



Guiding
Collaborative
Water Resources
Management within the
Ottawaing Biosphere Region



SEAS

SCHOOL FOR ENVIRONMENT
AND SUSTAINABILITY
UNIVERSITY OF MICHIGAN

Prepared For:

Central Michigan University Biological Station
Grand Traverse Regional Land Conservancy
Tip of the Mitt Watershed Council
The Nature Conservancy
National Audubon Society
University of Michigan Biological Station

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Executive Summary

Centrally located within the Laurentian Great Lakes, the newly reimagined Obtawaing Biosphere Region (OBR) is a geographic area recognized by the United Nations Educational, Scientific and Cultural Organization (UNESCO). The expanse covers the northern Lower Peninsula and eastern Upper Peninsula of Michigan, and seeks to promote the interconnectedness between local communities, culture, and the environment through regional partnerships. The term “Obtawaing” comes from the Anishinaabe term for “at the halfway place,” and signifies the historical and ongoing role of Native American and First Nation peoples’ management and governance in the region. In 2022, the new OBR coalition came together to form a strategic planning framework which provides a living document of the coalition’s mission and goals. However, implementing cohesive management strategies requires additional attention to the region’s historical landscape focus and stressors.

In 1979, UNESCO designated the University of Michigan Biological Station (UMBS) properties for the core protected land and waters as a biosphere reserve. As this area transitioned from one core biosphere *reserve* to a broadened biosphere *region*, it expanded to include a range of diverse partners, communities, and ecosystems. The OBR now encompasses a heterogeneous landscape that consists of an elaborate mosaic of ecological, hydrological, and societal factors. Northern Michigan has varied physiography and complex hydrology, which support a wide array of ecosystems and human societies. Due to the landscape heterogeneity and the social complexity characteristic of this region, emphasizing cohesive regional identities, creating a culture of collaboration, and realizing collective management efforts have been a major challenge. With increasing regional stressors of changing climate and increasing development, the OBR is making concerted efforts to highlight and unify around the region’s hydrologic resources. Since water flows across societal boundaries and through diverse landscapes, it carves a path linking communities and ecosystems. Regardless of the differences in OBR partner work, water remains a constant shared connection across places, among people, and through time.

To reinforce the OBR’s mission, this project aimed to capture perspectives on water values through interviewing, establish a collective vision surrounding water resources through mapping and development of a StoryMap, as well as provide a series of recommendations for how the OBR can establish unified efforts into the future.

We developed five main themes from interviewing local conservation organizations in the OBR, including 1) organizational structure for partner participation, 2) types of strategies in community engagement, 3) collaborators and processes for project collaboration, 4) surface

or groundwater focus, and 5) data sharing and management practices. We accumulated ecological, hydrological, infrastructural, and sociological spatial data layers that formed a principal geodatabase that stores relevant layers in a single location and in a common format. We then created a series of regional maps to visualize and conceptualize dimensions of the OBR. These maps built the foundation for a water-centric StoryMap for the OBR, which aimed to promote a collective vision, engage a broader audience, and expand partnerships. Lastly, based on our interviewing and mapping objectives, we determined 11 key recommendations for the future of the OBR.

In summary, we hope these recommendations, along with our water mapping tools, can provide guidance to the OBR coalition of partners towards collaborative management motivated by shared values in water resources. With this, the OBR can foster a meaningful culture of collaboration that works towards a unified effort in regional freshwater resources and relationships to continue to promote healthy ecosystems and communities as one.

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We would like to acknowledge all of the wonderful people that took the time to meet with us to discuss and explore the Obtawaing Biosphere Region. These experiences made this project possible and immensely enjoyable.

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Lastly, we are eternally grateful to our families and friends who have always supported and encouraged us. Thank you!

Land Acknowledgement

We first acknowledge that our residency and research throughout the Obtawaing Biosphere Region is on the traditional and contemporary homelands of the Anishinaabeg – Three Fires Confederacy of Ojibwa, Odawa, and Potawatomi peoples. We also acknowledge Indigenous people’s cession of lands under coercive treaties common in colonization and expansion of the United States:

The University of Michigan’s campuses are located on lands of the Anishinaabeg and Wyandot, which were ceded under Article 1 of the Treaty of Detroit in 1807. The University’s endowment was originally funded by sale of land granted under Article 16 of the 1817 Treaty of the Foot of the Rapids, also known as the Treaty of Ft. Meig (Bentley Historical Library, 2017).

We recognize and encourage understanding of the sovereignty of northern Michigan’s federally-recognized Indian nations (Bay Mills Indian Community, Grand Traverse Band of Ottawa and Chippewa Indians, Hannahville Indian Community, Keweenaw Bay Indian Community, Lac Vieux Desert Band of Lake Superior Chippewa Indians, Little River Band of Ottawa Indians, Little Traverse Bay Bands of Odawa Indians, and Sault Ste. Marie Tribe of Chippewa Indians), as well as other Indigenous people and historic tribes in northern Michigan (Burt Lake Band of Ottawa and Chippewa Indians and Mackinac Band of Chippewa and Ottawa Indians), across the rest of the region, and throughout Turtle Island (Miner, 2018).

We recognize that understanding the history of the land and ongoing Indigenous sovereignty is only the first step of the work that must occur. We also acknowledge the impacts of colonization that has and continues to affect Indigenous peoples and their lands. We seek to improve understanding of the history, culture, and practices of the region and hope this report encourages cooperative environmental stewardship that recognizes the equal importance of the various roles and responsibilities of Indigenous partners (Reo et al., 2017).

Introduction

In 1979, the United Nations Educational, Scientific and Cultural Organization (UNESCO) designated the University of Michigan Biological Station (UMBS) as a biosphere reserve under the Man and the Biosphere Programme. Under this program designation, a biosphere reserve identifies important landscapes that promote sustainable development and the interconnectedness between communities, culture, and the environment (UNESCO, 2021). In principle, biosphere reserves support the relationships between ecosystems and communities by recognizing three regional management components: core, buffer, and transition areas (Figure 1). A biosphere reserve's core area is the center for conservation and research and consists of explicitly protected land, recognized as ecologically significant (UNESCO, 2021). In contrast, buffer zones directly encircle the core area and are comprised of lands used for recreation and settlement in a way that sustains ecological education, monitoring, and research (UNESCO, 2021). Finally, transition areas surround the buffer zones and include communities that live in an ecologically and socio-culturally sustainable manner (UNESCO, 2021).



FIGURE 1. Conceptual structure of a terrestrial Biosphere Reserve (UNESCO, 2021).

The biosphere reserve designation was largely fitting for the UMBS, given its extensive history of ecological research and protection of representative ecosystem types (Heinen & Kopple, 2003). Located in Pellston, Michigan, the UMBS was established in 1909 after acquiring a tract of land formerly utilized by the lumber industry surrounding Douglas Lake (Gates, 1985). For 113 years, the UMBS has hosted a community of students, faculty, and

researchers from around the world to study and monitor the impact of environmental challenges on the ecosystem (UMBS, 2022). The UMBS Biosphere Reserve contained about 4,000 hectares of re-forested lands, riparian zones, wetlands, and lakeshore habitats (Ottawaing Biosphere Region, 2019). At the time, the biosphere reserve program was primarily targeted at terrestrial ecology and land management practices (Figure 2).

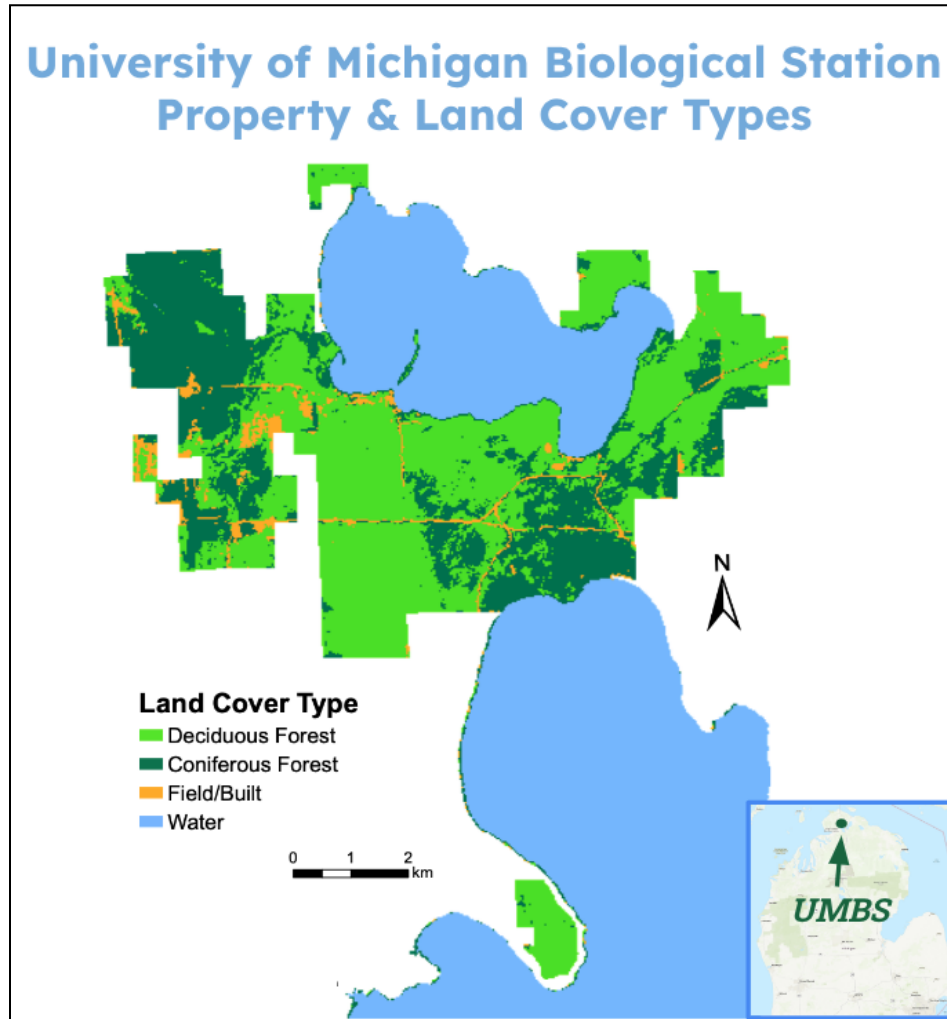


FIGURE 2. Property extent and land cover types of University of Michigan Biological Station (UMBS) in Pellston, Michigan. Unsupervised land-cover classification of Landsat 8 WRS-2 Path 22 Row 28 by Marisa Smedsrud, NAD 1983 UTM Zone 16N spatial reference.

