). A unique control option against EAB is the integrated management technique combining chemical and biological controls. Foresters inject ash trees with emamectin benzoate, followed by girdling the injected trees 5–14 days later. This results in fatal trap trees poisonous to leaf-feeding beetles and neonate larvae and extremely attractive to ovipositing adult female EABs (McCullough, 2019).

Recommendations and Research Needs

Considering the existing ecological threats and impacts to UMBS, it is imperative to consider the future of the UMBS property and research needs to address these challenges effectively. Ongoing research efforts should focus on monitoring the spread and impact of these threats over time, continuously assessing the effectiveness of management strategies, and exploring innovative solutions to combat ecological dangers. Strategies for adapting to and mitigating these threats in a changing climate should emphasize both short-term and long-term solutions, considering the ecological resilience of UMBS. Regional collaboration and conservation efforts are paramount, as many ecological threats transcend geographic boundaries and require a coordinated approach to manage and protect the area's unique ecosystems effectively. Collaborative initiatives can harness collective expertise and resources to address these challenges comprehensively and ensure the sustainability of UMBS in the face of evolving ecological threats.

Recommendation: Develop an Ecological Threat Management Strategy

Goal: Enable UMBS to adapt its management practices proactively, addressing new and emerging threats effectively.

The recommendation involves creating a successful ecological threat control strategy similar to the EPA's Ecological Risk Assessment guidelines. Starting with identifying specific invasive species and establishing clear objectives, whether the goal is eradication, containment, or

management. Planning an overall approach is emphasized, including stakeholder participation from government agencies, environmental organizations, and local communities. The state of Michigan's definition of invasive species is recommended for clarity and guidance in formulating the management strategy.

Considerations: Considerations include selecting appropriate management strategies such as chemical control, biological control, or mechanical removal. Determining management priorities precedes the development of an execution plan, including dates, responsible parties, and resource allocation. Monitoring and assessment are essential for ensuring the strategy's efficacy, with regular modifications as needed. Collaboration with the Department of Environmental Health and Safety at the University of Michigan is suggested for gathering and organizing relevant information. Securing resources, creating a budget, and establishing emergency reaction plans to change situations flexibly are crucial. Documenting activities is emphasized to develop improved management practices in the future.

Recommendation: Develop an Ecological Threat Watchlist

Goal: Familiarize UMBS researchers and staff with potential threats to the property, fostering proactive threat detection and management.

The recommendation emphasizes the importance of creating a future ecological threats watchlist, highlighting its role in streamlining the development of an invasive species management plan. This process resembles the approach taken in the ecological threat management recommendation, where the initial step involves compiling a list of potential threats, conducting risk and impact assessments, and monitoring and tracking them both on-site and by staying attuned to regional patterns and advancements.

Considerations: We outlined several conditions, beginning with identifying specific threats and the need for clear objectives. The process involves collecting data and conducting thorough research on the biology and implications of potential invasive species. Legal and regulatory considerations are crucial in developing the watchlist, ensuring compliance, and effectively managing identified threats. This proactive approach seeks to enhance UMBS's readiness to address ecological challenges and contributes to the overall sustainability of the biostation.

Findings & Recommendations



Preservation of Habitats & Species of Concern

The following section explores how intentional land management strategies can support the preservation of unique habitats and threatened species at UMBS. Drawing inspiration from established practices in the State of Michigan's Parks and Recreation Division, we propose the establishment of Management Zones based on factors such as the presence of sensitive species or rare habitat types, existing research use, human impact, and accessibility. These zones serve as a foundation for UMBS to tailor its land management specifications, aiming to accommodate the needs of various land users while minimizing conflicts between research, public use, and preservation. The ultimate goal is to provide clear guidelines and reduce ambiguity regarding permitted activities on different parts of the property, fostering effective decision-making aligned with preservation and research objectives. This section also recommends adaptive management strategies for species of concern such as the Michigan Monkey-Flower and Hungerford's Crawling Water Beetle. Due to limited existing knowledge of the distribution and sensitivities of UMBS populations, preservation efforts should be experimental and conducted alongside life history research projects.



Management Zones

The land at UMBS features a variety of uses ranging from the core UMBS functions of research, education, and preservation to various public uses such as hiking and hunting. This multi-use dynamic at UMBS dictates that different parcels of land be managed in different ways to avoid conflicts between these differing land uses. In conversations with Resident Biologist Adam Schubel and Data Manager, Jason Tallant, we have brainstormed possible spatial classifications based on activities and occurrences within spatial areas, including: presence of sensitive species or habitats, existing research, degree of human impact, and accessibility.

Together, these land classifications and permitted uses have been used to delineate ‘management zones’ similar to what exists on many US public lands including the US National Park System. Management zone delineation is common practice on large, multi-use properties such as National Parks, National Forests, and State Recreation areas. Locally, several State Recreation areas in Michigan utilize management zones to compartmentalize and manage large swaths of land for their varying uses. Examples of these can be seen in General Management Plans (GMPs) for Fort Custer State Park in Kalamazoo County, Waterloo State Recreation Area in Chelsea, and Wilderness State Park in Emmet County (Jensen, 2023; Curtis, 2012; Jensen, 2014). Each of these GMPs describes a list of management zones. These are taken from the State of Michigan’s Parks and Recreation Division’s nine standard management zones, produced on the MDNR’s website, described as “areas with defined characteristics and qualities, for which there are related user expectations, management guidance, and defined levels of development” and include:

- 1) Ecologically Sensitive
- 2) Primitive Zone,
- 3) Backcountry Zone,
- 4) Cultural Landscape Zone,
- 5) History Education Zone,
- 6) Scenic Zone,
- 7) Natural Resource Recreation Zone,
- 8) Developed Recreation Zone, and
- 9) Administrative Services Zone.

While UMBS is unique compared to State managed land in the sense that it primarily exists to further educational and research pursuits, several of UMBS’ institutional values and goals discussed throughout our report do align with those of the State’s Parks and Recreation Division and thus lessons from the State’s management zone delineation may be applied to the establishment of UMBS management zones if UMBS so chooses. Both value preservation of ecologically valuable communities, culturally sensitive sites, and some degree of interaction/relationship building with the public. The most obvious difference being UMBS’ focus on research opportunities, the PRD’s zones can be used as a starting point for UMBS to establish

zones that help efficiently determine where best to permit various research activities based on the footprint of those activities on the land and the level of ecological sensitivity determined at a given site.

Goals

To provide land management specifications aimed at tailoring to the needs of specific UMBS land users. In recommending clearly defined management zones, we also aim to reduce conflict between land use types such as research, public use, and preservation.

Recommendation: Management Zone Designation

With assistance from UMBS staff, we developed an example of what this zone breakdown could look like. In our example, UMBS land would fall into one of five categories or zones, each with specified management activities, research activities, and permitted uses. Similar to Michigan's PRD, these progress from the utmost ecologically sensitive zones to zones where natural resources are still important but where other uses such as experimental research or recreation activities are less restricted.

We recommend **UMBS classifies its properties into zones, each with clearly defined permitted activities and management strategies**. In general, management zones would serve to avoid confusion over what is allowed on a given part of the property based on how that area is managed. This can help UMBS to make decisions with respect to preservation as well as determining what research activities can take place where.

Considerations: However these zones are defined and applied would be at the discretion of UMBS should it choose to implement management zones. However, the team strongly recommends UMBS implement some sort of system to formally identify its most ecologically sensitive areas to restrict research activities and thus avoid conflict between two of its primary stated purposes of research and preservation. Subsequently, designating areas where observational or experimental research activities are permitted provides alternatives for research activity and further avoids potential conflict.

Toolbox: Draft Zone Designation Table

The draft zone designation table establishes five management zones from high to low conservation value and includes permitted uses (research, public use, development) along with management priorities.

The **Draft Zone Designation Table** can be found here:
[UMBS Draft Zone Designation Table - Google Sheets.](#)

UNESCO MAB ZONES	CORE/BUFFER	BUFFER	BUFFER	CORE	TRANSITION
	Observation Zone	Light Experimentation Zone	Heavy Experimentation Zone (recent heavy land use that has permanently altered land)	Conservation Zone (Area of Critical Environmental Concern)	Campus Zone (living quarters, library, dining room, labs, admin, maintenance area, utilities)
Research Activities	Permanent plots	Observational study areas, experimental with limitations	Experimental with minimal limitations (i.e. burn plots)	No Research unless approved by Director	Presentations; utilization of library; student research (e.g. site visits in courses)
Management Activities	Hands-off conservation, potentially dangerous areas (formerly "inviolate areas")	Minor disturbances to individual overstory and midstory trees (e.g. coring, installing sap flow sensors, or shades).	Restoration harvesting plots	Conservation for sensitive species / ecosystems, cultural sites / cache pits	Infrastructure Maintenance;
New road building	no*	no*	yes*	no*	yes
Trail building/maintenance	yes*	yes	yes*	no	yes
Observational Study	yes*	yes	yes*	no*	yes
Experimental Research	no*	no*	yes*	no	yes*
Hunting & Trapping	yes*	yes*	yes*	no	no

Figure 10. Screenshot of Draft Zone Designation Table



Threatened & Endangered Species

Several northern terrestrial and aquatic ecosystems are represented at UMBS, contributing to a high diversity of plant and animal species. As a result of the heterogeneous landscape and long history of sensitive habitat preservation at UMBS, several threatened and endangered species are found on the property. Not only do these populations underscore the importance of comprehensive land and water stewardship, but they also provide valuable opportunities for thoughtful and adaptive management. The following pages provide descriptions and specific management recommendations for two federally endangered species: the Michigan Monkey-Flower, *Mimulus michiganensis*, and Hungerford's Crawling Water Beetle, *Brychius hungerfordi*. Similar strategies could be developed for other species at risk.

Goals

Maintain and ideally increase known populations of threatened and endangered species on UMBS property. Preserve sensitive habitats and limit human disturbance whenever possible. Enhance understanding of local distribution and life history traits of these species. Monitor the effect of natural and human disturbances, including changes in hydrology and forest structure caused by beaver manipulation.

Michigan Monkey-Flower *Mimulus michiganensis*



Image 25. Michigan Monkey-Flower; Sara Thiessen 2023

The Michigan Monkey-Flower (MMF) is listed as an endangered species by the federal government and the State of Michigan due to its extremely limited range and sensitive habitat requirements. It is entirely endemic to Michigan and occurs in the Grand Traverse and Straits of Mackinac regions (Voss 1996). The only population of the species known to produce viable seeds is located in Emmet County just outside UMBS property along the Maple River. While currently within private property, this population is registered with the Michigan Chapter of The Nature Conservancy, and individuals from this population have been transplanted to sites within UMBS, Matthei Botanical Gardens in Ann Arbor, and Sleeping Bear Dunes National Lakeshore.

The MMF is an aquatic to semi-aquatic perennial plant that requires cold, active groundwater flow, alkaline (calcareous) conditions, and canopy openings for sunlight. The species is mostly dependent on vegetative propagation, resulting in very localized occurrences of small but dense patches along small springs within northern white cedar swamps. Stems root in silty-sand and produce shoots to form a mat-like clonal growth (Beadle 1989). The MMF is sensitive to changes in hydrology.

