Emphasizing Natural Infrastructure, Equity, and Justice in Coastal Resilience Planning and Management Across the Great Lakes

By:
Valerie Blakely, Ashley Jones, Alison Palmer, & Maria C. Ramirez

A project submitted
in partial fulfillment of the requirements
for the degree of Master of Science
(University of Michigan, School for Environment and Sustainability)
April 2023

TABLE OF CONTENTS

TABLES

EXECUTIVE SUMMARY

As climate change increases the intensity of storms along oceanic coasts, the Great Lakes region experiences disruptions of a different nature than their salt-water cousins. On lacustrine coasts, building ecosystem and community resilience to extreme shifts in climate poses a dynamic challenge for land managers and coastal communities alike. Conservation organizations in the Great Lakes region like The Nature Conservancy carry a vested interest in improving coastal resilience- the idea of a coastal area in one state-of-being receiving some impact and being able to return to its original state-of-being in some timescale (often less than a human lifetime). Coastal resilience applies to the physical environment, and this includes the human groups living in communion with coastlines, adding the depth of that social and cultural environment to this concept. Improving coastal resilience in the Great Lakes leads to less destruction of coastal ecosystems critical to the health of the region, and the preservation of ecosystem services that coastal communities enjoy and rely upon, but in this view also strengthens coastal communities' ability to adapt to or recover from change and still meet their needs.

Current inhibitors of coastal resilience include the high historical levels of industrialization and resulting land transformation done in the name of trade and economic prosperity along the Great Lakes coasts and the environmental injustices inflicted upon people living there that diminish human health and restrict access and connection to the surrounding environment. The spreading discussion of "green" and natural infrastructure as alternatives to the hard infrastructure that more heavily degrades ecosystems reflects the growing pressure on humans to create solutions to infrastructure challenges that, among other things, increase or maintain an area's resilience to extreme events rather than reduce it. Establishing more equitable and just conservation practices is a work in progress long over-due, but holistically achieving it involves actions that increase coastal community resilience such as supporting communities in rebuilding lost connection with and generational knowledge of their environment.

Emphasizing natural infrastructure along with equity and justice in future coastal resilience planning can and in fact should take unconventional forms alongside reducing pavement surface area and cleaning up Areas of Concern. In reaching for these emphases, the sheer variety in community values and needs across the Great Lakes coasts necessitates taking insight from a variety of coastal communities and highlights the importance of planning that uplifts community voices that are already aware of the specifics of their area. This report details the results of research, observations, and interviews in varied coastal communities that identify ways to incorporate natural infrastructure and equity and justice to improve coastal resilience planning and management.

There are many competing interests in the realm of coastal resilience planning and a lack of consistent standards regarding management. Setting clear measurable goals and having metrics that track progress towards these goals assists decision making in

this challenging environment. Recording and using data for social, cultural, economic, and environmental metrics reflects a wider range of coastal resilience traits that decision makers can consider.

Throughout United States history, the perspectives of marginalized communities; including people of color, Indigenous people, and other minority communities, have been largely disregarded, particularly within the conservation and environmental movements. It is important to give credit, acknowledge, and support displaced communities that have not received the proper space and resources to live in a clean environment where their cultural practices are allowed to exist and thrive. Four broad ideas were synthesized from a literature review and interviews to succinctly conceptualize equitable conservation:

1. Equitable distribution of benefits
2. Equitable distribution of harms
3. Meaningful inclusion of all perspectives
4. Importance of holistic background research.

Ultimately, equitable conservation should seek to undo or break generational racism and displacement through a shift of conservation ideology and practice.

Three outstanding themes that impact coastal resilience planning in regard to natural infrastructure equity and justice include:

1. **Factors impacting success of projects include conflicting interests and current governmental funding mechanisms** that seldom can guarantee long-term funding and do not successfully direct most coastal-resilience-related funding toward municipality-level actors despite them doing most of the implementation.
2. **Structural inequity created by historical patterns of racism and economic development still shapes and impacts coastal cities** in their construction, in the people living there experiencing the fallout of past injustice, and in the amount of degraded infrastructure left behind in marginalized communities that can compound the effects of climate-based disasters.
3. **Educational opportunities and local news are important to community knowledge and awareness of problems and opportunities with a communities coast** and natural environment, providing the foundation for community support of coastal resilience projects. We found many instances of lack of local environmental awareness and trusted information sources hindering success of projects related to community access to the environment and natural infrastructure, despite present knowledge of natural infrastructure in the community.