However, despite the UNESCO model of core, buffer, and transition zones, the UMBS Biosphere Reserve ultimately consisted of one terrestrial “core” area, which included only the research land possessed and managed by the UMBS. According to UNESCO (2021), buffer and transition areas are important for engagement and proper management as land-use demands impact socio-ecological systems into the future. After the UMBS submitted a periodic 10-year review of its fulfillment of biosphere reserve criteria in 2017,

UNESCO did not reapprove the UMBS Biosphere Reserve designation. Instead, the UMBS received recommendations for developing an outward-looking and expanded management model (UNESCO, 2021). UNESCO recommended the following: 1) revisiting the biosphere reserve's zonation to include buffer and transition area(s), acknowledging the barriers which may limit the success of its core, protected area; and 2) involving local communities in the management of the Biosphere Reserve to promote sustainable development and strengthen economies (Ottawaing Biosphere Region, 2019).

In response to the program recommendation and to better align with the goals of UNESCO and the Man and the Biosphere Programme, in 2019 the UMBS Biosphere Reserve explored a redesign in partnership with 15 geographically proximate organizations. These organizations represent regional tribal nations, non-profit conservation groups, and local government agencies throughout the northern Lower Peninsula and eastern Upper Peninsula of Michigan. The new, expanded landscape was formed around this region's many core conservation properties, such as Wilderness State Park, the Manitou Islands and Beaver Island Archipelago, the UMBS Pellston property, Sleeping Bear National Lakeshore, portions of National Forest holdings, numerous private/public land conservancy holdings, and the UMBS holdings on Sugar Island (Ottawaing Biosphere Region, 2019). This new area also covers a broad expanse of socio-ecological systems, encompassing a variety of management approaches and governing bodies.

Through this newfound partnership, the previous UMBS Biosphere *Reserve* was expanded and reimagined as the Ottawaing Biosphere *Region* (OBR), which was ultimately approved by UNESCO in 2021. This expansion led to the adoption of multiple core areas and establishment of several new buffer and transition zones. Similar to the structure of a biosphere reserve, the biosphere region model also has core, buffer, and transition area components. However, the Ottawaing Biosphere Region has a large transition area with multiple nested core areas and buffer zones rather than just one. The OBR was initially conceived as a large, regional-scale, terrestrial transition zone of $\sim 15562 \text{ km}^2$, with core and buffer zones of $\sim 54 \text{ km}^2$ and $\sim 4465 \text{ km}^2$, respectively; however, changes in partner member organizations and geographic area are expected (Figure 3) (Ottawaing Biosphere Region, 2019). Finally, the term "Ottawaing" comes from the Anishinaabe term for "at the halfway place", which was deemed appropriate given the historical and ongoing significance of Native American and First Nation peoples in the region (Ottawaing Biosphere Region, 2019). Moreover, the name reflects the OBR's geographic region of diverse partners, communities, and ecosystems rather than the previous single-managed reserve.

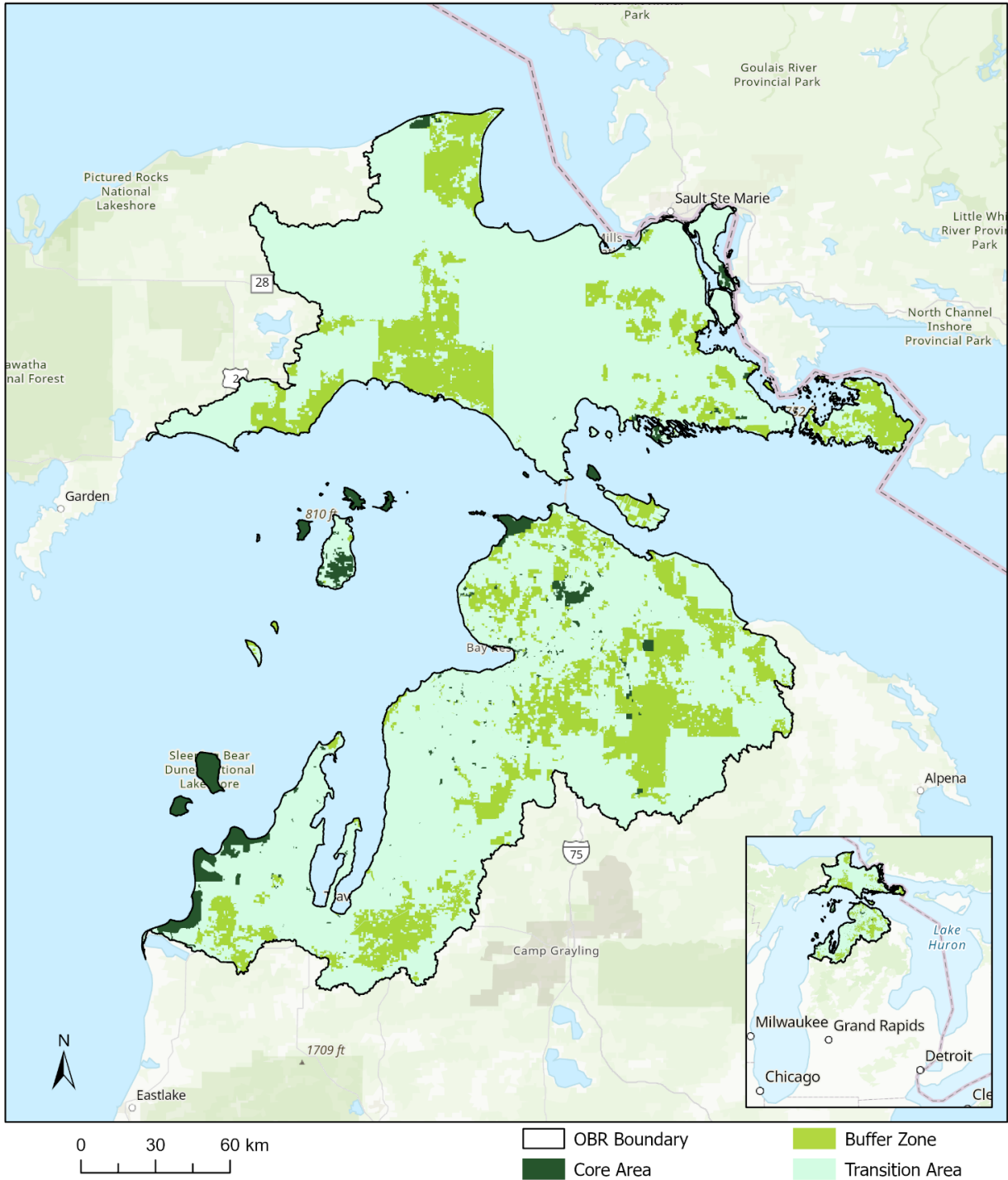


FIGURE 3. Current extent of the core (dark green), buffer (light green), and transition (cyan) areas within the Obtawaing Biosphere Region (black outline). Map modified from a previous core, buffer, and transition zone map created by Jason Tallant (UMBS) to include the new OBR boundary (Fernández Méndez Jiménez & Frederickson, 2022).

This new region's heterogeneous landscape consists of an elaborate mosaic of ecological, hydrological, and societal factors. The varied physiography of northern Michigan supports diverse ecosystems, including dunes, forests, prairies, and a wealth of aquatic systems. The region's underlying hydrology is diverse and complex, containing multiple watersheds, thousands of miles of rivers and highly-valued cold-water streams, thousands of inland lakes including some of the Midwest's largest, and the nearshore waters of three Great Lakes (Michigan Department of Environment, Great Lakes, and Energy, 2019; Tip of the Mitt Watershed Council, 2022a; Tip of the Mitt Watershed Council, 2022b). Beneath the land surface lie extensive groundwater networks, an invisible component of the region's hydrology that contribute significantly to many of the surface water ecosystems. Surficial geology and topography determine the specific geographies of groundwater movement and storage (Great Lakes Science Advisory Board, 2018). Human developments have historically been shaped by regional waters—as waterbodies, waterways, and the surrounding areas provide abundant food sources, yield ideal lands for agriculture and opportunities for irrigation, and establish practical transportation and shipping routes (Silbernagel et al., 1997). From ecological stewardship to logging, mining, and fur-trading, natural resource management practices and extraction continuously shape the communities, economies, and landscape of the region.

However, since landscape heterogeneity and social complexity are characteristic of this region, emphasizing cohesive regional identities and a culture of collaboration has been a major challenge. Although some collaborations occur on specific initiatives, management across this region has historically been conducted by each rightsholder and stakeholder separately. Decision-making by each organization pertains to each of their respective properties, resulting in frequently disjointed conservation and sustainability efforts. Therefore, the UNESCO biosphere region program offers the opportunity to create an all-encompassing ecosystem management strategy that prioritizes ecological integrity, economic well-being, human health, and cultural identity.