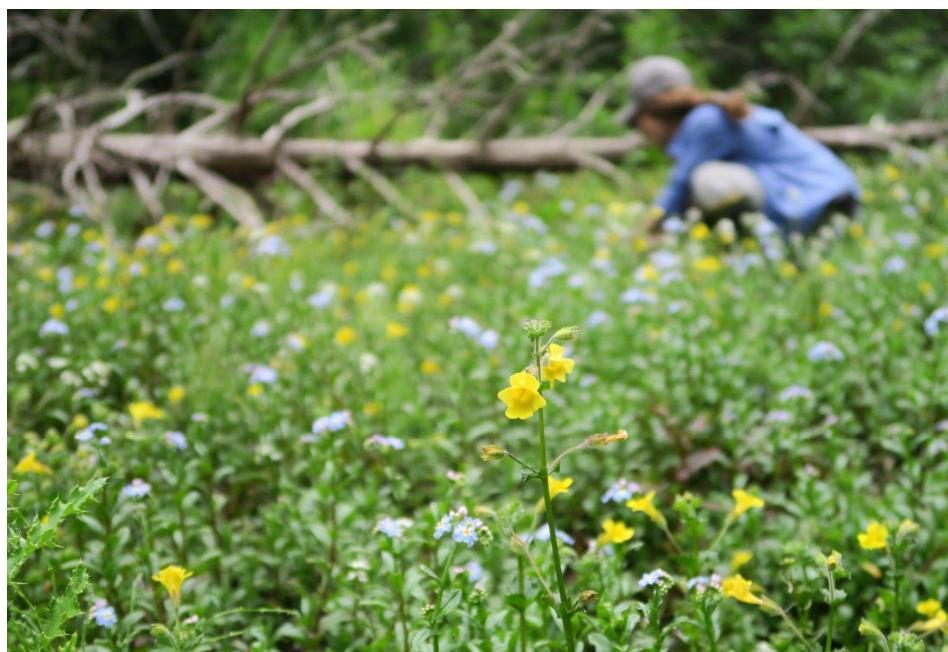


Image 26. MMF Preservation Workday; Sara Thiessen 2023

Recommendation: MMF Life History Research Project

In order to inform future conservation efforts, we recommend a MMF life history research project for an undergraduate student or summer research intern. The researcher would track occurrences of MMF on UMBS property and examine the plant's local characteristics. The survey would take place along Carp Creek in Unit 5 of the property, also known as Reese's Swamp. Ideally, this project would enhance understanding of MMF sensitivity to relevant disturbances such as flooding events, changes in hydrology, and disturbances to surrounding forests. Research could include a comparison of MMF distribution with locations of historical and current beaver activity, investigating potential correlations between beaver-driven habitat manipulations and MMF occurrences. Recent beaver activity along Hogsback Road has fragmented nearby MMF populations and could have redistributed MMF individuals to shallow areas downstream. Future research efforts could study under which conditions sexual vs vegetative reproduction takes place and inform conservation management of the Maple River population.

Recommendation: Research-Based MMF Management Plan

Work alongside the MMF Life History Research Project to create an operable UMBS MMF Management Plan that aligns with and advances the federal MMF recovery plan. This plan could include the experimental removal of neighboring and competing species such as Watercress (*Nasturtium officinale*), Marsh-Marigold (*Caltha palustris*), and Forget-Me-Not (*Myosotis scorpioides*) from the area, a preservation strategy currently implemented with the Maple River population. Additional habitat protection policies developed from the research project should embody established adaptive management principles such as ongoing learning, built-in monitoring and evaluation, and flexible management that adjusts to evolving knowledge.

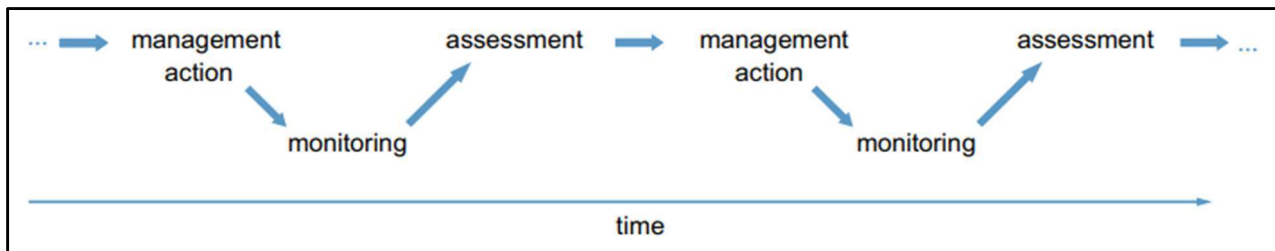


Figure 11. Iterative Cycle of Adaptive Management; DOI Adaptive Management Technical Guide (Williams et al. 2007)

Hungerford's Crawling Water Beetle *Brychius hungerfordi*



Image 27. Steve Marshall 2021

Hungerford's crawling water beetle (HCWB) is another federally and state designated endangered species found in and around UMBS property. This species has only been found in five locations in Ontario and northern Michigan. It was first collected from the East Branch of the Maple River in 1954, and additional populations were discovered in the Carp Lake River in 1997 (Keller et al. 1998). It is currently found on UMBS property along the East branch of the Maple River.

Adult beetles can be distinguished by their yellowish-brown coloring, irregular dark markings, and dark perforations in narrow stripes along the wing cover. They are about 4 mm long and can live for up to 18 months (Ministry of the Environment 2021). HCWB are typically found in cool,

actively flowing, glacial springs with good aeration, alkaline water conditions, partial to open canopy, and shallow to moderate water depth (Hyde and Smar 2000). These narrow habitat requirements contribute to a scattered and highly localized distribution of the species.

Recommendation: Ongoing HCWB Habitat Preservation

The biggest threat to HCWB is habitat degradation and destruction, especially by alterations to stream flow and agricultural practices that impact water quality. UMBS should continue to indirectly protect the HCWB through preservation of its general habitat hydrology on and around UMBS property. The beetle is often found immediately downstream from beaver dams, culverts and man-made barriers (Ministry of the Environment 2021), so any beaver control or dam removal efforts should include a careful HCWB impact assessment. The beetle may also be preyed on by introduced fish such as brown trout.

Recommendation: HCWB Research Project

In order to inform future conservation efforts, we recommend a research project for a graduate student or summer research intern to work with UMBS to track occurrences of HCWB on UMBS property. This project could increase understanding of the correlation between beaver activity and beetle occurrences by comparing distribution with locations of historical and current beaver activity. The best time to survey for the beetles is from mid-June through the end of August, with the highest numbers of adults in early summer and higher numbers of larvae in late summer (Hyde & Smar 2000). The spatial scope of this project would include Carp Creek and several locations along the Maple River.

Considerations:

Outreach Potential: Due to the sensitive nature of threatened species, outreach for field preservation efforts should be selective and limited to organizations with a history of partnership, such as Huron Pines AmeriCorps, Tip of the Mitt Watershed Council, The Nature Conservancy, and the Bug Camp Stewards. At the same time, threatened and endangered species preservation activities could be used to inform and model stewardship for community members and private landowners who may be unaware of species occurrences on their properties. General educational information about the threatened species could be included in UMBS brochures or proposed as a topic of discussion in a local township meeting.

Species Relocation: If the presence of beavers threatens the persistence of a known population of MMF or HCWB, additional steps should be considered to relocate the species of concern population. Permission for relocation of MMF was previously granted by the Michigan Department of Natural Resources, but transplants may no longer be considered endangered.

Funding: Outside of the University of Michigan and related fellowship grants, project funding sources could include the National Science Foundation (NSF) Research Grants, Michigan Department of Natural Resources (MDNR), The Nature Conservancy, and federal agencies such as the Environmental Protection Agency (EPA) or National Oceanic and Atmospheric Administration (NOAA). Specific grant programs could include the [USDA Conservation Innovation Grants](#), [MDNR Wildlife Habitat Grant Program](#), [Great Lakes Fisheries Trust Habitat Protection and Restoration Grants](#), and the U.S. Fish and Wildlife Service's [Cooperative Endangered Species Conservation Fund](#).

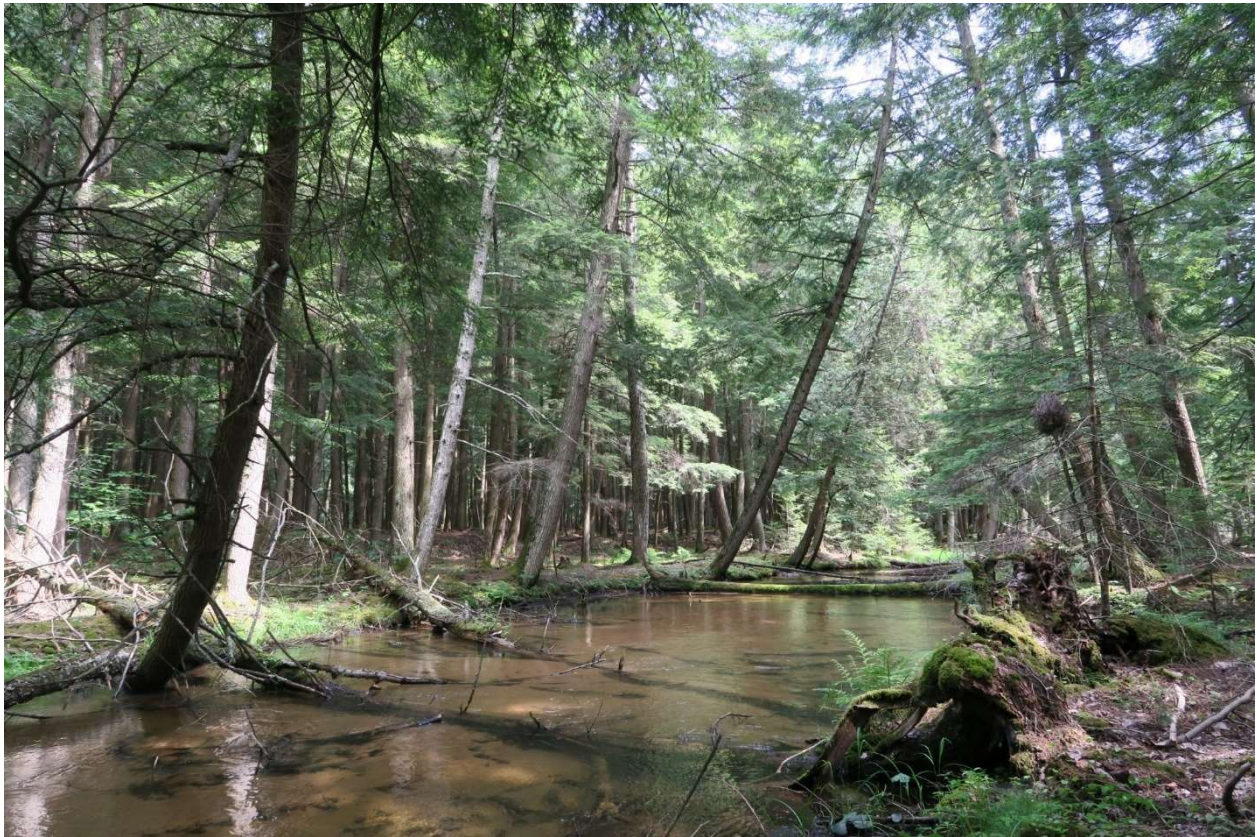


Image 28. Carp Creek in Unit 5, known habitat of MMF and HCWB; Sara Thiessen 2023



Carbon Storage & Biosequestration Estimation

Biosequestration is the capture and storage of atmospheric carbon dioxide by plants and other microorganisms through biological processes. Biosequestration in U.S. forests has been found to sequester up to 12% of annual U.S. carbon emissions - approximately 800 million tons per year (Penn State University, 2023). Trees, which bind atmospheric carbon in sugar compounds through photosynthesis, are a major carbon stock in the U.S. Sugar is used to compose the wood in the stem, branches, and roots of the tree, where the carbon will remain until decomposition occurs.

With 10,000 acres of terrestrial, aquatic, and largely undeveloped land, UMBS is a valuable carbon sink for both the University of Michigan as an institution, and for the surrounding communities of northern Michigan. Understanding the amount of carbon storage, as well as carbon sequestration potential, that this land holds is vital. Acquiring accurate estimates informs the University as they work towards carbon neutrality and allows for staff at UMBS to make informed land management decisions when considering land manipulation, potential research projects, and timber harvests.