Synthesizing observations between multiple cities, a gradient of evolving excitement and support for natural infrastructure projects between cities previously dominated by manufacturing industries emerged that has implications for which types of projects may best serve communities and see strong support in similar cities. Noting the negative historical impact of conservation work on marginalized communities, to incorporate equity and justice into coastal resilience requires each conservation organization to

conceptualize what equitable conservation means, in context of their mission, and how their work affects the health and livelihood of communities that are at a disadvantage. Master plans are a valuable source of community values and goals (though certainly not all-encompassing) and can also provide the foundation for local implementation of natural infrastructure projects and other coastal resilience measures. The level of engagement and communication between the community and governing bodies often determines what values, goals, and priorities are included in the Master Plan.

This report's final recommendations are as follows:

- **Build relationships with and support local entities in conservation, educational, and funding opportunities.**
- **Prioritize locations for implementing natural infrastructure** that:
    - Have strategic benefits for resilience to storms and flooding.
    - Are accessible to communities who: have been displaced by industry; have historically been segregated; and are of low-income (under the U.S. household average income).
- **Review and support joint work on Master Plans within and across Municipalities.**

LAND ACKNOWLEDGMENT

“University of Michigan occupies the ancestral, traditional and contemporary lands of the Anishinaabeg – Three Fires Confederacy of Ojibwe, Odawa and Potawatomi peoples. In particular, the university resides on land ceded in the 1819 Treaty of Saginaw. We recognize Michigan’s 12 federally recognized Native Nations, historic Indigenous communities in Michigan, Indigenous individuals and communities who live here now, and those who were forcibly removed from their homelands. In offering this land acknowledgement, we affirm Indigenous sovereignty, history and experiences.”

-Words by MSU

ACKNOWLEDGMENTS

This project would not have been made possible without the support and guidance of our project advisor, Dr. Paul Seelbach. Thank you for sharing your valuable insights, experiences, energy, and time with us throughout our research process. Also, thank you for pushing us to continue to think outside the box of regular academic writing and share more compelling narratives about the Great Lakes communities.

We would also like to sincerely thank Scott Sowa, the Great Lakes Director in the Lansing, Michigan chapter of The Nature Conservancy, Andrea, Raj, John, Alicia, & Patrick, and their amazing colleagues across all The Nature Conservancy chapters in New York, Chicago, Indiana, Wisconsin, and Ohio.

We would like to thank Dr. Richard Norton for all the guidance and advice he provided during this project.

Additionally, we would like to thank the Rackham Graduate School and School for Environment and Sustainability for providing the funding to complete this research.

Finally, a sincere thank you to the many people we met virtually and in person from across the Great Lakes basin throughout this project. Your personal lived experiences and connections to the Great Lakes inspired us to understand the community and how to carefully incorporate both equity and natural infrastructure in coastal resilience planning.

INTRODUCTION

IMPACTS OF INDUSTRIALIZATION IN THE MIDWEST

The North American Midwest entered a period of industrialization and economic growth in the 19th century, spurred by the creation of new shipping routes and railroads that linked the region to other parts of the country, particularly the already industrialized Northeast. The Erie Canal opened in 1825, allowing international shipping routes a path to the interior of the United States; and enabling coal, iron ore, and other raw materials to be transported to burgeoning industries in the Midwest (Ibáñez et al., 2017). As a result, the region accumulated significant wealth during its industrial period, chiefly through agriculture and manufacturing. Since this initial period of industrialization, efforts to increase use of the Great Lakes for shipping and commerce have continued and have often altered riverways or hardened coastlines. For example, during the 1950s, the Canadian and United States governments built the St. Lawrence Seaway, which involved: widening the St. Lawrence River, installing locking mechanisms to account for elevation differences, dredging sediment, and building canals to create a connected regional shipping lane (Egan, 2017). Ports and associated hard infrastructure offered protection from the lakes; and enabled the loading and offloading of cargo to support shipping, logging, and other industries (Ibáñez et al., 2017). The St. Lawrence Seaway aided the beyond-region movement of iron ore, coal, limestone, grain, cement, salt and stone aggregates, and other materials produced by industries in the area (United States Department of Transportation, 2020). The Seaway remains an integral part of the trade system in the U.S. and Canada, and upgrades continue.[1]