To broaden the UMBS Biosphere Reserve's historic terrestrial conservation focus and in response to the increasing regional stressors of changing climate and increasing development, the OBR is making a concerted effort to highlight the region's hydrologic resources. Michigan's abundant freshwater services, mild temperatures, and related quality of life will be impacted by climate change. Current climate projections predict increased frequency and variability in extreme temperature and precipitation events across Michigan (Great Lakes Integrated Sciences and Assessments, 2023). This climate context is critical to understanding the potential future tensions within northern Michigan, as the abundant freshwater and temperate climate of this region are likely to attract new residents, businesses,

and tourists—thus increasing demand for water resources in the future. Additionally, the predicted increase in frequency and intensity of seasonal heat waves and drought events in this region will result in new narratives for water resource use, particularly regarding the demand for agricultural irrigation (Schneider, 2021). Attention to ground and surface water protection initiatives in the state of Michigan has also provided awareness for freshwater conservation to all sectors (MSU Groundwater Assessment). For instance, the 30-year Water Strategy by the Office of the Great Lakes outlines achievable goals to ensure the sustainability of Michigan’s water resources through time (Michigan Office of the Great Lakes et al., 2016).

With the urgency of climate and development change, and the hydrologic context of northern Michigan in mind, implementing cohesive management strategies surrounding freshwater has never been more critical. Water flows across boundaries and below surfaces—across and through a mosaic of landscapes, carving a path linking ecosystems and communities. Although OBR partners work across different landscapes, have specific missions, and use various management approaches, water is a central theme. Whether organizations work on water-resource policy, advocacy, restoration, or other protections, OBR partners can establish a shared connection based on freshwater resources and values. Water, while often the root of conflict, must instead be a unifying factor among peoples, across places, and through time. Water is the connection to the natural world on which all life depends.

Our student team from the University of Michigan School for Environment and Sustainability (SEAS) aimed to forward the mission of the new OBR partnership, which is to “share ideas and implement solutions to foster relationships and to advance environmental, cultural, and socio-economic sustainability and well-being in the heart of the Great Lakes Region” (Ottawaing Biosphere Region Strategic Planning Framework, 2022). We supported this mission at the time of ongoing strategic framework visioning among OBR partners and built on prior organizational support provided by the SEAS 2022 student team. To reinforce the OBR’s mission, we discerned ways to unite the region around concerted water resources management through three key project objectives:

Project Objectives

I. Capture perspectives on values and relationships to water across the region through interviewing.

II. Establish a collective vision surrounding water resources, reach a broader audience, and expand partnerships through translating regional spatial data, mapping, and creating a StoryMap.

III. Provide recommendations for how the Ottawa-Bowling Green Biosphere Region can establish unified efforts surrounding collaborative water resources management.

Methods

To fully address these objectives and the broader project goals, we investigated connections between regional values related to water and the goals of the OBR partnership.

Project Location & Partner Experiences:

Given the OBR's broad domain, stretching across Michigan's northern Lower Peninsula and eastern Upper Peninsula, we felt it was critical to lay the foundation for this project through a place-based understanding of the OBR. Based at the UMBS, which is functionally and geographically central to the OBR partnership, we were able to travel across the region to meet with partners, conduct interviews, attend meetings and conferences, and participate in field research (Figure 4). The time we invested with OBR partners highlighted the environmental and social ecosystems that comprise the region and illuminated individual partner values and goals, projects and processes, and contributions to the OBR. While the OBR has numerous partners and affiliates, we worked specifically with the following six partners: University of Michigan Biological Station, Grand Traverse Regional Land Conservancy, Tip of the Mitt Watershed Council, The Nature Conservancy, National Audubon Society, and Central Michigan University.



FIGURE 4. Approximate location of the University of Michigan Biological Station within the current OBR boundary.

I. Capture perspectives on values and relationships to water across the region through interviewing.

Data Collection:

To understand values surrounding water held by OBR partners and other related environmental organizations across northern Michigan, we employed a qualitative, semi-structured interview approach. Gathering perspectives and unique personal recounts by OBR partners was consistent with a qualitative data collection method. Moreover, a semi-structured interview aims to capture specific project examples, stories, and perspectives guided by open-ended questions (Torkar et al., 2011). The following research questions guided our qualitative data collection and were developed to understand central themes surrounding sustainable water resources management and priorities in the OBR:

1. How do partners initiate collaboration? What is their organizational structure and capacity to collaborate?
2. How do partners see themselves and their communities engaging with water resources?
3. Which datasets, scientific research, or other information do partners utilize?
4. What values and approaches drive water resources management?
5. How do partners currently see the OBR? What are the benefits to having this Biosphere Region?

Interviews were conducted during summer in person and into fall online using the Zoom platform. Our extended interview timeline and subsequent transition to an online format were due to opportunistic sampling. Opportunistic sampling takes advantage of circumstances to gather interview data, for instance, after presenting on the OBR at a professional symposium or through networking with organizations focused on water-related topics (Palinkas et al., 2015). Summer was more conducive to shadowing OBR partners in the field since weather was most suitable for being outside and we were living in the region. In fall, we moved back to Ann Arbor and partners had more flexibility to interview virtually. All interviews included informed written and verbal consent, which follow the protocols outlined by the Human Subjects Research Protection Program at the University of Michigan. Interviews were scheduled for an hour, but ranged from 30 to 90 minutes. We recorded in-person interviews using a hand-held voice recording device and virtual interviews using built-in Zoom recording software. Recordings were then converted into transcripts using Adobe Premiere Pro software or with built-in Zoom software.

A total of 14 interviews were conducted representing organizations that manage protected lands or work in service areas within the OBR. Individual interviews representing conservation organizations gave insight into how partners execute priorities in day-to-day projects around the region. Some interview respondents came from the same organization but held different roles. For example, we interviewed the director of an organization and later interviewed the water resources biologist for the same organization (Table 1). Four interviews contained two respondents from the same organization, so a total of 18 individuals were interviewed. Interviewing multiple individuals representing the same organization became incredibly insightful, especially for larger organizations; and helped capture perspectives from both the organization’s higher-level values as well as from project-specific examples.

TABLE 1. Number of interview participants by organization during August - December, 2022.

Interview Organization	Number of Interviewees
Audubon Great Lakes, Michigan	1
Bay Mills Indian Community	1
Central Michigan Biological Station	1
FLOW (For Love of Water)	2
Grand Traverse Regional Land Conservancy	1
Huron Pines	1
Little Traverse Bay Band Tribal Fish Hatchery	1
Loyola University	1
National Audubon Society	1
Sleeping Bear Dunes National Lakeshore, Administration	1
Sleeping Bear Dunes National Lakeshore, Natural Resource Division	2
The Nature Conservancy	2
Tip of the Mitt Watershed Council	1
University of Michigan Biological Station	2
Total	14 18

Data Analysis:

To analyze and compare partner interview responses, we first developed a codebook to distill meaningful information from the transcribed interview recordings into generalized themes. A codebook is a list of researcher-generated words or phrases (codes) that symbolically

assigns a summative version of the transcribed interview data and helps to set standards for qualitative analysis among multiple team members (Saldaña, 2013). We formed this codebook from our original research questions and iteratively adapted it throughout the theme extraction process to better align with what our inquiries revealed. The codebook contained “parental” codes of higher-level themes formed from our research questions. Then, we inductively discerned multiple “child” codes, or sub-themes, within each parental code, in order to extract specific details from each interview transcript that fit into the broader research topics.

The final codebook was used as a template and responses to each sub-theme were summarized using any relevant language from the respondent (Appendix 1). Thus, rather than coding transcriptions by quotes, our process summarized the general response of an interviewee according to the corresponding sub-theme. Additionally, we analyzed transcripts according to the interviewed organization or department—four interviews contained more than one respondent and were therefore analyzed as one organization. Specific words and phrases used by the respondent within our interview analysis ultimately aided in our understanding of how the wider conservation community discusses water resources management in the OBR and ensured the relevancy of our results. Prior to conducting the full interview analysis, we selected a single interview to code as a team to confirm the team’s inter-researcher reliability and finalize the codebook’s themes and sub-themes. Then, each subsequent interview transcription was analyzed according to the codebook sub-theme by two researchers in shared, online spreadsheets, allowing us to discuss interpretations of responses and compile all details for each code.

After all content from interviews was summarized by sub-theme, we returned to our overarching research questions to identify similarities, differences, and other interesting remarks among all interviews. Thus, for each research question, we developed a set of themes emerging from all interviews, including 1) organizational capacities, 2) engagement in respective local communities, 3) criteria for collaboration success, 4) freshwater-related projects (including groundwater), and 5) data management and regional hydrologic knowledge gaps. All authors contributed to the review of the final results across all interviews. We note that our final codebook can neither be completely generalizable to other settings nor discuss interviewee responses in full detail (Palinkas et al., 2015). Instead, we emphasized gathering general themes that encompass personal values and relationships to water across the region.

II. Establish a collective vision surrounding water resources, reach a broader audience, and expand partnerships through translating regional spatial data, mapping, and creating a StoryMap.

To establish a collective vision surrounding water resources, we translated ArcGIS data layers into a regional geodatabase, created a series of maps, and developed a water-centric StoryMap of the OBR. A geodatabase is a data structure that stores assembled spatial layers in a single location, while a StoryMap is a compilation of maps, photos, and narrative text organized into an informative web page (ESRI, 2023a; ESRI, 2023b). The StoryMap platform creates an immersive and interactive experience, ideal for orienting and guiding viewers through the OBR. This StoryMap is a powerful tool to 1) inform broad, public audiences about the Obtawaing Biosphere Region and 2) expand partnerships in the region.

Organization of Spatial Data into a Foundational OBR Geodatabase:

As a result of conversations with project partners and a literature review, we identified a set of hydrological, ecological, geological, infrastructural, and sociological spatial data relevant to the water resources story of the OBR. We acquired GIS layers from the previous SEAS Master's project (Fernández Méndez Jiménez & Frederickson, 2022), Michigan's open GIS data website (State of Michigan, 2023), and directly from partners and regional organizations. Once acquired, we organized data into a geodatabase in ArcGIS Pro, georeferenced layers to the State of Michigan (if necessary), and reprojected all layers to a uniform projected coordinate system (NAD 1983 Michigan GeoRef). We clipped all spatial data layers to the current OBR boundary (Fernández Méndez Jiménez & Frederickson, 2022) based on subwatershed boundaries, as well as a portion to the entire state of Michigan—in case of any future boundary changes.