Current estimates of carbon storage on UMBS property are 712,594 - 1,733,850 tC, with an annual biosequestration rate of 23,279 - 42,963 tCO₂e/yr (Blankertz et al. 2021). These estimates were acquired using aerial imagery and GIS techniques to analyze the land-use and land-cover (LULC) of UMBS property. These LULC analyses were then used in calculations of carbon storage and biosequestration estimates based on forest type (e.g., deciduous forest, coniferous forest, mixed forest) and biometric data. While these methods of carbon storage estimation are well-founded, UMBS staff are interested in estimation that accounts for variances in storage and sequestration by tree species, rather than grouping all species found on the property into broad forest categories.

Goals

For this report, only the first step in the carbon storage and sequestration analysis was deemed appropriate to complete given the amount of time and scope of the UM Masters Project. Group member Ryleigh Landstra worked closely with UMBS Data Manager Jason Tallant towards the goal of mapping UMBS property to the tree species level using aerial imagery from September of 2020. This first step is key to further analysis of carbon storage and sequestration, as UMBS is too large, and the tree population too dense, to feasibly count, identify, and measure all trees on the property. The detailed methods of this process can be found in the Methods section of this report. Future goals for this project are to use the data, methods, and/or suggestions found in this report to acquire accurate carbon storage and biosequestration estimates.

Recommendation: Tree Species Mapping

Considerations:

Validation: The final deliverable of the tree species mapping project resulted in a classified raster with 7 species classes (*Populus grandidentata*, *Populus tremuloides*, *Acer rubrum*, *Acer saccharum*, *Quercus rubra*, *Pinus strobus*, and *Pinus resinosa*) and 6 classes representing other objects visible in the remote image (tree gaps, dead trees, roads, structures, field/bare earth, and water). The validation of this raster was conducted using points that were identified remotely from the image itself. Due to the difficulty in identifying tree species in an aerial image alone, it is recommended that UMBS staff further validate this raster using data points that are identified in the field.

This process would entail creating random points on the raster, acquiring the location of those points, identifying the dominant tree at the points, and cross-validating those identified species with the classified species in the raster. If the outcome of this validation yields unsatisfactory accuracy, a reclassification is recommended using additional data.

Reclassification: The vast majority of the data used to identify individual tree species in the remote image came from stem-plot data collected from other research projects. Since remote images capture the canopy cover, and not the understory trees, much of the stem-plot data was irrelevant and unusable. Furthermore, the abundance of trees mapped in this dataset created issues when attempting to identify singular trees in the image. Identification for this project relied on these datasets as reference points, but ultimately relied on visual cues in identifying the species. If reclassification is deemed necessary after ground validation, it is recommended that additional data points are collected. Ideally, these points would have a high locational accuracy, clearly have canopies easily seen in an image, and are representative of each species to be represented in the final classification. This new dataset can then ideally be used as a more reliable source of tree species identification when creating new/additional training samples for classification (see Tree Species Mapping in ‘Methods’).

Recommendation: Further Research

Student/Research Engagement: The ultimate goal of this project is to gather carbon storage and carbon sequestration estimates of the tree population on UMBS property based on tree species types and abundance. These estimates require a follow up over time of forest carbon measurements. Therefore, we recommend that UMBS develops a long-term plan of carbon accounting to be able to establish baselines and assess trends over time. Work needed could be part of summer classes, field labs, and/or undergraduate or MS students research projects.

We recommend that a broad research plan is developed prior to the continuation of the project - including an inventory of current and relevant datasets, an outline of additional data needed and a standardized collection method, and an outline of the possible methods/techniques that will be used to execute the storage and sequestration estimates. Using Forest Service Forest Carbon

Estimates protocols (Pearson et al. 2007) would provide a standard methodology to be used across teams and over time.

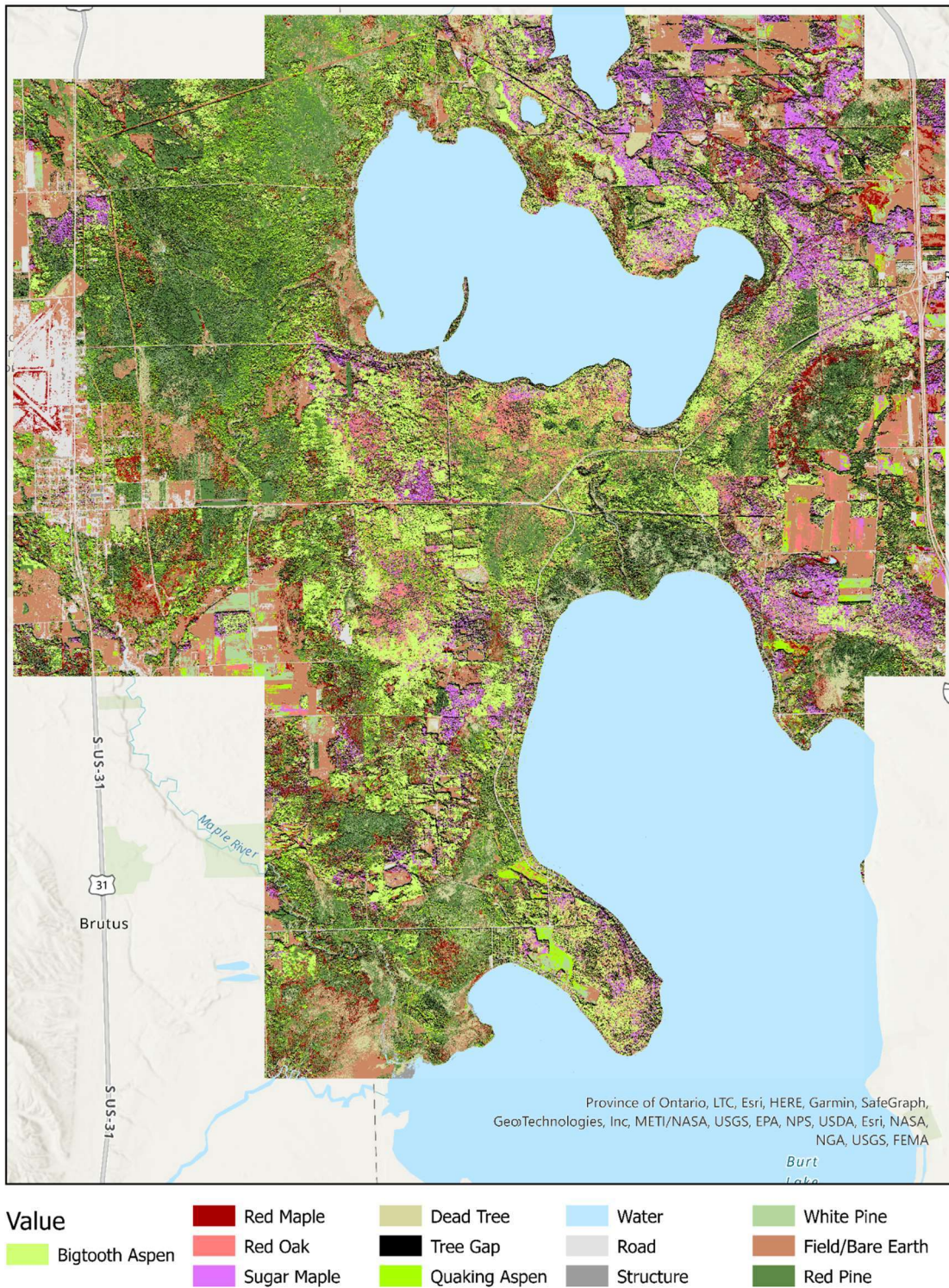


Figure 12. UMBS Forest Map by Tree Species

Methods

Literature Review

We conducted a comprehensive literature review where we first analyzed a diverse range of stewardship and management plans, including but not limited to the Harvard Forest Plan, Burt Lake Watershed Management Plan, Hunting Wildlife Forest Natural Resources Management Plan, Calvin Ecosystem Preserve & Native Gardens Land Management Plan, and the Northern Lower Peninsula Regional State Forest Management Plan. To further support the development of our deliverable, we examined multiple zone management plans that were tailored to UMBS by Michigan Technological University teams and other UMBS documents. UMBS documents detailed multiple considerations related to the property including rules and regulations, threats, important sites, timber sales, history, land uses and modifications, regional context, species, cover types, and ecological communities. We also consulted The Natural Community and Special Animal Abstracts from the Michigan Natural Features Inventory to inform our ecologically-focused recommendations and Unit Profiles. Additionally, we conducted a review of scholarly literature to inform our background and introduction and sets of recommendations. These resources were obtained from a range of academic databases such as Google Scholar, Semantic Scholar, and U-M Library. Gray literature including guidelines on timber sales from university extension services, and news stories were explored as well.

To further strengthen the foundation of our recommendations, the team examined relevant rules and regulations of other biostations, land conservancies and trusts, and local, state, and federal agencies through their official websites. This entailed an investigation of how these entities manage recreational activities like hunting and trapping and Off-Road Vehicles (ORVs) as well as details on the management of ecological threats and timber harvesting. Moreover, the team reviewed policies and laws in Michigan related to timber harvest, hunting and trapping, and signage. This review helped ensure that the proposed recommendations were legally viable and not redundant given that local, state, and federal laws apply to UMBS and the Station can only implement rules and regulations that are stricter than what exists at the government level.

GIS Mapping

During the summer of 2023, team member Sara Thiessen conducted comprehensive field surveys across eleven units of UMBS property. Using the Field Maps application within ArcGIS Online, physical infrastructure was mapped, including the locations of signs, gates, fences, and bridges, as well as miscellaneous or temporary features such as hunting blinds, bird boxes, and trail cameras. Due to extensive pre-existing spatial data and the focus of this report on land and water management outside of the immediate campus area Unit 4 (UMBS Campus; Fig 1) was excluded from this field survey. All features were separated in ArcGIS Online, so they can be individually downloaded or used to create unique map products.

These features, along with pre-existing spatial datasets in ArcGIS Online, informed the development of a property maintenance schedule. The property infrastructure layer was also used to propose updated signage content and locations.

Tree Species Mapping

During the summer and fall of 2023, team member Ryleigh Landstra worked closely with UMBS data manager Jason Tallant in mapping UMBS property to a tree species-level classification using remote imagery and supplementary reference data. Most of the work done for this project was conducted in ArcGIS Pro using data supplied by UMBS. One additional dataset was created by Ryleigh Landstra and Sara Thiessen during the summer of 2023, where field work was conducted at 4 locations on UMBS property to map the locations of trees and identify the species for future reference. This section summarizes the general methods and concepts used for this project.

A 4-band, 60 cm, leaf-on National Agriculture Imagery Program (NAIP) image (September 2020) was used for the classification. A segmented image was created using ArcGIS Pro to transform the image into individual segments (as a proxy for individual tree crowns), which were then selected, identified, and saved into a ‘training’ dataset. To identify the selected tree in the image, stem plot datasets and natural community/forest type maps were used to gain an understanding of which types of tree species were dominant in an area. Additionally, a NAIP leaf-off image from 2016, as well as a LiDAR-derived Canopy Height Model (CHM) was used as reference to identify tree locations. Visual cues and interpretation were then used to identify individual trees to the species level within that area. Some trees were directly identified from the reference dataset that UMBS team members created in the summer of 2023, but the vast majority of identified trees in the ‘training’ dataset could not be directly identified using the reference stem plot data. This was due to insufficient data and locational issues of these datasets.

In addition to tree species, samples were selected from the image to represent additional objects within the image. In total, 547 training samples were taken, where 75% of those samples made up the ‘training’ dataset, and 25% made up the ‘validation’ dataset. The ‘training’ dataset was then used to classify the NAIP (2020) image. A Support Vector Machine Classification was run in ArcGIS Pro with the following classes: Bigtooth Aspen (*Populus grandidentata*), Quaking Aspen (*Populus tremuloides*), Red Maple (*Acer rubrum*), Sugar Maple (*Acer saccharum*), Northern Red Oak (*Quercus rubra*), White Pine (*Pinus strobus*), Red Pine (*Pinus resinosa*), Tree Gaps, Dead Trees, Roads, Structures, Field/Bare Earth, Water. The resulting image was then filtered using Focal Statistics with a ‘majority’ statistics type and a 5x5 cell, circular window.