Today the Midwest region is colloquially referred to as the Rust Belt, which refers to the impacts of deindustrialization: economic decline, population loss, and urban decay. This deindustrialization resulted from various factors, but primarily the linked decline of the automotive and steel industries in the mid-twentieth century (Ibáñez et al., 2017). Many extractive industries that once thrived are struggling to survive, raw materials are sourced from cheaper distributors, and manufacturing facilities have moved to other countries (Green, 2020). About 75% of the baseline wetland areas in heavily settled Great Lakes areas have been lost, and remaining wetlands are degraded by urbanization and declining water quality (Jude and Pappas, 1992). What has been left behind in America's former industrial heartland are: 1) social issues such as poverty and lasting impacts of segregation; and 2) environmental issues such as air and water pollution, soil contamination, and degraded or destroyed wetlands.

Degradation of the natural environment typically intensifies social stressors, perpetuating the issues associated with the Rust Belt era. This link between coastal ecosystem degradation and social stressors has been documented for long-developed European coasts, where issues such as: development too close to shorelines, habitat

[1] According to MLive Media Group, the Detroit District of the U.S. Army Corps of Engineers awarded a 1 billion dollar contract to an Ohio-based company in July of 2022 to build a new chamber at the Soo Locks on St. Marys River.

destruction, loss of biodiversity, and contamination of soil and water resources have led to or compounded societal issues such as: unemployment and social instability, increased competition for resources, and destruction of cultural heritage (Commission of the European Communities, 2000). Thus, interventions that can address both ecological and social factors in coastal communities are needed to achieve positive outcomes.

HARD INFRASTRUCTURE, CRITICAL NEARSHORE ECOSYSTEMS, AND THE POTENTIAL BENEFITS OF NATURAL INFRASTRUCTURE

Impacts of Hard Infrastructure

Hard infrastructure is central to the pursuit of building shipping lanes, ports, harbors, and coastal towns and cities - all aimed at harnessing select ecosystem services. Hard infrastructure refers to man-made, built structures; and along coastlines, it takes the form of piers, sea walls, levees, culverts, bulkheads, and other hardened structures (Sutton-Grier et al., 2015). Such infrastructure has dominated approaches to coastal protection and development but can also undermine critical nearshore ecosystems.

Industrialization in the Great Lakes region prioritized harnessing a narrow set of aquatic ecosystem services. During the 1800s, these principally involved maintaining harbor functionality and using nearshore waters for waste assimilation (Pebbles et al., 2013). In seeking to maximize these select services, people transformed large swaths of Great Lakes coastlines during the 19th and 20th centuries, and in many cases, impaired vital but (at that point) undervalued ecosystem services such as fish population production, wildlife production, flora production, water supply, erosion and sedimentation, water quality, cultural services, and supporting services (Pebbles et al., 2013). These ecosystem services provide numerous benefits to humans, and their degradation can lead to declines in human well-being (Commission of the European Communities, 2000). As a result, nearshore and coastal ecosystems (and their embedded human communities) need management that prioritizes the restoration of this broader set of ecosystem services.

Critical Nearshore Ecosystems

Three coastal ecosystem types in the Great Lakes region are particularly vulnerable to impairment by hard infrastructure engineering: rivermouth deltas and estuaries, lowland glacial lake plains and their rivermouth floodplain wetlands (where dikes and levees support agriculture), and sandy bluff and dune systems.

Rivermouths and Associated Wetlands. — In the Great Lakes and around the world, rivermouths are a focal point of human interaction with coastlines (Larson et al., 2013). Estuaries that occur at rivermouths provide highly valued ecosystem services, including: safe harbor, access to drinking water, a sink for waste products, recreation, and aesthetics (Pebbles et al., 2013). These factors have drawn humans to build settlements near them for thousands of years. Rivermouths are depositional zones for

sediments and as such, are home to deltaic wetlands. As a result, they require continual dredging to support ports and shipping. These rivermouths play a critical role in larger ecosystem functioning, but human infrastructure alters their natural hydro-geomorphic processes and associated habitats. For example, many fish species in the Great Lakes use both upstream and rivermouth habitats during their life cycles (Jude & Pappas, 1992; Larson et al., 2013), and rivermouths affect the nearshore temperature and quality of water as well as nutrient cycling between water and local soils (Morrice et al., 2004; Steinman et al., 2009; Howell et al., 2012; Larson et al., 2013). Additionally, rivermouths are critical mixing and processing zones for river and lake waters because their deltaic wetlands slow down the flow of river water to the lake and enhance the ability for processing of nutrients within the estuary. When dredging occurs, this processing is minimized and materials from the watershed flow straight into the lake.