Layer Extraction and Mapping:

Working from our comprehensive geodatabase, our team extracted select spatial data layers to use for mapping different dimensions of the OBR. These layers related broadly to landscapes, social systems, conservation lands, and the OBR's core, buffer, and transition zone structure. With this data, our team used ArcGIS Pro to design and develop maps. In some cases, several spatial data layers were translated into a single new map depicting related spatial data (i.e. lakes, rivers, and wetlands were translated into regional waterways). Once map symbology was updated and finalized, we uploaded maps to ArcGIS Online in preparation for use in the StoryMap.

StoryMap Development:

To guide our StoryMap and narrative development, we crafted an “And, But, Therefore”(ABT) storytelling framework designed to build a compelling storyline surrounding OBR’s freshwater resources (Olson, 2015). The “And” portion provides critical background information, and the “But” portion establishes compelling tensions, which draw in the reader and set the stage for resolution in the “Therefore”.

After identifying the “And, But, Therefore” components, we identified which of our maps would accurately and sufficiently represent and tell the freshwater story of the OBR. We developed a strong narrative for the overarching ABT storyline, which consisted of an accompanying narrative for each map. Narrative design guideposts were based on the ABT framework developed in the initial StoryMap planning process, which ensured that our story incorporated all necessary components of the OBR’s freshwater story. Additionally, the narrative was supported by relevant literature and resources, all of which were listed in the “References” section at the end of the StoryMap. Our narrative ultimately fosters a sense of place and identifies opportunities for new partnerships in the OBR.

We selected an interactive and scrollable interface within the ArcGIS StoryMap platform that incorporates both visuals and narratives. Using this design, we developed a StoryMap utilizing the maps and narrative mentioned above. After initial maps and designs were in place, the StoryMap went through an iterative review process with advisors, project partners, and SEAS colleagues, to ensure proper scope and content.

III. Provide recommendations for how the Obtawaing Biosphere Region can establish unified efforts surrounding collaborative water resources management.

We developed recommendations to guide future management decisions and directions for the Obtawaing Biosphere Region based on our results for objectives I and II. Immersing ourselves in the emerging OBR coalition allowed our team to understand regional resources and cultures, partner relationships, and program goals. Being present in northern Michigan and speaking personally to organizations working in the region aided our understanding of the priorities and challenges facing this water-rich landscape. Results from our interviews and subsequently derived themes directly influenced recommendations for future partner collaboration on water resources management. Lastly, developing and iteratively reviewing a water-centric StoryMap for the OBR helped us identify additional recommendations and opportunities for the region. All recommendations were supported by relevant literature.

Results

I. Capture perspectives on values and relationships to water across the Region through interviewing.

We identified five main themes to later guide recommendations on collaborative resources management in the Ottawa Biosphere Region. Themes are categorized by the major findings from our interview analysis: 1) organizational structure for partner participation, 2) types of strategies in community engagement, 3) collaborators and processes for project collaboration, 4) surface or groundwater focus, and 5) data sharing and management practices.

Theme 1. Organizational Structures: Understanding Mechanisms for Partner Participation

We found a wide range of organizational capacities, structures, and areas of focus that illuminate complementary work and preferences across the region. Partners and organizations in the OBR have particular agency to work together in the region based on more than just their organizational missions and capacities. Interviewees discussed staff structure, funding sources, geographic scope, and organizational values. Staffing ranged from small-scale with moderate capacity (30 or fewer staff) to large-scale, multi-division organizations. Smaller organizations relied on partnerships with community groups, agencies, or researchers to support their work. All interviewees referenced increasing funding and organizational capacity to implement collaborative projects and meet greater socio-ecological objectives. Both small- and large-sized organizations referenced grant-funded projects most often when discussing funding sources, mainly citing collaborative projects funded by the Great Lakes Restoration Initiative (GLRI). Additionally, all respondents discussed the wider Great Lakes region as their geographic focus; either currently as part of their organization's mission, or in pursuit of as they take on more initiatives and collaborate more broadly. Organizational values were numerous, including: preservation, stewardship, community empowerment, health and societal improvements, education, and recreation. Cultural and social influences can also inform capacity and structures for collaborations. For instance, in the case of tribal nations, tribal governance leaders, elders, and traditional practitioners may advise or approve projects, and current community priorities or funding influence what projects are pursued.

Theme 2. Community Engagement: Utilizing Active and Passive Strategies to Connect to Diverse Groups

Interviewees shared many different ways of connecting with their surrounding community, both actively and passively. Ninety-three percent of interviewed organizations actively engaged with the community in some capacity, while only 36% of organizations passively engaged with the community (Table 2). Active engagement involved hands-on, face-to-face, and field-based projects and programs; where communities interacted with partner organizations. Examples of active forms of engagement include restoration or environmental projects, such as removing invasive species or rehabilitating habitats, citizen science projects, including harmful algal bloom reporting, water quality monitoring, and bird and plant identification, as well as educational programs to the broader public or school and youth camps directed specifically toward schoolchildren. Passive engagement was described where partner organizations and communities do not necessarily interact hands-on or face-to-face—relying more on indirect forms of communication and education through park signs, online information, email blasts and newsletters, or phone applications.

Partner organizations predominantly actively engage with communities—providing opportunities for them to understand community challenges, identify community needs, and encourage community passions. Partners within the OBR are effectively engaging with communities in various ways. Across all of the interviewed organizations, active types of community engagement are regularly implemented through environmental and research projects, educational and volunteer programs, employment opportunities, meetings and trainings, or teachable recreational experiences (Table 2). These forms of community engagement are often hands-on, face-to-face, and field-based opportunities, providing partner organizations quality time to interact with the broad groups of people they engage. Through this active time investment and interaction, community members become well acquainted with and invested in partner organization values and goals, creating a mutually supportive environment. Overall, because of the connections partner organizations build within the community, there is the development of rapport—where partner organizations can better understand challenges their communities face, identify needs of their communities, and also share in celebrating successes.

TABLE 2. Active and passive methods of community engagement and their corresponding percent mentioned by interviewees working in the Ottawaing Biosphere Region (N=14).

Community Engagement Type	% of Respondents
Active	93%
Restoration/Eco Projects	57%
Community-Based Conservation	50%
Volunteer Programs	50%
Educational Programs	43%
School/Youth Camps	43%
Citizen Science Project	36%
Employment Opportunities	21%
Field Trips	21%
Symposiums/Public Presentations	21%
Public Meetings/Feedback Events	21%
Trainings/Workshops	14%
Passive	36%
Apps	21%
Public Signage	14%
Social Media/Online Presence	14%
Emails & Newsletters	14%

Organizations engaged with a variety of different community groups, highlighting strengths and weaknesses in engagement throughout the community. The most common group specified by interview respondents was the general public (71%) (Table 3). Volunteers, youth, and local stakeholders, including landowners were also highly mentioned as targeted engagement groups by partner organizations. Almost half of interviewees specifically noted tribal nations as a community group they aim to engage. Fewer interviewees noted engaging with businesses, health agencies and housing authorities, non-profits, and crop advisors or farmers—highlighting opportunities for more targeted engagement in the future.

TABLE 3. Engaged community groups as recognized by interviewees, each matched with their frequency of note (N=14).

Engaged Community Groups	% of Respondents
General Public	71%
Local Stakeholders	50%
Volunteers	50%
Youth	50%
Tribal Nations	43%
Citizen Scientists	36%
Municipalities/Townships	36%
Colleges/Research Institutions	29%
Affinity Groups	21%
Community Foundations	21%
Lake Associations/Conservancies/Watershed Councils	21%
Businesses	14%
Environmental Health Agencies/Housing Authorities	14%
Non-Profits	14%
Advocacy Organizations	7%
Crop Advisors/Farmers	7%
Interviewed organization Members/Chapters	7%

Theme 3. Collaboration: Highlighting Diverse Partnerships and Advice for the OBR

We found partners and organizations collaborating on projects with several different entities around the OBR. References on project collaborations were not always specific toward water resources management, and instead were more generally about how partners think about or approach collaboration in the OBR. The Michigan Department of Natural Resources (DNR) had the most project collaborations with interviewed partners, followed by university researchers. Additionally, more than one interviewee reported a project collaboration with a local tribe, non-profit organization, or the Michigan Department of Environment, Great Lakes, and Energy (EGLE). Every interviewee referenced working with a particular community group that we did not identify as collaborators with other partners and organizations. For instance, specific city and township governments, local hunters and fishers, tribal fish hatcheries, community foundations, and local colleges were mentioned as primary project collaborators by only one interviewee.

We gathered respondent perspectives and personal advice regarding collaboration experiences, such as benefits collaboration provides to overall organizational mission and best collaboration processes. References toward project collaborations were overwhelmingly positive; partners recognized benefits in increasing resources, expertise, and collective impact (both ecologically and socially); and interviewees offered advice toward successful project collaborations based on shared values and goals. We categorized collaboration advice by seven general topics (Table 4). Top respondent advice categories included incorporating community engagement (57%), understanding partner priorities (42%), and co-developing OBR and partner responsibilities (42%). Themes to enact respondent advice such as these are derived from respondent experiences on successful collaboration and advice for collaboration in the OBR. We collected 25 themes for enacting collaboration and matched themes to specific strategies or objectives in the OBR Strategic Planning Framework (2022). For instance, interviewees discussed advice on incorporating community engagement on collaborative projects by utilizing social media and partner connections with respective communities. We matched this advice with OBR's plans to create a website, social media platforms, and encourage information sharing for facilitating communication outside of the partners and with the broader public (OBR Strategic Planning Framework: Objective 3.1 & Strategy 5.1.2, 2022). Fifty-percent of collaboration themes were matched with specific strategies or objectives in the OBR Strategic Planning Framework. Lastly, a range of various obstacles concerning project collaborations were mentioned by interviewees: conflicting priorities, time required for more upfront project planning, desire for longer-term relationship building or participation, and difficulty in defining who should be a collaborator and expectations of a "good" collaborator. These obstacles were mentioned by more than one interviewee, either in response to follow-up questions on a specific project or through story-telling of their own project management experiences.