The ‘validation’ dataset was then used to find the overall accuracy of the classified image. Random points were created within each of the ‘validation’ tree polygons, where each point was assigned the class of that polygon in the attribute table. The class of the classified image was then manually

recorded in the validation points dataset, and a confusion matrix was created to compare the 'known' species and the classified species. The overall accuracy of the image was 61%.

Interviews

Over the summer, the team was on site at UMBS and conducted a series of interviews with various UMBS staff aimed at understanding more about individuals' perceptions of UMBS and long-term goals for the property as well as perceptions of challenges related to UMBS stewardship. Meetings with the following personnel were conducted from May to August 2023:

Resident Biologist Adam Schubel and **Data Manager** Jason Tallant - Since the beginning of project work, May 2023, we held bi-weekly meetings to discuss details about UMBS' mission, history, natural communities, research infrastructure, and organizational structure as it relates to stewardship.

Former UMBS Associate Director Mark Paddock - We met via video conference with Dr. Paddock to discuss some of the history of the property and for him to share his long-term hopes for the land.

Facilities Manager Scott Haley and **Building and Facilities Supervisor** Eareckson Myers - We discussed facilities management activities and challenges, and we also brainstormed some possible solutions.

Associate Director Karie Slavik - We discussed overarching short- and long-term goals for the property, including possibilities for outreach and preservation initiatives.

Research Coordinator and Lab Manager Helen Habicht - We discussed issues with hunting and the intersection of stewardship, education, and research and how best to maximize outcomes for all of these activities.

UMBS Director Aimée Classen - We discussed her vision of stewardship at UMBS as well as her overarching goals for the property's future, including the importance of communication and engagement with the Northern Michigan community.

From May 2023 to August 2023, the team held a combination of remote and in person meetings and interviews with a variety of other knowledgeable volunteers and professionals with unique perspectives on UMBS and different aspects of stewardship. The team also spent a morning assisting the Bug Camp Stewards with weekly volunteer work to informally discuss their work and perspective on UMBS stewardship as well as to do some rewarding trail and boardwalk maintenance in Carp Creek Gorge.

Site Visit

From June 30 to July 7, 2023, our team was on site at UMBS and used this time to become familiar with as much of the property as possible. Adam Schubel and Jason Tallant arranged an itinerary that consisted partly of a series of visits to different parts of the property to see notable natural communities, trails, and research infrastructure.

Indian Point - We visited this site to learn more about its history, including the tragic events of the Burt Lake Burnout, where people of the Burt Lake Band were forcefully evicted by local sheriffs who then burned their village to the ground. The team also toured the trails at Indian Point, which contain one of the last remaining old growth White Pine and Hemlock forests in Michigan's Northern Lower Peninsula.

Hogsback Road & Reese's Swamp - We visited Hogsback Road to observe firsthand some of the threats posed to the adjacent wetland habitat by dumping activities and erosion from standard road use and maintenance. As a part of this visit, we conducted a sample Floristic Quality Analysis (FQA) in a bog in Reese's Swamp south of Hogsback Road to represent the many bogs on UMBS land and to understand the ecological value of the area.

Douglas Lake - Adam Schubel gave us a tour of Douglas Lake via UMBS pontoon boat. We were able to visit parts of the property that are ecologically significant but also heavily trafficked by recreational boaters on the Lake. Adam Schubel highlighted East Point, Hook Point, and Sedge Point as areas of particular ecological concern or of educational value to UMBS.

The Gorge - We joined the Bug Camp Stewards for a morning of trail maintenance and boardwalk repair in Carp Creek Gorge, seeing firsthand the work the Bug Camp Stewards have been doing. We also had the chance to talk with them about the property.

Research Sites - We visited several of UMBS' active research sites. The team toured the Burn Plots, FLUX Towers, Stream Lab, Rhizotron, and DIRT Plots.

Case Studies

The team developed three case studies with the goal of informing Standard Operating Procedures (SOPs) related to timber sales, property maintenance, and property acquisition. To inform the property acquisition SOP, Max Palese met with Associate Director, Karie Slavik, to learn about the acquisition process of a 40-acre parcel in 2023. For the development of the timber sales SOP, Jordan Truitt consulted relevant literature and the Resident Biologist and Associate Director to gain insight into the planning, implementation, monitoring, and reporting of the Station's most recent timber sale in 2019. Lastly, J. Truitt consulted the Resident Biologist and utilized the team's summer visit to develop a case study on the repair of stairs and bridges at the Mark and Ruth Paddock Trail at Carp Creek Gorge in 2023.

Conclusion

The University of Michigan Biological Station (UMBS) expressed a need for a comprehensive plan to ensure consistent, long-term stewardship of its 10,000 acres of diverse lands and waters and ultimately advance Research, Education, Outreach, and Preservation. In response, we developed this report, which provides a set of recommended strategies, policies, and tools for UMBS to consider in future efforts to steward the property. Importantly, these findings are not meant to be comprehensive or prescriptive; rather, they serve as a set of guidelines on how land and water stewardship values could be embodied at UMBS. The recommendations and tools provided in this report aim to advance one or more of the following categories that are central to the mission of UMBS and support stewardship: Research, Education, Outreach, and Preservation outcomes, that in turn reinforce stewardship. Our recommendations cover topics which include improved data management, timber sales, maintenance and reporting, public use management, signage, public outreach and communication, planning for ecological threats, and managing species of concern. The tools we designed are meant to be more actionable deliverables UMBS can utilize now to improve stewardship functions. These include a proposed management zone layout and justifications for policy changes. The majority of these are included as a part of the appendices of this report.

All recommendations made in this report have a role in supporting stewardship at UMBS; these are simply a few that are needed on a short-term basis. Pulling from our recommendations in this report, we would like to highlight a few that should be prioritized due to their immediate importance and feasibility for implementation:

- Increasing/starting data collection to inform prioritization of tasks currently with limited staff and resources, such as shorebird and fish surveys in North Fishtail Bay and implementing public and internal surveys would be logical first steps.
- Follow a maintenance schedule to improve efficiency in visiting different parts of the property to inform where routine work is needed but also to identify problem areas in terms of public use.
- The signage and kiosk recommendations should also be prioritized, as a positive interface with the public is key to deter harmful public use as well as build a mutually beneficial relationship with the Northern Michigan community.

We strongly emphasize that this report serves as a starting point, not a final prescriptive stewardship plan for UMBS. Some of the tools we developed may be actionable and implementable now; however, the vast majority of our work was aimed at identifying needs and providing options for UMBS to consider when addressing those needs. Stewardship and land management of a 10,000 acre university-owned property is a vast endeavor that encompasses university and UMBS administrative function, relationships with the public, local government,

tribes, and law enforcement, regulatory considerations, ecological science, monitoring and evaluation, mapping, and data/property information management. This report represents the first step towards a comprehensive stewardship plan and its scope was constrained by the nature of a 1-year project led by Master's students that are external to UMBS. We touch on many of the elements listed above; however, there are gaps in this report that need to be addressed in future efforts. More attention is needed related to relationships with local governments, tribes, and law enforcement to build on our outreach recommendations and ensure stewardship is a collaborative effort between UMBS and the surrounding community. More attention should also be given to university and UMBS administrative functions as they relate to stewardship. We briefly addressed this in our maintenance schedule, but this could be its own endeavor if there is buy-in from these institutions. Monitoring and program evaluation plans also need to be developed to ensure the lasting effectiveness of UMBS stewardship activities.

We recommend UMBS continues to work towards a comprehensive stewardship plan using our report as a baseline. In doing so, UMBS should consider hiring additional staff to work on different aspects of the plan. If UMBS continues to work with Master's students, they should consider assigning a group of students to work on a specific, defined portion of the plan since a comprehensive plan involves so many individual components that should each be given their own complete project period to be considered comprehensive. For example, a project dedicated to tree species mapping and carbon sequestration efforts or a project that focuses exclusively on the public use/misuse challenges touched on in this report. Any of the gaps listed in the previous paragraph could also be their own projects, which would allow more focus and resources to tackle each topic, hopefully filling in some of the gaps we identified. The development of a comprehensive UMBS Land and Water Stewardship Plan should be a multi-year, multi-disciplinary undertaking that is constantly evolving as conditions, both environmental and administrative, change. Overall, this report should be utilized to serve as a launching point for this undertaking. UMBS should read and consider the needs we have identified as well as our subsequent recommendation to determine next steps they want to take and which issues seem most pressing to focus on in developing a more prescriptive plan for UMBS stewardship.

Acknowledgements

We would like to thank our clients and primary points of contact at UMBS, Adam Schubel and Jason Tallant as well as our project advisors Dr. Ines Ibanez and Dr. Shannon Brines. We also want to thank Dr. Aimée Classen, Karie Slavik, Scott Haley, Eareckson Myers, and Helen Habicht for taking the time to meet with us during our time on-site in Pellston to discuss various aspects of stewardship priorities, challenges, and goals of UMBS to help us make informed tools and recommendations to further stewardship of UMBS land.

We also would like to respectfully acknowledge the original inhabitants of UMBS land, the Burt Lake Band of Ottawa and Chippewa people. In our efforts to form a stewardship plan and policy recommendations, we have worked with our clients to ensure our work to help preserve this land takes into account the cultural history of the land. In an effort outside the scope of this project, The University of Michigan has recently established a committee to investigate the burnout and make recommendations for actions that would acknowledge this history and incorporate lessons learned from this event into their education, research, and outreach missions.

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Appendix C: North Fishtail Bay and Unit 5 Public Use Concerns & Intervention Options

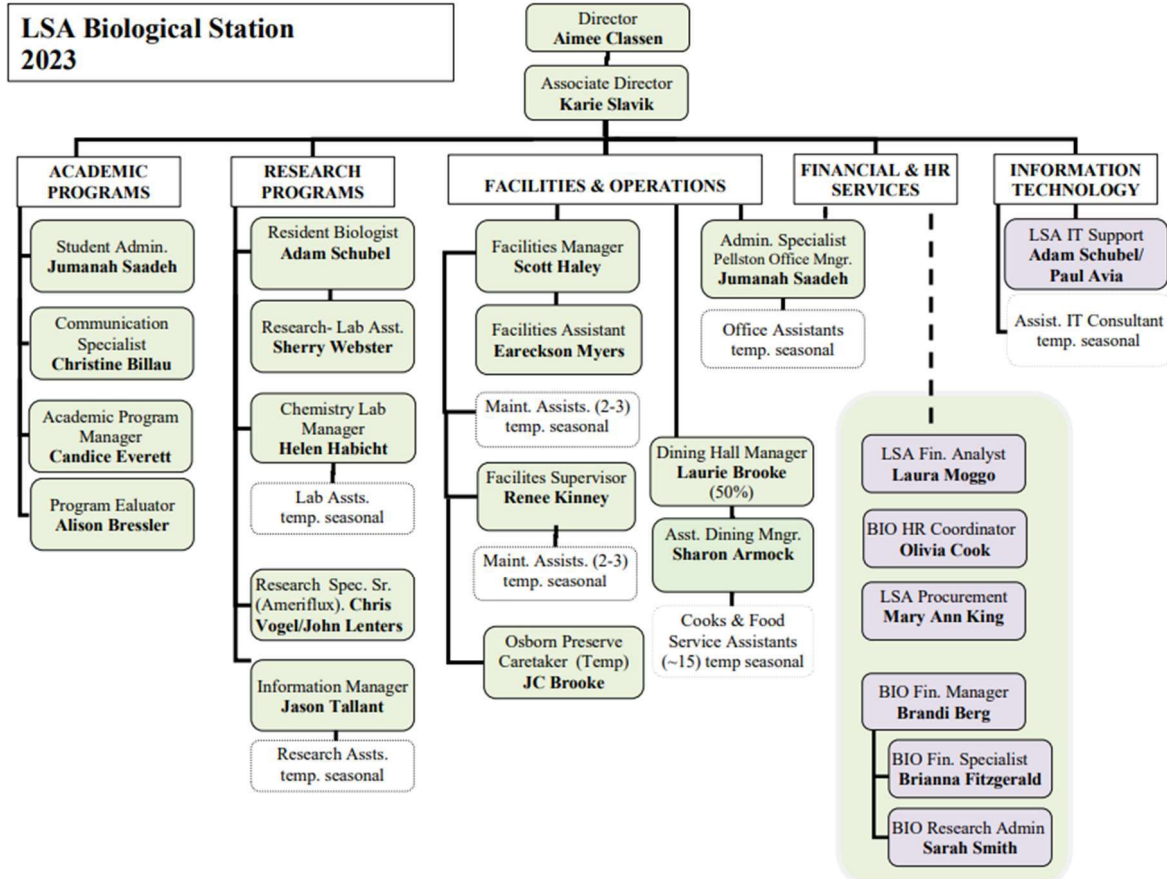
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Appendices