Lakeplains and their Rivermouth Floodplains. — Rivermouth floodplains of the Great Lakes Basin encompass areas of high biodiversity and their wetlands are crucial to slowing and managing high water volumes. Wetlands serve as wildlife nursery areas and important habitat for many bird species, including migratory birds (McKinney et al., 2011). Additionally, their high productivity of invertebrate prey is vital to the growth of juvenile and adult fish (Uzarski et al., 2005). Wetland diversity "strengthens the ability of systems to resist disease and disturbance, which is particularly important in the face of climate change and other stressors on riparian systems" (Mace et al., 2005, United States Forest Service, 2017). Additionally, wetlands serve as carbon sinks: they sequester and store large amounts of carbon from the atmosphere in their soils (Mitsch et al. 2015).

Where rivermouths occur within glacial lake plain landscapes, associated floodplain wetlands were once extensive. These landscapes were once glacial-lake bottoms and now are broad, flat plains composed of silt and clay lithology. These plains are ideal for agriculture, but especially prone to seasonal and storm-driven flooding. The way floodwaters move through floodplains near and at their river mouths is notable in two ways: (1) The river's natural floodplain partially accepts flood waters and slows them down; and again, these riverine floodplains were naturally vast across the lakeplain landscape. And (2), main channel flood flows are often still high and strong enough that when they reach the river mouth—the lake proper water elevation—they are forced to back up and take the path of least resistance: namely, by spilling out onto the empty surrounding low-elevation land; this occurs when lake levels are high due to decadal swings or seiche action. Such low-lying floodplains and estuarine wetlands are influenced by a combination of riverine and lake dynamics.

These ecosystems, including their river mouths, sustain water and nutrient cycling - as well as the biodiversity of Great Lakes' coastlines as a whole. Nevertheless, these same areas are attractive for development during low flows and lake levels, and when flooding can be at least partially controlled (e.g., by diking), due to the host of ecosystem services they offer. When such areas are developed, (1) people and structures are at risk from peak event flooding, and (2) the floodplain's functionality is greatly impaired.

Dunes and Beaches. — Dunes and beaches in the Great Lakes provide essential and highly valued ecosystem services. They are widely valued for their significant aesthetic and recreational benefits, attracting millions of visitors from all over the country each year and driving seasonal, local economies. For example, the State of Michigan alone has over 600 public beaches, and Song et al. (2010) found that closing an individual beach site on Lake Michigan for a season would result in a loss of revenue between $360 K and $24 M, and closing all beach sites on Lake Michigan would result in a loss as high as $2.7 B.[2] Dunes and beaches also provide distinctive wildlife and vegetative habitats; and are both shaped by, and enablers of, essential coastal geomorphic processes of erosion, transport, and deposition of sediment along shorelines. Beaches are not static but rather continuously formed through the progression among these three processes as sand is eroded from dunes and bluffs, transported parallel to the shoreline, and deposited at an adjacent beach over a long timescale. Beaches are thus depositional zones within dynamic, larger-scale shoreline processes (Fisher & Hansen, 2014). When jetties, sea-walls, or other infrastructure block this cycling—and especially when lake levels are high in their decadal cycling—the "seiche"[3] of the Great Lakes erodes the blocked-off beach entirely and begins to eat away at the adjacent dunes on the now receding shoreline bereft of its usual replacement sediment (Mangor et al., 2017). These dunes and bluffs support habitats and biota that thrive amongst natural erosion and deposition dynamics, and serve as a protective buffer for wind and high lake levels for areas further inland. These coastal ecosystems all rely on similarly interconnected natural systems to maintain themselves.

The Promise of Natural Infrastructure

The concept of "natural infrastructure" offers a promising approach to bolster and sustain these coastal ecosystems and habitats, while also providing typical functions of hard infrastructure to protect and support human communities. In aquatic environments (freshwater and marine), this can include: wetlands, dunes, barrier islands, seagrasses, coral and oyster reefs, and mangroves; these all help reduce the risk of coastal flooding and erosion and provide protection from extreme events (Sutton-Grier et al., 2015). In the Great Lakes region, important coastal natural infrastructures include: wetlands, barrier islands, rock reefs, and dunes. Natural infrastructure elements can also occur higher in the watershed, and include: rain gardens, bioswales, re-naturalized river channels, two-stage ditches, groundwater recharge basins, and buffer zones between working land and water bodies. In the face of increased intensity and variability of weather patterns (such as drought and flooding) due to climate change, natural infrastructure can simultaneously protect coastal communities and benefit ecosystems, thus increasing the resilience of both.