TABLE 4. Advice on meaningful project collaborations, with themes to enact advice based on interviewee experiences. Italicized themes indicate a directly corresponding strategy or objective from the Ottawa Biosphere Region Strategic Planning Framework (N=14) (OBR Strategic Planning Framework, 2022).

Advice for Collaboration in the OBR	Themes of Enactment	% of Respondents
Incorporate community engagement in projects/programs	<ul style="list-style-type: none"> • <i>Utilize social media (Strategy 5.1.2)</i> • Integrate goals that are driven by improving communities • Build research questions guided by local concerns or community impacted • Uplift community science tools for data sharing 	57%
Understand partner priorities & highlight partner expertise	<ul style="list-style-type: none"> • Transparency around own goals while conscious of goals of collaborator • Be sensitive to preferences & capacities, ex: different tribal nations, non-profits, etc. • Leverage shared interests 	42%
Co-develop responsibilities of the OBR & partners, including clear expectations	<ul style="list-style-type: none"> • <i>Encourage targets for collaborating at different levels on a project (Objective 2.3)</i> • Co-develop what it means to be a "good" collaborator • Clear meeting agendas, agreed upon code of conduct, & pathway forward, circling back when needed • Creation of action plan or roadmap for organizations to easily understand partner engagement in the OBR 	42%
Uplift local programs & knowledge	<ul style="list-style-type: none"> • <i>Hold seasonal structured meetings (Strategy 5.2.1)</i> • <i>Interest in learning local management & best management practices (Strategy 4.2.3; Strategy 5.2.1)</i> • <i>Work with tribal natural resource groups or projects (Objective 2.3)</i> • Interact with Georgian Bay Biosphere Region & continue to connect locally 	36%
Reciprocity; Partners get something in return for their effort	<ul style="list-style-type: none"> • <i>Participatory interaction (Objective 2.1; Strategy 5.2.1)</i> • <i>Partners are reminded how OBR applies to them (Strategy 3.1.3)</i> • <i>Trust in long-term relationship building & learning, not just the quick project "wins" (Strategy 5.3.1)</i> 	36%
Co-develop practices for shared regional understanding	<ul style="list-style-type: none"> • <i>Co-develop standard for data creation & sharing (Strategy 2.2.2)</i> • <i>Dedicate host to manage shared database (Strategy 2.2.2)</i> • Encourage "upfront" planning: sense of place, system, & relationship building 	29%
Create consistent communication & engagement	<ul style="list-style-type: none"> • <i>Engaging early, often, & with as many partners as possible (Strategy 2.3.2)</i> • <i>Re-engage when things "fall off" & be sensitive to preferences (Strategy 2.3.2)</i> • <i>Dedicated communicator & website creation (Strategy 2.3.2; Strategy 5.1.2)</i> • Continue to utilize zoom 	29%

Interviewees had much more to say about the benefits of collaboration than when we asked what the benefits are of the OBR specifically. We recognized that we should ask a question referring to the OBR last, to allow time to reflect or build upon previous answers to water-related projects, community engagement, collaborations, and data or information sharing. Still, we received greater detail and responses while coding for “collaboration benefits” than specific “OBR benefits”. Sometimes responses coded as “collaboration benefits” were co-referenced with the code “OBR benefits”. For example, a particular project partnership can increase funding for strengthening capacity, which is a benefit to collaboration that is also later referenced as a benefit of the OBR. However, partners can easily relate benefits to collaborating with others in their work, especially in projects concerning interdisciplinary freshwater topics. Some interviewees expressed interest in how the OBR might benefit or affect their day-to-day work. Yet, all interviewees recognize that benefits exist and see value in the OBR, especially by engaging with our questions and field excursions in northern Michigan.

Theme 4. Freshwater Resources: Recognizing Collective Strengths & Identifying Opportunities for Growth

We found that while not all organizational projects are intentionally aimed at water resources management and conservation, conservation projects, in general, can be understood as directly or indirectly benefiting northern Michigan’s freshwater resources. Therefore, while our sample of respondents consisted of organizations with diverse goals and foci that spanned both land and water, water is at the root of each organization in some capacity, supporting the idea that water-related values can be the unifier between both collaborations and strategic motivations across the OBR. When inquiring about significant projects conducted by each conservation organization, we found that 86% of respondents worked on projects categorized as directly related to freshwater, whereas 100% of respondents were working on projects categorized as indirectly related to freshwater (Table 5). Direct projects were identified as projects that specifically impact freshwater resources, as well as inputs to and outputs from freshwater systems. We categorized direct projects into five groups: monitoring, management, research, infrastructure, and policy. Monitoring projects focused on observing and recording changes, with some projects explicitly looking at water quality, wetlands, or septic systems. Management projects centered around restoration, conservation, or mitigation; often of habitats, fisheries, or contaminated sites. Research projects involved systematic data collection and analysis; with partner organizations targeting wetlands, coastlines, fishes, or microplastics. Infrastructure projects revolved around the human, built environment, specifically addressing stormwater, dams, roads, erosion, or flood control. Lastly, policy projects aimed to define action and management plans while working in a decision-level or legal format. Indirect projects were identified by interviewees as projects in which water resources are not directly managed or manipulated, but still consequently

benefit freshwater. We categorized indirect projects into four groups: monitoring, management, research, and community. While indirect monitoring, management, and research projects are similar to direct projects, they often differ in their focus—delving deeper into systems-level issues like forest resilience, land use, and bird and animal health. Community projects broadly relate to societal well-being, including education, outreach, culture, or art.

TABLE 5. Direct and indirect freshwater quality project topics in the Obtawaing Biosphere Region from interviews. Within the direct and indirect sections, projects are categorized by a broad overarching theme, illustrating the diversity of current freshwater work in the Region (N=14).

Direct Freshwater Quality Projects				
<i>Monitoring</i>	<i>Management</i>	<i>Research</i>	<i>Infrastructure</i>	<i>Policy</i>
<ul style="list-style-type: none"> • Water Quality • Precipitation & Runoff • Wetland • Septic Systems • Habitat • Climate Change 	<ul style="list-style-type: none"> • Habitats • Habitat Restoration • Spatial Prioritization of Conservation • Ecosystem Health Assessments • Sustainable Fisheries • Habitat Improvements • Nature-based Solutions • Contamination Site Mitigation 	<ul style="list-style-type: none"> • Wetland • Coastal • Long Term • Fish Community Health • Microplastics • Modeling 	<ul style="list-style-type: none"> • Stormwater Management • Septic Systems • Infrastructure Improvements • Dam Removal • Road Stream Crossing • Erosion & Flood Mitigation • Federal Water Infrastructure Bill • Line 5 	<ul style="list-style-type: none"> • Conservation Action Plans • Watershed Management Plans • Federal Water Infrastructure Bill • Contamination Site Recognition • Line 5
Indirect Freshwater Quality Projects				
<i>Monitoring</i>	<i>Management</i>	<i>Research</i>	<i>Community</i>	
<ul style="list-style-type: none"> • Birds • Food Web Health 	<ul style="list-style-type: none"> • Invasive Species Removal • Land Conservation • Habitat Protection • Habitat/Landscape Connectivity • Prescribed Burns 	<ul style="list-style-type: none"> • Birds • Forest Resilience • Adjacent Land-Use 	<ul style="list-style-type: none"> • Public Education & Outreach • Stewardship • Local Artist Projects • Cultural Preservation • Lake-Wide Action Group • AmeriCorps 	

In addition, we found that while organizations in northern Michigan value groundwater as a fundamental resource, current management projects heavily favor surface waters. One hundred percent of respondents spend time conceptualizing groundwater issues and impacts in general or in their respective areas; however, only one interviewed organization currently works on projects that directly address groundwater issues (Table 6). Organizational concerns surrounding groundwater included: contamination, over-withdrawal (by industry and agriculture), or lack of understanding of the resource (Table 7). In addition, all interviewees expressed interest in future groundwater projects such as regional hydrologic mapping and policy and awareness initiatives. However, our interviews identified funding, complexity, and lack of available resources as critical limitations to studying groundwater.

Some partners highlighted potential opportunities surrounding groundwater, such as the Information Reduction Act, which provides opportunities for grants, collaboration, and community support.

TABLE 6. Comparison of current work on water related projects and expression of concern for the resource in the Ottawaing Biosphere Region. Percentages of current water-related projects by category (direct groundwater, direct freshwater, indirect freshwater) as well as percentages of respondents considering groundwater impacts in their work (N=14).

Project Categories	Percent of Respondents (%)
Working on Projects Directly Related to <i>Groundwater</i>	7%
Thinking about Groundwater Issues and Impacts	100%
Working on Projects Directly Related to <i>Freshwater</i>	86%
Working on Projects Indirectly Related to <i>Freshwater</i>	100%

TABLE 7. Groundwater themes extracted from interviews (N=14). Themes relate to categories including concerns surrounding groundwater, limitations to studying groundwater, groundwater project interests, groundwater opportunities, and the importance of groundwater in the Ottawaing Biosphere Region (OBR).