Appendix A: UMBS Organizational Chart (2023)



Appendix B: Natural Communities of UMBS

Natural Community	Acreage	Percentage
Dry-mesic Northern Forest	6,339	62%
Mesic Northern Forest	2,413	24%
Northern Hardwood Swamp	516	5%
Rich Conifer Swamp	421	4%
Boreal Forest	219	2%
Floodplain Forest	116	1%
Northern Shrub Thicket	107	1%
Hardwood-Conifer Swamp	53	0.5%
Northern Wet Meadow	28	0.3%
Bog	14	0.1%
Sand and Gravel Beach	6	0.05%
Northern Fen	5	0.05%
TOTAL	10,239	100%

Appendix C: Cases for Policy Changes

North Fishtail Bay and Unit 5 Public Use Concerns & Intervention Options



Aerial photos of Douglas Lake and North Fishtail Bay - UMBS Units 1 and 2. Left to right: 1 - Sedge Point, 2 - Hook Point, 3 - East Point.

North Fishtail Bay, located in the Northeast corner of Douglas Lake, features shoreline that makes up Unit 1, and a small portion of Unit 2. East Point located in Unit 2, is home to a variety of sensitive shoreline vegetation. The point at the Northwest end of Fishtail Bay, Hook Point, down to Sedge Point is prime nesting habitat for a variety of shorebird species. UMBS' wooden loon nesting platform is located just North of Hook Point. Other bird species that frequent the northwest shores of Douglas Lake and are ground nesters include Terns, Killdeer, Sandpipers, and a variety of duck species. Many of these species make their nests in the sand on the beaches, loons look for patches of land adjacent to or surrounded by water. In both cases, nests are vulnerable to disruption from the wakes of large motorized boats, which are common in this part of Douglas Lake (Loon Preservation Committee, n.d.).



Left: UMBS Loon Nesting Box at Hook Point; Right: Natural Loon Nest

In addition to large boat wakes, smaller jet skis which frequent north fishtail bay are also known to be disruptive to ground nesting birds. In addition to wakes, noise is a concern with jet skis. This

issue has been well documented with ORV disturbance, with studies finding repeated disturbance and noise from ORVs can eventually lead to nest abandonment. Potential disruption of courtship activities, over-exposure of eggs or young birds to weather, and premature fledging of juveniles have all been documented as a result of ORV disturbance (Hamann et al., 1999). These short-term disturbances can lead to long-term bird community changes (Anderson et al. 1990). Though these studies do not cover jet skis and their impact on shorebirds, for the sake of management, it is reasonable to assume that excessive motor noise from jet skis, similar to ORVs, could produce the same disruptive effects on ground nesting shorebirds.

Looking towards the point opposite hook point, East Point and the shallow sandbar south of the point features a variety of sensitive shoreline plant species that are of interest to UMBS. Adam Schubel cited concerns about the shoreline and aquatic plant species here due to their sensitivity to disruption. Shoreline plants are vulnerable to heavy beach use, including unleashed dogs. The aquatic vegetation is vulnerable to boat wakes and direct impact from boat motors. This is a very popular area for boaters on Douglas Lake and during our pontoon tour of the lake, we directly observed approximately 20 boats anchored in the sandbar off the shoreline just south of East Point. In addition to the intrinsic value of the aquatic vegetation here, these plants may be significant rearing habitat for a variety of Douglas Lake fish species. It is well documented that species like Northern Pike, a common sportfish in Douglas Lake, require areas of dense aquatic vegetation for successful spawning and recruitment (Smith et al., 2016). Habitat for supporting aquatic vegetation also extends beyond East Point, up across much of the north shore of North Fishtail Bay.

These concerns also extend to UMBS shoreline on the north end of Burt Lake in Unit 5. Adam Schubel cited similar concerns with aquatic vegetation in the shallow bays and the presence of nesting shorebirds on the beaches. As with Douglas Lake, Burt Lake has a high density of private homes and docks with motorized boats as well as public boat launches. UMBS has less qualitative data on where boaters tend to congregate compared to Douglas Lake, however large wakes from boats have still been cited.



Aerial Photos of Burt Lake's North Shoreline & UMBS Unit 5

As has been mentioned, public use is a concern in North Fishtail Bay and Unit 5 shoreline on Burt Lake. The most pressing concern with respect to the ground nesting shorebirds, aquatic vegetation, and fish rearing habitat is careless boat handling, resulting in trampling of vegetation and large boat wakes that disrupt bird nests. In addition, there have been issues with boaters disposing of trash in the lake and along the shoreline in North Fishtail Bay. The public also routinely accesses

North Fishtail Bay Beach via North Fishtail Bay Road and there are issues with trash disposal and beach erosion from people driving motorized vehicles directly onto the beach.

Recommendation: Shorebird Survey

UMBS is aware of the presence of ground nesting birds in North Fishtail Bay and North Burt Lake but has limited data on annual nest locations. Prior to posting signage, buoys, or lobbying for no wake zones on Douglas Lake, UMBS should consider conducting surveys of shorebird nests to have a clearer picture of where to concentrate their efforts to deter disruption from public use. It may also be interesting and useful to study the behavioral impacts that human disturbance has on nesting birds, particularly loons between Hook and Sedge points.

Recommendation: Signage & Buoys

Similar to the recommendations given in the Signage & Rule Communication and Kiosk sections, signage posted on Buoys along the shorelines of North Fishtail Bay and Burt Lake may aid in voluntary reductions in detrimental public behavior. Signs with educational content similar to those suggested at kiosks could be helpful to bring awareness about the shorebirds and aquatic vegetation that exist here, but should be posted in conjunction with specialized signs that clearly communicate a specific message. In areas with regular nesting activity this could read something like “ground nesting birds/sensitive vegetation in this area, please slow down/maintain minimum distance from shore/keep out,” or whatever UMBS wants to communicate here. Text should be large and accompanied by an image or icon that also communicates the message so that boaters can see the message from a distance. Signage should aim to educate about the bird species and vegetation in the area and the roles each plays in the ecosystem but also clearly communicate a bottom line aimed at deterring certain behavior.

Seasonal Closure of North Fishtail Bay Beach

UMBS should also consider closing access to the lakeshore and beaches via units 1, 2, and 5 during certain times of the year, especially during bird nesting season in the spring. The exact dates of closure should be considered based on the results of the proposed shorebird survey and the species UMBS is most interested in protecting, but generally a few months seasonal closure sometime in the spring or early summer should be considered. If closures are infeasible or unenforceable, steps should still be taken to protect bird nests. Signage and enclosures around specific, known nesting areas should be considered.

Recommendation: Limiting Beach Access from North Fishtail Bay Road

North Fishtail Bay Road is a popular point of public access to the shoreline. People regularly drive right onto the beach from the road, which creates erosion issues and concerns over shorebird nest trampling. There have also been instances of campfires on the beach, which is prohibited anywhere on UMBS property. It is a County Road; however, it is unclear where the road ends and UMBS' property on the beach begins, creating a question of how much authority UMBS has to restrict activities just off the road on the beach. UMBS has not received a clear answer from the County on where their road boundary ends. One option would be to inquire what the County's listed road

mileage is and to go out and measure the mileage of the road to compare. If UMBS can use its own road mileage measurement to determine the boundary and restrict beach access there. UMBS has explored the option of placing boulders at the end of the road to prevent vehicle traffic. This is a good option but should be done in conjunction with signage in accordance with State standards communicating the boundary and communicating prohibited activities such as vehicle use on UMBS property.

Recommendation: No Wake Zones

While this is a more drastic option that would be very challenging politically at this time, there is a solid foundation for justification of a no wake zone in North Fishtail Bay. To continue to build this foundation, UMBS should continue to document instances of public uses along UMBS shoreline that are inconsistent with UMBS' mission, including preservation. Additionally, more data on the shorebird ground nesting activity which could be built through the suggested shorebird surveys would help make the case for no wake in these areas. Additionally, more research on the role that North Fishtail Bay aquatic vegetation in particular plays in fish rearing, especially of game fish species that the DNR may be more interested in protecting. Studies documenting fish spawning activity or surveying populations of young of year fish using the vegetation here could contribute to a base of evidence for the importance of this habitat in fish rearing on Douglas Lake. Research projects like these and the shorebird survey could be Master's Projects of their own and would continue to strengthen the case for no wake zone implementation.

The Case for Hogsback Road Closure

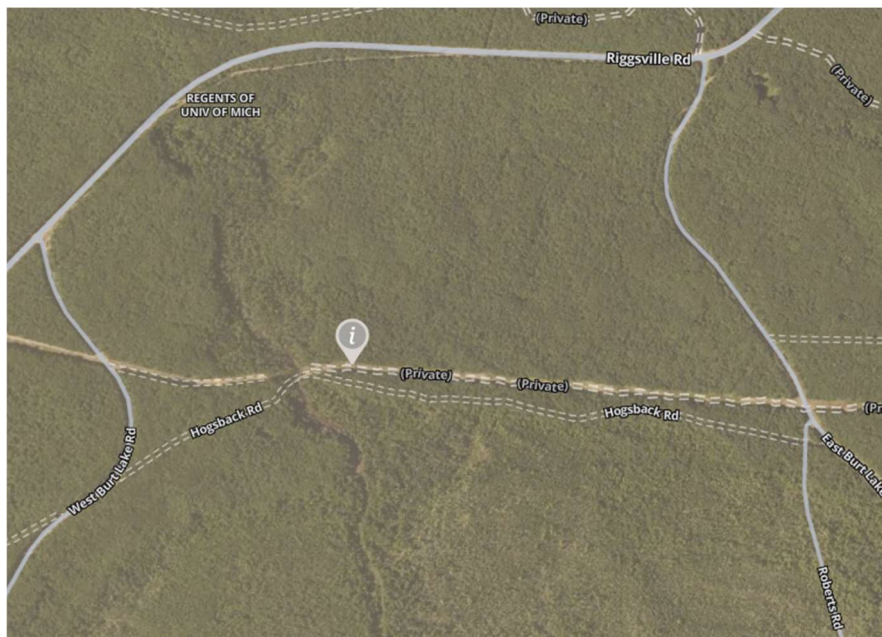
Hogsback Road is an unpaved county road approximately 1 mile in length, which crosses Carp Creek and connects East and West Burt Lake Roads south of Riggsville Road in UMBS' Unit 5. The road provides access to the Gorge trail system and Carp Creek, with limited undesignated parking spaces located near Carp Creek. Hogsback Road travels through some of UMBS' most sensitive natural areas, including a variety of forested wetland communities. Among them are hardwood conifer swamps, northern hardwood swamps, and rich conifer swamps, that form the riparian buffer surrounding Carp Creek as it flows through the Gorge (UMBS Unit 5 Profile). Wetlands filter and purify water, act as buffers for flooding in high rain events, help stabilize stream banks and manage erosion and sedimentation of nearby streams, provide habitat for a huge variety of species including many of the Country's Federally recognized threatened and endangered species, not to mention the educational value they provide (National Parks Service, n.d.). These benefits are of particular value to an institution like UMBS that places utmost value on preservation and education. The critically endangered Michigan Monkey-Flower (*Mimulus michiganensis*) is present along the Carp Creek stream corridor. The concern over the long-term health of the ecosystems around Hogsback Road and the case for road closure center primarily around two issues: 1. Erosion and sedimentation of road gravel occurring from rainfall and runoff 2. Land misuse by members of the public, including dumping, poaching, and fire.



Michigan Natural Communities

- Bog
- Boreal Forest
- Dry-mesic Northern Forest
- Floodplain Forest
- Hardwood-Conifer Swamp
- Mesic Northern Forest
- Northern Hardwood Swamp
- Northern Shrub Thicket
- Northern Wet Meadow
- Rich Conifer Swamp
- Sand and Gravel Beach
- UMBS Property Lines

Unit 5 Natural Communities Map - Hogsback Road is located within the red rectangle



Focused Map - Hogsback Road in Unit 5

Erosion and Sedimentation

Hogsback Road occurs atop a steep gradient for much of its length. Wetlands and Carp Creek occur at the bottom of this gradient. Where Hogsback Road slopes down to Carp Creek, gravel continually erodes and deposits in the creek and adjacent wetland. UMBS has discussed collecting data to estimate the volume and extent of gravel accumulation in the wetland area. It is evident from visual observation that there is a substantial amount of accumulated sediment. There is no easy fix for this issue, as the nature of a dirt road at the top of a steep gradient will inevitably result in erosion and sedimentation of the road surface. Paving the road would only result in further development of a sensitive area, the benefits of which would be unlikely to outweigh the harms caused by erosion and sedimentation. Some other strategies may be employed to reduce sedimentation in the interim or permanently if road closure proves unattainable.

A guide of best management practices for dirt and gravel roads produced by the Culpeper Soil and Water Conservation District in Virginia provides some suggestions that may be applicable on Hogsback Road. The guide asserts that roadside vegetation can be a buffer limiting runoff and sedimentation from reaching sensitive riparian areas downhill of the road (Culpeper Soil and Water Conservation District, 2019). Thus, vegetation adjacent to Hogsback Road should be preserved and well maintained and planting new plants in certain areas with higher sedimentation may be necessary. The State of Michigan has a [published guide from the Van Buren Conservation District](#) that provides a native plant list that can be referenced for a variety of plant species that can serve as buffers for sedimentation (Van Buren Conservation District, 2014). The Tip of the Mitt Watershed Council also has more [general information about shoreline and streambank stabilization](#). Additionally, the overhead tree canopy can influence the extent of erosion and sedimentation. Dense canopy can reduce the effect of heavy rain on erosion while areas with open canopy will likely be more cause for concern (Culpeper Soil and Water Conservation District, 2019). Thus, efforts to stabilize or buffer the roadside should be prioritized in areas directly adjacent to wetland habitat that have limited tree canopy cover. Whatever management approach may be best suited to Hogsback Road, UMBS should reach out to Cheboygan Road Commission to voice concerns and build a working relationship to address the problem in a mutually beneficial manner.



South edge of Hogsback Road just East of Carp Creek

Public Misuse

Dumping

UMBS has cited issues with dumping occurring along Hogsback Road. The road's position atop a steep gradient means individuals participating in dumping activities are using the road to deposit their waste into the wetland and riparian area at the bottom of the gradient beneath the road. Some

of the information and recommendations provided in the signage and rule communication section may be helpful in discouraging these activities, particularly implementing signage in accordance with Michigan State standards for the purpose of receiving enforcement assistance from the DNR and local law enforcement. However, much of the focus of our signage recommendations is on educating the public who may not be fully aware of property rules and boundaries. Plainly, those dumping trash off Hogsback Road are unlikely reachable by this signage strategy. Besides road closure, an increase in enforcement power may be the only way to try to limit these incidents on Hogsback Road. UMBS should consider an increased presence along Hogsback Road, either in the form of trail camera surveillance or physical staff presence.

Poaching

Evidence of poaching activity has been observed, and it is believed that poachers are shooting deer in the Carp River Gorge from Hogsback Road, using their vehicles to scout along the road for deer. Unfortunately, similar to the issue of dumping, the public outreach strategies discussed elsewhere in this report are unlikely to modify this type of behavior. Per the recommendations in the Signage and Rule Communication section, UMBS may be able to get enforcement aid from the Michigan DNR, by formatting signage in accordance with state standards. As stated above regarding dumping issues, an increase in enforcement power may be the only way to try to limit these incidents on Hogsback Road. UMBS should consider an increased presence along Hogsback Road, either in the form of trail camera surveillance or physical staff presence.

Fire

There is a history of campfires on UMBS land off Hogsback Road which is not permitted. In one instance from 2018 cited by Adam Schubel, a campfire in Unit 5 started by individuals accessing the land via Hogsback Road resulted in a forest fire in the Carp River Gorge. While this may be a rare occurrence and such activity may be deterred by public outreach strategies and signage placement, it is an example of why road closure may be the best strategy to reduce serious risks to a very sensitive and valuable area.



Carp Creek North of Hogsback Road

Recommendation: Permanent Road Closure

Although there may be some management strategies that can be implemented to reduce erosion and sedimentation and to deter dumping activities, the best option in this case may be to pursue permanent closure of Hogsback Road. The benefits of road closure are clear, eliminating easy access for people to dump their waste into sensitive wetland habitat, poach, and start illegal campfires. Additionally, the costs of road closure are limited as Hogsback Road is only a mile in length, and connects two roads, East and West Burt Lake Roads, that are already connected via Riggsville Road. The road does provide access to the popular Douglas Lake Trail, however there are several other trail access points, including the trailhead off Riggsville Road which contains a small parking lot. If road closure does occur, UMBS should consider placing parking areas at either end of Hogsback Road so the corridor could still be accessed on foot by hikers. In the event of closure, there would also be an opportunity for additional ecological benefit via restoration efforts that would involve removing gravel and planting additional buffer plant species. Of course, this restoration would come with an additional cost that UMBS would have to bear.

Appendix D: List of Game Species at UMBS

Common Name	Scientific Name	Class	Order
White-Tailed Deer	<i>Odocoileus virginianus</i>	Mammalia	Artiodactyla
American Badger	<i>Taxidea taxus</i>	Mammalia	Carnivora
American Black Bear	<i>Ursus americanus</i>	Mammalia	Carnivora
American Mink	<i>Neovison vison</i>	Mammalia	Carnivora
Bobcat	<i>Lynx rufus</i>	Mammalia	Carnivora
Coyote	<i>Canis latrans</i>	Mammalia	Carnivora
Long-Tailed Weasel	<i>Mustela frenata</i>	Mammalia	Carnivora
North American River Otter	<i>Lontra canadensis</i>	Mammalia	Carnivora
Raccoon	<i>Procyon lotor</i>	Mammalia	Carnivora
Red Fox	<i>Vulpes vulpes</i>	Mammalia	Carnivora
Short-Tailed Weasel	<i>Mustela erminea</i>	Mammalia	Carnivora
Striped Skunk	<i>Mephitis mephitis</i>	Mammalia	Carnivora
Virginia Opossum	<i>Didelphis marsupialis</i>	Mammalia	Didelphimorphia
Cottontail Rabbit	<i>Sylvilagus floridanus</i>	Mammalia	Lagomorpha
Snowshoe Hare	<i>Lepus americanus</i>	Mammalia	Lagomorpha
American Red Squirrel	<i>Tamiasciurus hudsonicus</i>	Mammalia	Rodentia
Gray Squirrel	<i>Sciurus carolinensis</i>	Mammalia	Rodentia
Muskrat	<i>Ondatra zibethicus</i>	Mammalia	Rodentia
North American Beaver	<i>Castor canadensis</i>	Mammalia	Rodentia
North American Porcupine	<i>Erethizon dorsatum</i>	Mammalia	Rodentia
Bufflehead	<i>Bucephala albeola</i>	Aves	Anseriformes
Canada Goose	<i>Branta canadensis</i>	Aves	Anseriformes
Common Goldeneye	<i>Bucephala clangula</i>	Aves	Anseriformes
Common Merganser	<i>Mergus merganser</i>	Aves	Anseriformes
Greater Scaup	<i>Aythya marila</i>	Aves	Anseriformes
Hooded Merganser	<i>Lophodytes cucullatus</i>	Aves	Anseriformes
Lesser Scaup	<i>Aythya affinis</i>	Aves	Anseriformes
Mallard	<i>Anas platyrhynchos</i>	Aves	Anseriformes
Wood Duck	<i>Aix sponsa</i>	Aves	Anseriformes

American Woodcock	<i>Scolopax minor</i>	Aves	Charadriiformes
Mourning Dove	<i>Zenaida macroura</i>	Aves	Columbiformes
Ruffed Grouse	<i>Bonasa umbellus</i>	Aves	Galliformes
Wild Turkey	<i>Meleagris gallopavo</i>	Aves	Galliformes
American Crow	<i>Corvus brachyrhynchos</i>	Aves	Passeriformes

Appendix E: List of Threatened and Endangered Species at UMBS

Common Name	Scientific Name	Class	Order	Status
American Goshawk	<i>Accipiter gentilis</i>	Aves	Accipitriformes	State special concern
Red-Shouldered Hawk	<i>Buteo lineatus</i>	Aves	Accipitriformes	State threatened
Common Loon	<i>Gavia immer</i>	Aves	Gaviiformes	State threatened
Bald Eagle	<i>Haliaeetus leucocephalus</i>	Aves	Accipitriformes	State special concern
Hungerford's Crawling Water Beetle	<i>Brychius hungerfordi</i>	Insecta	Coleoptera	Federally endangered
Woodland Vole	<i>Microtus pinetorum</i>	Mammalia	Rodentia	State special concern
Limestone Oak Fern	<i>Gymnocarpium robertianum</i>	Polypodiopsida	Polypodiales	State threatened
Michigan Monkey-Flower	<i>Mimulus michiganensis</i>	Eudicots	Lamiales	Federally endangered

Appendix F: List of Invasive Species at UMBS

Common Name	Scientific Name
Zebra Mussel	<i>Dreissena polymorpha</i>
Autumn Olive	<i>Elaeagnus umbellata</i>
Rusty Crayfish	<i>Faxonius rusticus</i>
Emerald Ash Borer	<i>Agrilus planipennis</i>
Garlic Mustard	<i>Alliaria petiolata</i>
Spotted Knapweed	<i>Centaurea stoebe</i>
Common Buckthorn	<i>Rhamnus cathartica</i>
Glossy Buckthorn	<i>Frangula alnus</i>
Black Locust	<i>Robinia pseudoacacia</i>
Beech Bark Disease	<i>Cryptococcus fagisuga</i> + <i>Neonectria spp.</i>
Japanese Beetle	<i>Popilla japonica</i>
Spongy Moth	<i>Lymantria dispar</i>
Morrow's Honeysuckle	<i>Lonicera morrowii</i>
Bells Honeysuckle	<i>Lonicera xbella</i>
Tatarian Honeysuckle	<i>Lonicera tatarica</i>
Oregon Grape	<i>Mahonia aquifolium</i>
Alsike Clover	<i>Trifolium hybridum</i>
Birdsfoot-trefoil	<i>Lotus corniculatus</i>
Bittersweet nightshade	<i>Solanum dulcumara</i>
Black Medic	<i>Medicago lupulina</i>
Bladder Campion	<i>Silene vulgaris</i>
Bouncing Bet, Soapwort	<i>Saponaria officinalis</i>
Broadleaf Helleborine	<i>Epipactis helleborine</i>
Bull Thistle	<i>Cirsium vulgare</i>
Butter and Eggs	<i>Linaria vulgaris</i>
Canada Thistle	<i>Cirsium arvense</i>
Catnip	<i>Nepeta cataria</i>
Chicory	<i>Cichorium intybus</i>
Common St. Johnswort	<i>Hypericum perforatum</i>