Groundwater in the OBR				
<i>Concerns Surrounding Groundwater</i>	<i>Limitations to Studying Groundwater</i>	<i>Groundwater Project Interests</i>	<i>Groundwater Opportunities</i>	<i>Importance of Groundwater</i>
<ul style="list-style-type: none"> • Limited Resource • Understudied • Not well understood • Contamination • Over-withdrawal (agriculture & industry) • Depletion • Unprotected • Infrastructure • Low public awareness • Increased demand • Water quality • Public health • Remediation needed • Lack of policy 	<ul style="list-style-type: none"> • Funding • Lack of available visualizations • Complex system • Not well understood • Lack of available mapping resources & data • Difficult to access • Hydrogeology not well known 	<ul style="list-style-type: none"> • Regional hydrologic mapping • Thermal mapping • Policy & awareness • Aquifer recharge • Wetland-groundwater dynamics • Sustainable development • Royalty on bottled water 	<ul style="list-style-type: none"> • Water-based conservancies • Information reduction act = increase in opportunities for collaboration, communities, & grants • Increasing public awareness & advocacy 	<ul style="list-style-type: none"> • Precious resource • Water is life • Shapes ecosystems • Climate change buffer • Drives environmental conditions & patterns • "6th Great Lake" • Inseparable from surface water

Theme 5. Data Management: Identifying Best Practices and Dissemination Strategies

Data management capabilities and procedures differ widely across the partnership, and a few niches emerged from our interviews. We found that several partners were limited in their data management capabilities and experienced difficulty in areas such as digitization of extensive data records, or comparing research results among different individuals and/or projects within the organization. Still, many interviewees expressed that they had a relatively streamlined and consistent data management program. These respondents managed data within ESRI Hubs, in-house data repositories, or sometimes by third parties or government entities. Some organizations could house data from multiple external entities themselves through research assimilation agreements, while others submitted their datasets to public repositories according to funding requirements. While we found that available funding and staffing devoted to data management varied across partner organizations, a consistent theme was that organizations possess data in large amounts. Yet, when asked, all organizations listed several different gaps in data availability related to water resources and each organization mentioned different needs, suggesting that data collection in this area is still necessary.

In contrast to data management, we found many consistencies across respondents surrounding data-sharing tendencies and standards within and among organizations. Almost all organizations leveraged the versatility of online platforms by making data available via their websites or submitting data to public online databases. Moreover, partners often refrained from sharing raw data and instead formulated online information (i.e., summarized data) tools for easier use by outside managers and community members. We found that some organizations frequently provided their specific data upon request or when particular joint projects formed relationships. Finally, a few respondents mentioned that conferences and meetings served as an effective avenue for sharing and comparing data and research findings. A common thread among the interviewees was an affinity toward an OBR-wide data repository.

II. Establish a collective vision surrounding water resources, reach a broader audience, and expand partnerships through mapping, translating regional data, and creating a StoryMap.

We created a foundational geodatabase for future use by the OBR's steering committee and broad regional network. This geodatabase contains 64 different map layers, with a selection of the layers duplicated at two different geographic extents: 1) to the current OBR boundary, and 2) to the State of Michigan boundary (Appendix 2). Our geodatabase is stored in the shared OBR core partner, ArcGIS Online group.

We selected a subset of 26 layers from the geodatabase for use in our OBR StoryMap, based on their suitability as geographic support for our And, But, Therefore (ABT) narrative. This subset included layers such as: PAD-US (protected land areas), coastal wetlands, inland lakes, water wells, municipalities and unincorporated places, and land cost (Appendix 2). After selecting layers from the geodatabase, maps produced for the StoryMap include: geology and glacial land systems, regional hydrology and waterways, ecoregions, communities, population centers, cost of living, income by county, aging well and water infrastructure, conservation and protected lands, as well as a map illustrating core, buffer, and transition zones of the OBR. Our StoryMap was published to a shared OBR ArcGIS Online group for use by the OBR partners and is currently available for viewing at the following website:

(<https://storymaps.arcgis.com/stories/7dbf1efe5150445abcd3c86d9974cc52>)

Recommendations for how the Ottawaing Biosphere Region can establish unified efforts surrounding collaborative water resources management

We present 11 key recommendations for the Ottawaing Biosphere Region moving forward. Individual recommendations emerged directly from what we learned through interviewing, observing, and mapping. Each recommendation is followed by a supporting paragraph, which elaborates on larger themes and partner experiences introduced in the results, incorporates relevant literature, and compares the recommendation to the current Ottawaing Biosphere Region Strategic Planning Framework (2022). It is our sincere hope that these recommendations can help the OBR establish intentional and unified efforts surrounding collaborative water resources management.

Recommendation 1. Strengthen partner capacities and projects by exploring and facilitating grant applications through a dedicated committee or communication process.

Interviewees commonly expressed the potential increase in funding and resources as one significant benefit of collaboration—enabling projects to have greater impact, scope, or capacity for activities beyond what one organization can do alone. While funding is intuitively critical for project implementation, the OBR can strategically consider the budgeting effects of each specific organization’s engagement and capacity in regional projects. Grant limitations, priorities of each organization, and stakeholder needs signify how involved a partner can be in OBR collaborations. One interviewee referenced their capacity to engage in partnerships was reliant on grant-funding. Their department’s capacity for collaborative projects also involves consideration by tribal leadership and project benefits to the community. Funding can support expanding projects to meet multiple community and partner priorities and specifically build “capacity to ensure full and equitable tribal representation and engagement” (Kania et al., 2021; Ottawaing Biosphere Region Strategic Planning Framework: Objective 1.2, 2022). Respondents also communicated that partners might not have the capacity to participate in OBR conversations or regional projects, but this does not indicate a lack of interest in regional collaboration. To keep interested individuals informed, a communicator can regularly share funding opportunities, while a dedicated committee would be responsible for exploring and potentially facilitating grant applications to support regional collaboration.

Recommendation 2. Engage local collaborators of current partners to broaden the OBR network strategically and include localized knowledge.

Connecting with more diverse organizations through existing partner networks is critical as the OBR explores new collaborative projects and embraces multiple ways of knowledge generation. Interviewees implementing projects in the OBR work closely with specific groups, including municipal and tribal governments, health and housing agencies, fish hatcheries, and watershed centers and councils. Some of these groups work with several OBR partners, whereas others only have ties to a single partner, demonstrating existing partners' well-established networks with various local collaborators. As one interviewee mentioned, their organization is a trusted source of local knowledge regarding conservation work, which makes them highly sought after for collaborations with townships, landowners, and watershed groups. Existing partner relationships in other sectors can enhance the OBR network as formal partners to collaboration or by providing scientific, lay, local, and traditional knowledge (Feist et al., 2020). Embracing local networks spurred by a common interest in water resources management can provide learning opportunities for the entire OBR partnership. Generating, sharing, and encouraging diverse perspectives, including Indigenous knowledge and collaboration, are incorporated in several strategies in the OBR (Ottawa Biosphere Region Strategic Planning Framework: Goal 2, 2022). Additionally, strategies that embrace informal social learning events can be opportunities to engage existing partner networks (Ottawa Biosphere Region Strategic Planning Framework: Strategies 4.2.3 and 5.3.1, 2022). Whether local organizations are active in new projects or participate in informal events put on by the OBR, any form of engagement with local groups contributes to equitable processes and products in the OBR (Feist et al., 2020).

Recommendation 3. Leverage the established relationships that partner organizations have within their communities.

Since partner organizations are already effectively engaging and developing rapport with local residents, they are positioned to be the connection between the OBR and regional communities. According to the mission and goals of the OBR Strategic Planning Framework, groups and organizations involved in the OBR are “regional tribal nations, government agencies, universities, non-profit organizations, and local communities” (Ottawa Biosphere Region Strategic Planning Framework: Who is Involved, 2022). However, with the deliberate nature of the OBR roll-out and the infancy of the OBR coalition, local communities have yet to be fully incorporated into OBR development. To achieve this, the OBR can lean on partner organizations to involve and invest in broadening the OBR, as partner organizations already have connections specifically within local communities. This is especially important in engaging tribal communities, where building

trust and relationships takes time and leadership (Judge & Mason, 2019). Network-building could take shape through partner organizations' active projects and programs, as well as in passive signs and emails—building an OBR presence based on well-established, trusted relationships built between partner organizations and the communities they engage with. Having partner organizations involved with connecting the community and OBR also allows the OBR to target people and groups, like farmers and crop advisors, that ideally will become engaged in the OBR conversations and development.

Recommendation 4. Bolster community engagement and reach a broader audience by implementing more passive types of engagement.

With only 36% of interviewees describing passive forms of engagement, compared to the 93% who describe active forms of engagement, the OBR has an opportunity to increase phone applications, public signage, social media and online presence, as well as emails and newsletters. Increasing passive engagement should complement current active engagement efforts, as this provides opportunities to tie together different programming strategies while also encouraging a “two-way-street” of interaction between organizations and local communities (Clutter, 2019; Kellogg Commission, 1999). Implementation of more passive types of engagement can provide more flexibility for both the partner organizations and the communities they engage—allowing the OBR to help produce content that partners can share in a more casual, hands-off atmosphere and communities to receive content in a self-directed manner (Clutter, 2019). Improving passive engagement aligns well with the OBR Strategic Planning Framework, which aims to “organize community outreach in high-visibility places to produce interesting and educational material such as radio interviews, written blogs, webinars” as well as “publicize interesting environmental initiatives for the public” (Ottawaing Biosphere Region Strategic Planning Framework: Strategies 3.1.1 and 3.1.2, 2022). Most importantly, this Framework notes the opportunity the OBR has to “create shared OBR talking points for partners to integrate into their own outreach and engagement programming”—providing passive tools and materials for partners to share with their communities to inform a broader audience on OBR goals and initiatives (Ottawaing Biosphere Region Strategic Planning Framework: Strategy 3.1.3, 2022).

Recommendation 5. Provide our water-centric, OBR StoryMap to partner organizations as a multi-faceted and versatile tool to promote a collective vision surrounding water resources, reach a broader audience, expand partnerships, and initiate more passive community engagement.

The OBR aims to broaden partnerships with businesses, municipalities, non-profits, research universities, and tribal nations throughout the region—these can be initiated and stimulated through information sharing via online platforms and tools. This way, prospective partners

can develop an understanding of the OBR; its collective vision, mission, and future goals at their own pace. Our novel mapping visualizations can help partners see and understand the extent and multiple dimensions of the OBR, and help to stimulate new ideas and management directions (Winchester & Vannithone, 2001). The growing network of partners could also help educate the general public about the OBR by distributing available content throughout their communities. The question posed in the strategic planning framework as to “how can the vision of the Obtawaing Biosphere Region be brought to the general public through education and information sharing so that this initiative is not limited only to the governments, organizations, and institutions involved in the working group?” is addressed through this content sharing strategy (Obtawaing Biosphere Region Strategic Planning Framework: Next Steps, 2022).

Recommendation 6. Continually update the StoryMap, the geodatabase, and other vehicles for sharing the OBR narrative and vision.

While our water-centric StoryMap represents the current mission, goals, and geographic extent of the OBR, this tool is intended to be a flexible form of science communication—updated and improved upon as the OBR continuously grows. Our StoryMap is limited in detailed content, as we had to balance design and scope to effectively serve dual purposes in partner recruitment and public education. Since the OBR core team has access through the ArcGIS Online group to published and unpublished versions of the StoryMap, and our geodatabase of data layers, they can develop more targeted and informed versions as desired. Certainly, new spatial data layers and improved map resolutions will continue to become available, so updating is advised. Furthermore, we collected many more layers than we could feasibly incorporate in our StoryMap. Some examples of available layers that were not incorporated include the EPA’s Environmental Justice Indexes and the DNR’s estimated groundwater recharge map (Environmental Protection Agency, 2023; Michigan Department of Natural Resources, 2022). All layers in the geodatabase are valuable for the OBR network and should be regularly considered and updated to guide future work in the region.

Recommendation 7. Establish clear expectations for OBR partner involvement, considering impacts on partners’ day-to-day work and time.

Setting partner and OBR expectations, with a process to evaluate them later, addresses several obstacles in the early stages of collaborative water resources management. The assumption that collaboration will occur naturally and successfully without supporting infrastructure and equitable processes is a shift in cross-sector coordination (Kania & Kramer, 2011). While we highlight the OBR’s primary activity as a “forum for collaboration

and service to people and communities,” ensuring partnerships embrace equitable processes will take dedicated time to develop together (Ottawaing Biosphere Region Strategic Planning Framework, 2022). Several interviewees discussed obstacles during the collaboration process that the OBR can consider: time and desire for longer-term relationship building or participation, difficulty defining who should be a collaborator, and expectations of a “good” collaborator. These themes are broadly captured in OBR strategies to organize informal meetings and events as well as in further defining appropriate knowledge sharing, gathering, and synthesizing (Ottawaing Biosphere Region Strategic Planning Framework: Strategies 2.1.1, 4.2.3, and 5.3.1, 2022). However, interviewees reflected a vague understanding of how a novel coalition will organize around the strategies in the OBR Strategic Planning Framework. Fully understanding each other’s priorities and co-developing partner responsibilities, given their everyday capacities, requires attention to the daily, often complicated, and messy experience of working with others to achieve shared goals (Mowles et al., 2008). Drafting an understanding of roles and expectations of each partner is also one of many key themes to enable Indigenous partner engagement in the Great Lakes (Reo et al., 2017). Providing expectations that require evaluation also ensures that this process continues to work for individuals through the evolution of the OBR coalition. We suggest planning during OBR’s stages of early partner development on what an authentic collaborator should consider, especially concerning diverse partner experiences and preferences.

Recommendation 8. Make freshwater resources an intentional focus for the OBR, given its core importance and the extent of related work happening in the region.

With the breadth of available resources and excitement surrounding freshwater in the region, the OBR has an opportunity to intentionally form freshwater-focused, regional strategies and frameworks. During our interviews, we purposefully asked a sample of partners and organizations from around the region about their ongoing work and connections to freshwater. These interviews elucidated that partners and organizations specialize in research and conservation work within the broad topics of freshwater monitoring, management, research, infrastructure, communities, and policy. While the specific projects and research mentioned by interviewees were only partially representative of all work within an individual organization or the OBR, there is still an apparent wealth of freshwater knowledge, research, and capacity. Moreover, we found a common passion for sustaining and protecting Michigan’s abundant surface water resources. However, the OBR goals and objectives outlined in the Strategic Planning Framework are broad and overarching rather than freshwater-specific and aim to “Maintain and cherish the cultures and natural world of the Ottawaing Biosphere Region” (Ottawaing Biosphere Region Strategic Planning Framework: Goal 1, 2022). While we see the benefit of this broad view that implicitly includes freshwater,

explicitly highlighting freshwater is critical for developing sustained regional collaborations and projects to protect this valuable resource. Such regional collaboration is both intuitive and necessary to achieve holistic freshwater management—considering that water systems do not conform to the geographic boundaries of many of the individual OBR partners.

Recommendation 9. Elevate groundwater recognition, research, understanding, and protection as a top priority and focus, considering partner awareness and capacity contrasted against the current lack of groundwater-focused projects.

Interviewees identified groundwater as the “sixth Great Lake”, which is both inseparable from surface water and the driver behind environmental conditions, patterns, and life. Nevertheless, there is currently very little active partner work focused directly on groundwater. To help provide insight for future groundwater management and research, our interviews explored concerns, limitations, project interests, and future opportunities related explicitly to groundwater. Recurring concerns were broadly associated with both groundwater quality and quantity. For example, interviewees stressed the need for collective planning in anticipation of increased agricultural and population demands on groundwater reservoirs. This specific topic was recently investigated in parallel workshops by the Institute of Water Research (Michigan State University; Asher et al., 2023) and by members of the Michigan Groundwater Table (led by For the Love Of Water; Steinman et al., 2022a), as well as during a 2021 groundwater summit (Cooperative Institute for Great Lakes Research; Steinman et al., 2022b). These workshops involved current OBR leaders, partners, and state-wide organizations; and resulted in a publication and two reports that specifically identify and provide recommendations for addressing groundwater issues in Michigan. These should be primary resources for guiding groundwater-focused work in the OBR. Interviewees expressed their limitations to studying groundwater were mainly due to a lack of available resources, data, or funding. But, considering that Michigan now has new groundwater-specific funding sources available, the OBR should take advantage of these funding opportunities to address groundwater priorities and increase our collective understanding of groundwater resources. Furthermore, the OBR should leverage the knowledge and networks of groundwater-focused organizations in the region (i.e., For Love of Water), who could help the OBR identify even more collaboration and funding opportunities (i.e., Information Reduction Act). Therefore, similarly to freshwater as a whole, groundwater must be explicitly addressed in the Strategic Planning Framework and budget of the OBR.

Recommendation 10. Establish a data management committee to provide oversight for consistent and compatible data management efforts across OBR collaborative projects.

Due to the evident variation in data management strategies and procedures, there is cause for an examination of best management practices for the sake of collaboration toward regional collective impact. It is important to note that it is not uncommon or unnecessary for there to be a variety of data management protocols depending on data type, scientific field, and project design; however, whenever possible, it is crucial to be intentional towards data collection, curation, and management so that projects can be compared against one another across the broader landscape of knowledge. Therefore, setting data management plans during the initial stages of all projects should be a central part of all OBR collaborations. Within the current Strategic Planning Framework, there exists a motion to “Pursue funding to support a management office” (Ottawa Biosphere Region Strategic Planning Framework: Objective 5.1, 2022). However, the subsequent strategies solely consist of roles devoted to communications and outreach (Ottawa Biosphere Region Strategic Planning Framework: Strategies 5.1.1 and 5.1.2). Adding to this objective, we recommend that the OBR form a data management committee, comprising a network of roles, within the broader management office. This data management network could incorporate existing organizational members or hired employees who serve as leaders in best practices surrounding data creation and management for the broader OBR. While it might be beneficial for each committee member to specialize in a particular aspect of data creation and management (i.e., collection, analysis, dissemination, storage, and archiving), this committee network should be collaborative and in regular communication. The OBR could alternatively, or in conjunction, seek additional funding for data management specialists or advisors who oversee proper data collection and storage done by each partner organization and act as consultants that support the lifespan of various OBR project collaborations.

Recommendation 11. Institute standard data-sharing protocols and allocate funding for data organization and updates.

The OBR and its subsequent organizations are already sharing data and planning for future best practices effectively; however, we found opportunities for the OBR to be more intentional regarding data accessibility and upkeep. Through our interviews, we observed widespread enthusiasm for better techniques for facilitating information sharing. According to the Strategic Planning Framework, the OBR currently has robust plans for data and information sharing through annual meetings and an OBR-wide repository devoted to storing spatial datasets that come out of collaborative projects (Ottawa Biosphere Region Strategic Planning Framework: Objective 5.2, 2022). Many organizations within the OBR

already take advantage of modern tools available for efficient dissemination of information, such as sharing through online platforms or using web based tools for users. However, there are still large amounts of data that need to be converted into a digital form, so it would be beneficial to seek funding towards digitization efforts. In addition, relevant data sharing is still sometimes conducted via word of mouth and through existing relationships, leaving room for knowledge gaps depending on an organization's established network. For example, we observed many instances of datasets only being available by making a request to their creator, rather than the datasets being publicly available via an online database. While the OBR seeks to strengthen the broader network of organizations in northern Michigan, standardized data-sharing protocols could help identify datasets that are not currently accessible and establish a broad knowledge baseline that is crucial for collective impact.

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Appendices

APPENDIX 1. Codebook organized by theme and sub-theme used in 2022 Ottawaing Biosphere Region interview analysis.