Common Speedwell	<i>Veronica officinalis</i>
Common Motherwort	<i>Leonurus cardiaca</i>
Common Mullein	<i>Verbascum thapsus</i>
Common Periwinkle	<i>Vinca minor</i>
Common Plantain	<i>Plantago major</i>
Common Ragweed	<i>Ambrosia artemisiifolia</i>
Common Self-heal	<i>Prunella vulgaris</i>
Common Sheep Sorrel	<i>Rumex acetosella</i>
Common Yarrow	<i>Achillea millefolium</i>
Corn Speedwell	<i>Veronica arvensis</i>
Cow Vetch	<i>Vicia cracca</i>
Curly Dock	<i>Rumex crispus</i>
Deptford Pink	<i>Dianthus armeria</i>
Lily-of-the-valley	<i>Convallaria majalis</i>
European Swamp Thistle	<i>Cirsium palustre</i>
Yellow Rocket	<i>Barbarea vulgaris</i>
Giant Bellflower	<i>Campanula latifolia</i>
Mossy Stonecrop	<i>Sedum acre</i>
Hoary Alyssum	<i>Berteroa incana</i>
Common Burdock	<i>Arctium minus</i>
Horseweed	<i>Conyza canadensis</i>
Narrowleaf Plantain	<i>Plantago lanceolata</i>
Orange Daylily	<i>Hemerocallis fulva</i>
Orange Hawkweed	<i>Hieracium aurantiacum</i>
Oxeye Daisy	<i>Leucanthemum vulgare</i>
Peppermint	<i>Mentha xpiperita</i>
Perennial Sowthistle	<i>Sonchus arvensis</i>
Queen Anne's Lace	<i>Daucus carota</i>
Red Clover	<i>Trifolium pratense</i>
Rough Cocklebur	<i>Xanthium strumarium</i>
Silver Cinquefoil	<i>Potentilla argentea</i>

Tall Buttercup	<i>Ranunculus acris</i>
Tall Hawkweed	<i>Hieracium piloselloides</i>
Forget-Me-Not	<i>Myosotis scorpioides</i>
Watercress	<i>Nasturtium officinale</i>
White Clover	<i>Trifolium repens</i>
White Sweet Clover	<i>Melilotus albus</i>
Canada Bluegrass	<i>Poa compressa</i>
Cheatgrass	<i>Bromus tectorum</i>
Green Foxtail	<i>Setaria viridis</i>
Kentucky Bluegrass	<i>Poa pratensis</i>
Orchardgrass	<i>Dactylis glomerata</i>
Quackgrass	<i>Elymus repens</i>
Redtop	<i>Agrostis gigantea</i>
Reed Canarygrass	<i>Phalaris arundinacea</i>
Smooth Brome	<i>Bromus inermis</i>
Timothy	<i>Phleum pratense</i>
Norway Spruce	<i>Picea abies</i>
Scots Pine	<i>Pinus sylvestris</i>
Crown Vetch	<i>Securigera varia</i>
Perennial Pea	<i>Lathyrus latifolius</i>
Hybrid Cat-tail	<i>Typha xglauca</i>
Narrow-leaved Cat-tail	<i>Typha angustifolia</i>
Common Lilac	<i>Syringa vulgaris</i>

Appendix G: Timber Sale License Agreement Example

(a) Licensee shall, at its sole cost and expense, obtain and maintain in full force and effect without interruption during the term of this License Agreement, the following types of insurance coverage, with minimum limits as set forth below:

1. Commercial General Liability covering liability arising from premises, operations, independent contractors, products-completed operations, personal and advertising injury, and blanket contractual liability - \$1,000,000 each occurrence, \$2,000,000 aggregate.
2. Business Automobile Liability covering all owned, hired, and non-owned vehicles - \$500,000 each occurrence, including all applicable statutory coverages.
3. Workers Compensation – statutory limits for all states of operation.
4. Employers Liability - \$500,000 each employee for bodily injury by accident and \$500,000 each employee for bodily injury by disease.

(b) All policies of insurance procured by Licensee shall be written as primary policies; not contributing with or in excess of coverage that Licensor may carry. If Licensee's liability policy does not contain the standard separation of insureds provision, or a substantially similar clause, it shall be endorsed to provide cross-liability coverage. Licensee shall agree to waive its insurer's right of recovery under its policies. Licensor shall be listed as an additional named insured on such policies (except Workers Compensation and Employers Liability) and at Licensor's request Licensee shall provide Licensor with certificates of insurance evidencing compliance with the limits, insurance requirements and waiver of subrogation set forth above. Such certificates shall be in a form acceptable to, and underwritten by an insurance company reasonably satisfactory to Licensor and with an A.M. Best Company rating of A- or above. By requiring insurance herein, Licensor does not represent that coverage and limits will

(a) Licensee shall, at its sole cost and expense, obtain and maintain in full force and effect without interruption during the term of this License Agreement, the following types of insurance coverage, with minimum limits as set forth below:

1. Commercial General Liability covering liability arising from premises, operations, independent contractors, products-completed operations, personal and advertising injury, and blanket contractual liability - \$1,000,000 each occurrence, \$2,000,000 aggregate.
2. Business Automobile Liability covering all owned, hired, and non-owned vehicles - \$500,000 each occurrence, including all applicable statutory coverages.
3. Workers Compensation – statutory limits for all states of operation.
4. Employers Liability - \$500,000 each employee for bodily injury by accident and \$500,000 each employee for bodily injury by disease.

(b) All policies of insurance procured by Licensee shall be written as primary policies; not contributing with or in excess of coverage that Licensor may carry. If Licensee's liability policy does not contain the standard separation of insureds provision, or a substantially similar clause, it shall be endorsed to provide cross-liability coverage. Licensee shall agree to waive its insurer's right of recovery under its policies. Licensor shall be listed as an additional named insured on such policies (except Workers Compensation and Employers Liability) and at Licensor's request Licensee shall provide Licensor with certificates of insurance evidencing compliance with the limits, insurance requirements and waiver of subrogation set forth above. Such certificates shall be in a form acceptable to, and underwritten by an insurance company reasonably satisfactory to Licensor and with an A.M. Best Company rating of A- or above. By requiring insurance herein, Licensor does not represent that coverage and limits will necessarily be adequate to protect Licensee or Licensor. The purchase of appropriate insurance coverage by Licensee or the furnishing of

requiring repair or maintenance pertaining to the use and occupancy of the License Area; and (2) avoid any the condition until the condition has been repaired or maintained as may be required.

- (3) **LICENSE FEE:** There is no license fee for this license.
- (4) **TERM:** The term of the License shall be commence at 8:00 a.m. on October 31, 2018 and end at 5:00 p.m. on December 31, 2019 (the Term).
- (5) **SUPERVISION:** Licensee shall be responsible during the term of this License for the supervision of the activities of all of Licensee's agents, employees, licensees and invitees in connection with access to and use of the License Area, and Licensee shall take all precautions, including but not limited to the policing of the area, as are necessary in the interest of public safety and for the safety of any persons traveling upon or in any way using the License Area or land adjacent thereto. If any University property is damaged other than for purposes of the timber harvest, Licensee is responsible for the cost of all the expenses associated with any repairs.
- (6) **CONFORMITY WITH LAW AND LICENSOR'S RULES AND REGULATIONS:** All operations and activities conducted by Licensee on the License Area shall conform with safe practices and shall at all times comply with all local, State, and Federal laws, statutes, rules, and regulations pertaining thereto. Licensee is also responsible for compliance with University of Michigan rules and guidelines, for adherence to any posted regulations on the Licensor's Property, and any conditions or rules and regulations shown on the attached Exhibit B.
- (7) **RESTORATION:** INTENTIONALLY OMITTED
- (8) **INSURANCE:**

certificates of insurance shall not release Licensee from its obligations or liabilities under this Agreement. The insurer under such policy shall agree not to cancel, materially change, or fail to renew the coverage provided by such policy, without first giving Licensor ten (10) days advance written notice.

- (9) **INDEMNIFICATION:** To the extent permitted by law, Licensee shall defend, indemnify, protect, and hold harmless Licensor, its officers, directors, agents, representatives and employees from and against any and all claims, demands, actions, suits, damages, liabilities, costs, and expenses, including reasonable attorneys' fees and disbursements that: (i) arise from or are in connection with the License granted hereunder for the License Area or any portion thereof; (ii) arise from or are in connection with any act or omission of Licensee or Licensee's agents, employees, licensees, invitees, or others; (iii) result from any default of this License Agreement or any provision hereof by Licensee; or (iv) result from the presence of Licensee's agents', employees', licensees', or invitees' property or equipment on the License Area; all regardless of whether such claims are asserted or incurred before, during, or after the term of this License Agreement. Licensee's obligations under this Paragraph shall survive the expiration of this License Agreement. Licensee's indemnification of Licensor includes any and all costs and expenses incurred in connection with the enforcement of this Paragraph.
- (10) **VACATION OF PREMISES:** Upon termination of this License Agreement, Licensee shall be responsible for (i) the disposal of trash generated in the License Area other than for purposes of the timber harvest and (ii) the removal of its personal property from the License Area.
- (11) **WASTE OR NUISANCE:** Other than as is necessary for commencement and undertaking of the timber harvest, Licensee shall not commit or suffer to be committed any waste or nuisance upon the License Area. Licensee shall take such action as may be necessary to

prevent or terminate any such nuisance or waste arising out of Licensee's use of the License Area, including, without limitation, any nuisance created by Licensee's agents, employees, contractors, subcontractors, licensees and invitees.

(12) **DEFAULT:** If Licensee fails to observe or perform any of its obligations under this License Agreement, then Licensee shall be in default under this License Agreement, and Licensor may, at its option, exercise one or more of the following remedies:

- (a) After contacting and conferring with Licensee to resolve the nonperformance, declare this License Agreement terminated;
- (b) Obtain specific performance of the covenants and obligations of Licensee under this License Agreement; or
- (c) Perform such obligation on behalf of Licensee in which event the costs and expenses paid or incurred by Licensor in performing Licensee's obligations shall be immediately due and payable to Licensor following receipt of Licensor's invoice.

(13) **NATURE OF LICENSE:** No legal title, easement or other possessory interest in real estate, including any leasehold interest in the licensed premises, or any appurtenances thereto, shall be created or deemed or construed to have been created or vested in Licensee by anything contained in this License Agreement.

(14) **GOVERNING LAW:** All matters arising out of or related to this License Agreement shall be governed by and construed under the laws of the State of Michigan without regard for principles of choice of law and shall be brought in a court of subject matter jurisdiction within the state of Michigan. Any claims, demands, or actions asserted against Licensor for damages shall be brought in the Michigan Court of Claims. The parties and their successors and assigns consent to the jurisdiction of the courts of or within the state of Michigan with respect to any other claims arising under this License Agreement.

unenforceable, invalid, or illegal in any respect under applicable law, the unenforceability, invalidity, or illegality will not affect any other provision of this License Agreement and this License Agreement will be construed as if the unenforceable, invalid, or illegal provision had never been contained in this License Agreement.

(18) **NO WAIVER:** No delay or failure on the part of the Licensor in the exercise of any right granted under this License Agreement or otherwise available by License Agreement, at law, or in equity, shall impair any right, to be construed as a waiver of any default or any acquiescence.