Code #	Theme/"Parent-Code"	Sub-Theme/"Child-Code"	Definition
1.0	Capacity		Organization-specific capacity that's helpful for others to know about how org runs
1.1		Org Structure	Mention of # of personnel, leadership, contact-person or other organizational processes that are helpful to know for collaboration (e.g. an org mentions they do annual reports of their work; an org mentions they work under a certain process to initiate new projects)
1.2		Resources	Funding, equipment, relationships with other partners or lack there-of that concerns an org
2.0	Community		
2.1		Comm Benefits	Mention of advantage to community engagement or why org likes to do this. Can be any, such as benefit to ecosystem monitoring, relationships, scale of project, efficiency, relationships, etc.
2.2		Engagement	Process of engagement with communities, what type of community involvement is in their projects
2.3		Who	Names of orgs, communities, groups they currently engage with locally
2.4		What	Types of community projects org has a collaboration with
3.0	Collaboration		
3.1		Collab Benefits	Mention of advantage to collaboration or why org likes to collaborate. Can be any, such as benefit to ecosystem monitoring, relationships, scale of project, efficiency, relationships, etc.
3.2		Conditions for Success	Advice for good collaboration or an experience when collaboration worked out well
3.3		Obstacles	Social barriers or concerns for collaboration
3.4		Opportunities	Mention of projects or opportunities that interviewee sees would warrant collaboration. Could be a new idea for a project or a current project they want collaborators on
3.5		Who	Names of orgs or individuals interviewee currently collaborates with
3.6		What	Types of projects org has a collaboration with
4.0	Water		
4.1		Groundwater	Mention of groundwater concerns or groundwater projects in org, or lack-there of; advice to make groundwater issues visible

Code #	Theme/"Parent-Code"	Sub-Theme/"Child-Code"	Definition
4.2		Direct Projects	Project that org perceives or has directly stated involves freshwater concerns
4.3		Indirect Projects	Projects that org suggests could influence freshwater, or projects where they're thinking about freshwater but not necessarily directly measuring variables that influence it
4.4		Water Benefits	Values or benefits associated with improving aspects of freshwater
5.0	Data		
5.1		GIS	Mention of the type of GIS information org has used or produced
5.2		Data Management	Storage, organization, or other descriptions of how data is used within org
5.3		Sharing	Mention of why an org shares data, obstacles to sharing, or ways data is shared effectively (e.g. use a data hub to store and share translated ecosystem data)
6.0	Gaps		
6.1		Short-term	Missing or not yet found GIS layers, narratives, or knowledge that would be possible for project team to look into & deliver
6.2		Long-term	Higher level thinking, GIS projects, or other gaps in regional knowledge or data that partners could be thinking about
7.0	GIS Resources		GIS layers, data sets, or other information a partner thinks would be helpful to project team; any resources that might be helpful for OBR partners to know about
8.0	Obtawaing		
8.1		OBR Benefits	Advantages of being part of OBR
8.2		Interaction	Mention of how an org wants to interact with OBR in future, or how they've interacted so far
8.3		Advice for OBR	Any advice for cohesive collaboration across the region
9.0	Interesting/ New Info		Any interesting resources or info new to project team that should be looked into further

APPENDIX 2. List of map layers contained in the Obtawaing Biosphere Region geodatabase, as well as supplemental metadata (description, source, and data type) for each layer.

#	Layer Name	Description	Source
1	<i>Baseflow_OBR</i>	Estimates of groundwater contribution to streams in the OBR	EGLE (GIS Open Data)
2	<i>Baseflow_MI</i>	Estimates of groundwater contribution to streams in Michigan	EGLE (GIS Open Data)
3	<i>Census2020_OBR</i>	2020 Census data for the OBR	U.S. Census Bureau
4	<i>Census_Designated_Places_OBR</i>	Census designated places of the OBR	U.S. Census Bureau
5	<i>CensusTribalLands_MI</i>	Tribal census tracts for Michigan as identified through the 2020 census	TIGER/ U.S. Census Bureau
6	<i>CensusTribalLands_OBR</i>	Tribal census tracts for the OBR as identified through the 2020 census	TIGER/ U.S. Census Bureau
7	<i>Cities_OBR</i>	Cities of the OBR	State of Michigan (GIS Open Data)
8	<i>Counties_OBR</i>	Counties of the OBR	State of Michigan (GIS Open Data)
9	<i>Darcy_MI</i>	Darcy groundwater estimates for Michigan	MI DNR (GIS Open Data)
10	<i>Darcy_OBR</i>	Darcy groundwater estimates for the OBR	MI DNR (GIS Open Data)
11	<i>EcoRegions_MI</i>	EcoRegions of Michigan	EGLE (GIS Open Data)
12	<i>EcoRegions_OBR</i>	EcoRegions of the OBR	EGLE (GIS Open Data)
13	<i>EJ_Screen_MI</i>	Environmental and demographic information for Michigan	U.S. EPA EJ Screen
14	<i>EJ_Screen_OBR</i>	Environmental and demographic information for the OBR	U.S. EPA EJ Screen
15	<i>Estimated_Groundwater_Recharge_MI</i>	Estimated groundwater recharge of Michigan	EGLE (GIS Open Data)
16	<i>Estimated_Groundwater_Recharge_OBR</i>	Estimated groundwater recharge of the OBR	EGLE (GIS Open Data)
17	<i>Glacial_Landsystems_MI</i>	Glacial landsystems of Michigan	EGLE (GIS Open Data)
18	<i>Glacial_Landsystems_OBR</i>	Glacial landsystems of the OBR	EGLE (GIS Open Data)
19	<i>GLCWC_Coastal_Wetlands_MI</i>	Coastal wetlands of Michigan	GLCWC (GLAHF)
20	<i>GLCWC_Coastal_Wetlands_OBR</i>	Coastal wetlands of the OBR	GLCWC (GLAHF)
21	<i>GTRLC_Service_Area</i>	Extent of Grand Traverse Regional Land Conservancy service area	GTRLC
22	<i>GTRLC_Service_Area_OBR</i>	Extent of Grand Traverse Regional Land Conservancy service area within the OBR	GTRLC

#	Layer Name	Description	Source
23	<i>High_Erosion_Risk_MI</i>	High erosion risk zones of Michigan	EGLE (GIS Open Data)
24	<i>High_Erosion_Risk_OBR</i>	High erosion risk zones of the OBR	EGLE (GIS Open Data)
25	<i>Huron_Pines_Service_Area</i>	Extent of Huron Pines service area	Huron Pines
26	<i>Huron_Pines_Service_Area_OBR</i>	Extent of Huron Pines service area within the OBR	Huron Pines
27	<i>Inland_Lakes_MI</i>	Inland lakes of Michigan	State of Michigan (GIS Open Data)
28	<i>Inland_Lakes_OBR</i>	Inland lakes of the OBR	State of Michigan (GIS Open Data)
29	<i>Lake_Superior</i>	Shapefile of the extent of Lake Superior	USGS GLRI
30	<i>Lake_Michigan</i>	Shapefile of the extent of Lake Michigan	USGS GLRI
31	<i>Lake_Huron</i>	Shapefile of the extent of Lake Huron	USGS GLRI
32	<i>Land_Cost_MI</i>	Land cost estimates for Michigan (https://doi.org/10.1073/pnas.2012865117)	Nolte, 2020
33	<i>Land_Cost_OBR</i>	Land cost estimates for the OBR (https://doi.org/10.1073/pnas.2012865117)	Nolte, 2020
34	<i>Land_Cover_MI</i>	Gap Analysis Project (GAP): Land cover types of Michigan	USGS
35	<i>Land_Cover_OBR</i>	Gap Analysis Project (GAP): Land cover types of the OBR	USGS
36	<i>LTBB_Historical_Reservation</i>	Historical Reservation area for the Little Traverse Bay Bands of Odawa Indians	LTBB Odawa
37	<i>Median_Income_OBR</i>	Median income by county for the OBR	U.S. Census Bureau
38	<i>MI_Boundary</i>	Boundary for the State of Michigan	U.S. Census Bureau
39	<i>NHDWaterbody_MI</i>	National Hydrography Dataset: Flow of water through stream networks of Michigan	USGS
40	<i>NHDWaterbody_OBR</i>	National Hydrography Dataset: Flow of water through stream networks of the OBR	USGS
41	<i>NWI_Wetlands_MI</i>	National Wetland Inventory (NWI) Plus 2005's inventory of wetlands for the OBR	EGLE (GIS Open Data)
42	<i>NWI_Wetlands_OBR</i>	National Wetland Inventory (NWI) Plus 2005's inventory of wetlands for the OBR	EGLE (GIS Open Data)
43	<i>OBR_Boundary</i>	OBR boundary shapefile (as of 4/18/2023) based on HUC-12 subwatersheds	SEAS 2022 Team
44	<i>Populated_Places_OBR</i>	Census populated places of the OBR	U.S. Census Bureau
45	<i>Protected_Lands_MI</i>	PAD-US protected lands of Michigan	USGS
46	<i>Protected_Lands_OBR</i>	PAD-US protected lands of the OBR	USGS
47	<i>Regulated_Dams_MI</i>	State of Michigan regulated dams of Michigan	EGLE (GIS Open Data)

#	Layer Name	Description	Source
48	<i>Regulated_Dams_OBR</i>	State of Michigan regulated dams of the OBR	EGLE (GIS Open Data)
49	<i>St.Marys_River</i>	St.Mary's river AOC boundary	U.S. EPA
50	<i>Streams_MI</i>	Assessment Unit Identification (AUID) streams of Michigan	EGLE (GIS Open Data)
51	<i>Streams_OBR</i>	Assessment Unit Identification (AUID) streams of the OBR	EGLE (GIS Open Data)
52	<i>Subwatersheds_MI</i>	Subwatersheds of Michigan	MI DNR
53	<i>Subwatersheds_OBR</i>	Subwatersheds of the OBR	MI DNR
54	<i>TNC_Preserves_OBR</i>	The Nature Conservancy's properties within the OBR	TNC
55	<i>TOMWC_Service_Area</i>	Tip of the Mitt Watershed Council's service area	TOMWC
56	<i>Townships_OBR</i>	Townships of the OBR	State of Michigan (GIS Open Data)
57	<i>Unincorporated_Places_OBR</i>	Unincorporated places of the OBR	State of Michigan (GIS Open Data)
58	<i>Veg_1800s_MI</i>	1800s Vegetation types of Michigan	State of Michigan
59	<i>Veg_1800s_OBR</i>	1800s Vegetation types of the OBR	State of Michigan
60	<i>Villages_OBR</i>	Villages of the OBR	State of Michigan (GIS Open Data)
61	<i>Water_Wells_NMi</i>	Water wells according to EGLE's groundwater database for Northern Michigan	EGLE (GIS Open Data)
62	<i>Water_Wells_OBR</i>	Water wells according to EGLE's groundwater database for the OBR	EGLE (GIS Open Data)
63	<i>Watersheds_MI</i>	Watersheds of Michigan	MI DNR
64	<i>Watersheds_OBR</i>	Watersheds of the OBR	MI DNR



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