(19) **RELATIONSHIP OF THE PARTIES:** Nothing contained in this License Agreement shall be deemed or construed by the parties or by a third party to create the relationship of principal and agent or of a partnership or of a joint venture or of any association whatsoever between Licensor and Licensee.

(20) **COUNTERPARTS:** This License Agreement may be executed in one or more counterparts, each of which will be deemed an original, but all of which together will constitute one and the same instrument. Delivery of a scanned copy by email of the License Agreement shall be deemed a good and valid execution and delivery of this Agreement.

(21) **ENTIRE AGREEMENT:** This License Agreement together with all its Exhibits constitutes the entire agreement between the parties to the License Agreement regarding the subject matter of this Agreement and cannot be amended or modified except by a writing signed by all of the parties to this Agreement. The exhibit attached to this Agreement is incorporated into the Agreement and made a part of this Agreement for all purposes.

(22) **SUCCESSORS AND ASSIGNS:** This License Agreement is personal to the Licensee and may not be assigned to another party.

(15) **NOTICES:** All notices or other communications provided for under this License Agreement shall be in writing, signed by the party giving the same, and shall be deemed properly given and received (i) when actually delivered and received, if personally delivered; or (ii) three (3) business days after being mailed, if sent by registered or certified mail, postage prepaid, return receipt requested; or (iii) one (1) business day after being sent by overnight delivery service, all to the following addresses:

If to Licensor: The University of Michigan
Real Estate Office 326
326 E. Hoover Street
Ann Arbor, MI 48109-1002
Attention: Executive Director of Real Estate

If to Licensee: Louisiana-Pacific Corporation,
PO Box 80
Newberry, MI 49868
Attn: Travis Kangas

Each party shall have the right to designate other or additional addresses or addressees for the delivery of notices, by giving notice of the same in the manner as previously set forth in this License Agreement. Email correspondence given by Chris Allen from Licensor shall be deemed to be written notice for purposes of this License Agreement.

(16) **THIRD PARTY BENEFICIARIES:** Nothing in this License Agreement, express or implied, is intended to or will be construed to confer upon any person or party, other than the Licensor and Licensee, any right, remedy, or claim under or with regard to the License Agreement.

(17) **SEVERABILITY:** Whenever possible, each provision of this License Agreement will be interpreted in a manner so as to be enforceable, valid, and legal under applicable law. If any provision of this License Agreement is held by a court of competent jurisdiction to be

(23) **PARTIES IN INTEREST:** Each party represents that this Amendment is executed by its authorized representative.

IN WITNESS WHEREOF, Licensor and Licensee entered into this License Agreement on the date in the introductory paragraph.

LICENSOR:

THE REGENTS OF THE UNIVERSITY OF MICHIGAN,
a Michigan constitutional corporation

By: 
Its: Executive Vice President and Chief Financial Officer

LICENSEE:

Louisiana-Pacific Corporation.


By:  d-22-19
Its: Resource Manager

EXHIBIT A

LICENSOR'S PROPERTY AND LICENSE AREA

LICENSOR'S PROPERTY AND LICENSE AREA



Plots to be harvested are in pink (plot numbers 3, 7, 9, and 13)

EXHIBIT B

RULES AND REGULATIONS

Exhibit B

The roads are to be smoothed up after the job is complete.

All debris generated by the Licensee such as machine parts, oil cans, lunch papers, etc., will be removed from the area by the Licensee.

All roads, landings, and decking areas shall be cleared of debris and bladed smooth by the Licensee at the conclusion of the operation. No slash is to be left on the power line or two tracks.

The Licensee shall do all in her/his power to prevent and suppress any and all forest fires. In the event that he or his employees cause fire damage, the value of the lost timber shall be charged to the Licensee.

These additional Rules and Regulations will remain in effect:

- Existing vehicle access restrictions and hunting sanctuary areas remain in effect.
- Recreational use by full-size vehicles is prohibited on UMBS-owned two tracks.
- No unauthorized motorized vehicles beyond public roads
- No littering
- No dumping
- No fires
- No camping
- No hunting or trapping within sanctuary boundaries
- No permanent blinds
- No unauthorized storage
- No firewood removal

Appendix H: Cutting Specifications Document Example

TIMBER SALE CUTTING SPECIFICATIONS BLOCK # 5 -18

OWNER: University of Michigan Biological Station (UMBS)

DESCRIPTION: E ½ NE ¼, Sec. 6 & W ½, Sec. 5, T 36N R 3W, Cheboygan County

APPROXIMATE ACREAGE: 77.4 acres in 4 units

PERFORMANCE BOND: A ~~\$ 7,000.~~ Cash or Surety Bond to be held by D & S Forestry Services Co.

LENGTH OF CONTRACT: CUTTING SHALL BE COMPLETED BY Dec. 31, 2019. CLEANUP AND HAULING OPERATIONS SHALL BE COMPLETED AS SOON AFTER CUTTING AS POSSIBLE.

CUTTING SPECIFICATIONS:

1. The Units on this timber sale are part of a larger aspen research area on a 10,000 acre field station whose mission is research and teaching. Forester and representatives of UMBS are to meet with the contractor on-site prior to the beginning of work to approve roads, landing locations, and to review contract specifications. The contractor must notify the forester at least 7 days prior to schedule this meeting.
2. Contractor will be required to deliver 10 cords of dense pulpwood (maple, beech, oak) not to exceed 16" diameter on the large end to UMBS off this timber sale. A credit of \$70 per cord will be allowed towards stumpage payment requirements.
3. Heavy truck access to the area will be directly off Riggsville Rd. (C-64, a Class A road) via South Bryant Rd. (seasonal two-track), with several additional two-track roads to the Units of the sale (see map following these specifications). Turn-arounds and "T's" will only be allowed using existing roads into the Units to be cut, avoiding saved trees in each Unit. Existing two-track roads will have to be widened in some places to haul products off this timber sale. Trees that need to be removed to widen the roads and that have at least one merchantable 8" pulpwood stick to a 4" diameter top will be required to be utilized and removed from the site. The stumps of trees cut off for this purpose must be up-righted off the edge of the road. UMBS staff communicated with Cheboygan Co. Road Commission Engineer and Manager Mr. Brent Shank (May 23, 2018), who approved widening the county two-track roads, as well as additional improvements described in the following specification.
4. A portion of S. Bryant Rd. will need to be improved (yellow highlighted section on map), but a credit against timber will be provided. Approximately 150 yards south of Riggsville Rd., a stretch of S. Bryant Rd. that is 15' wide by 75' long will need to be improved by installing a 12" X 20' galvanized culvert; putting in pit run gravel to establish a base for the road to bring it up to grade; and capping this stretch of road base with 6" of 22A gravel. Successful completion of this work will create a credit of \$ 1,800.00 against amount due for timber stumpage. This estimate of work was provided by Mr. Tony Merchant of Merchant Excavating of Cheboygan at 231-627-2434 on May 30, 2018. The Cheboygan County Road Commission Engineer and Manager approved of these improvements, and stated that there will be a \$30 permit fee for them to be made. Mr. Shank also stated that the Road Commission will inspect and repair or replace (if necessary) the culvert that is located on the south shoulder of Riggsville Rd. at its intersection with S. Bryant Rd.
5. Until improvements are made, S. Bryant Rd. is not usable for access to the sale Units; current access is via the two-track seasonal road (Chicory Trail) that runs S/SE off of Riggsville Rd. approximately ¼ mile west of S. Bryant Rd. Witness trees at the corners of the Units along S. Bryant Rd. are marked with Unit numbers in red paint. Care must be taken to prevent damage to these trees and corners.
6. Roads used by the contractor are to be leveled, but left with slight crown to the center of the roads after all cut wood is removed from the sale.
7. In Research Unit 3 (16.4 acres), cut all aspen and beech trees within red paint lines and S. Bryant Rd. that contain at least one merchantable 8" pulpwood stick to a 4" diameter top except 111 aspen and 90 beech trees encircled with red paint at chest height and with a stump mark. Care must be taken around saved trees, including merchantable and pole-sized trees. Areas in the northern portion of the Unit have locally steep slopes and careful operations are requested to minimize rutting and erosion in these locations. The operator(s) are requested to create 10-12 residue/slash piles (tops, limbs, etc.), each 20 to 25 feet in diameter

and 3-4 feet high, scattered at random locations across the Unit for research purposes; all other residues may be left as they lay.

8. In Research Unit 7 (17.5 acres), cut all aspen and jack pine trees within red paint lines and S. Bryant Rd. that contain at least one merchantable 8" pulpwood stick to a 4" diameter top except 3 aspen trees encircled with red paint at chest height and with a stump mark. Also cut all red pine and beech marked with orange paint. Save all hemlock, white pine, and other hardwood trees. Care must be taken around saved and residual trees.
9. In Research Unit 9 (18.3 acres), cut all aspen and beech trees within red paint lines and S. Bryant Rd. that contain at least one merchantable 8" pulpwood stick to a 4" diameter top except 38 aspen and 86 beech trees encircled with red paint at chest height and with a stump mark. Also cut all red pine, white pine and red oak trees marked with orange paint. Care must be taken around saved and residual trees.
10. In Research Unit 13 (25.2 acres), cut all trees within red paint line and S. Bryant Rd. that contain at least one merchantable 8" pulpwood stick to a 4" diameter top except for 13 red oak, 73 beech, and 30 white birch trees encircled with red paint at chest height and with stump mark. Care must be taken around saved trees. Tracked processor is preferred for this unit to provide scarification for improved white birch regeneration. Path of processor is to be left clear of slash for walking access of researchers and slash is to be accumulated in piles as much as possible to improve regeneration of hardwood species from deer browsing. Several research locations and a historical artifact are present in this Unit and require special attention. Most important are four shallow groundwater wells, located in the central and northern portion of this unit. These are indicated as red points on the map that follows these specifications. Each well has a 2-3' tall standpipe (1 1/4" diameter PVC pipe) that has been painted blaze orange, and red flagging tape hangs from the lower limb of a tree within 2-3 yards. These wells are not to be damaged, but operator(s) are requested to work as close to them as is comfortable and not otherwise deviate from the prescription. Also present is a 100-year old stagecoach road that bisects the Unit from NE to SW (indicated as a yellow line on the map). The stagecoach road bed is 10-12' wide. It is subtle in level areas and looks like an old haul road, but in steeper areas of the Unit it is eroded 2-4' into the topography. Operator(s) are requested not to drive upon the stagecoach road, to refrain from crossing it where it is eroded more than 18" into the ground, and to minimize crossing it in all other areas.
11. Harvesting and hauling may not be conducted between May 1st and August 18th due to student and researcher use of the management area.
12. No tree length skidding or skidding of logs over 17 feet is allowed in Research Units.
13. Harvesting operations must follow BMPs (Best Management Practices). No skidding shall take place if ruts greater than 6 inches are created. Skidding and cutting shall cease until conditions improve so that ruts are not developed. Maximum stump heights are to average 12" on sawlog sized trees and 6" on pole sized trees, measured on the high side.
14. Trees are to be felled away from red and paint lines, roads, Riggsville Rd right-of-way, shallow groundwater wells, and the old stagecoach road.
15. No red painted trees are to be cut. Leave standing dead trees for wildlife unless hazardous to operations.
16. No tops are to be left in access roads or trails.

PAYMENT SCHEDULE

1. 10% OF BID TO BE PAID WITHIN 30 DAYS OF SALE DATE AND TIME.
2. THE SALE IS BROKEN INTO 4 PAYMENT/CUTTING UNITS. RESEARCH UNIT 3 VALUE IS 20% OF THE SALE, UNIT 7 IS 23% OF THE SALE, UNIT 9 IS 24% OF THIS SALE, AND UNIT 13 IS 33% OF THE SALE. THE BALANCE OF A UNIT IS DUE PRIOR TO THE START OF CUTTING OPERATIONS OF THIS SALE.