Natural infrastructure can provide a range of social, economic, and environmental benefits. Co-benefits of natural infrastructure include: water purification, carbon

[2] While not stated explicitly, this loss is assumed to refer to both local economies and state revenue.

[3] "Seiche" refers to the regular pseudo-tidal sloshing of waves caused by strong winds or rapid changes in atmospheric pressure.

sequestration, habitat restoration, fishery revitalization, and recreational use (Sutton-Grier et al., 2015). Many natural infrastructure features decrease or prevent flooding through water retention. Restoring natural ecosystems and increasing communities' access to them benefits society by making a broad range of coastal and rivermouth ecosystem services functional and available for use. Natural infrastructure projects can also importantly increase access to coastal recreation opportunities, which have huge seasonal economic value. Increasing access to natural spaces through the implementation of natural infrastructure can also have important equity implications, as access to green space has many benefits[4] but has not been equitably distributed and has tended to disproportionately benefit predominately white and more affluent communities (Wolch et al., 2014).

A WINDOW OF OPPORTUNITY FOR A BLUE ECONOMY

With increasing recognition of benefits of restoring ecosystems and bolstering a broadened set of ecosystem services, there is a shift in the Great Lakes region towards developing a 'blue economy,' which would center sustainability and the protection of aquatic environments (Roy, 2018). This economy will value and support a broader range of ecosystem services compared to the last couple of centuries. The Great Lakes Commission (2021) published an action plan for growing the Great Lakes Blue Economy, which emphasizes the importance of restoring and maintaining water quality, ensuring that basin infrastructure is resilient to changing climate conditions, providing equitable and affordable public access to water resources, and promoting and strengthening community-based leadership.

Natural infrastructure has important co-benefits of: decreasing flood risk through stormwater absorption, increasing access to clean drinking water through water purification, tackling the climate crisis through habitat restoration and carbon sequestration, and advancing environmental justice by making the benefits of natural coastal areas equally available to all. There is a window of opportunity to launch a new blue economy that emphasizes natural infrastructure and equitable access, as billions of federal dollars are being directed towards infrastructure though the US Congressional Infrastructure Investment and Jobs Act, passed in November of 2021. According to the White House, this law will "rebuild America's roads, bridges and rails, expand access to clean drinking water, ensure every American has access to high-speed internet, tackle the climate crisis, advance environmental justice, and invest in communities that have too often been left behind" (Infrastructure Investment and Jobs Act, 2021). In light of the broad benefits of natural infrastructure, it is important that federal infrastructure funds not be solely dedicated to installing hard infrastructure.

The Great Lakes region is becoming recognized as a climate haven and likely will experience an influx in population over the coming decades (Van Berkel et al., 202This

[4] Green space provides health benefits by filtering air, removing pollution, decreasing temperatures, infiltrating storm water, and replenishing groundwater (Wolch et al., 2014). Green space is also associated with stress reduction, improved neighborhood social cohesion, reduced crime, and reduced morbidity in multiple disease categories (Beyer et al., 2014).

influx may increase the pressures on systems of hard infrastructure that are already old or degraded. Therefore, planners must prepare for these increased pressures of population growth and climate change by bolstering the resilience of coastal communities through measures such as natural infrastructure.

EMPHASIZING EQUITY AND SOCIAL JUSTICE WITHIN COASTAL RESILIENCE PROGRAMS

Along with valuing a broad range of ecosystem services and bolstering the use of natural infrastructure, this new age of coastal management must also center issues of equity and justice. It is essential to begin by taking this region's history of colonization into account. During colonization, Indigenous peoples lost land sovereignty through war, genocide, and assimilation (Milwaukee Public Museum, 2022). Additionally, colonization has reshaped ecosystems and land use patterns. Prior to western European approaches of colonization, capitalism, and a global extractive economy; Indigenous peoples managed, cared for, and shaped ecosystems in the Americas for thousands of years (Gilio-Whitaker, 2019). Indigenous management practices included: cultural burning (now widely recognized as vital to many ecosystems), rotating the use of land to avoid over-extraction, recognizing the land and biota as co-beings, methods akin to agroforestry, and managing natural ecosystems holistically - enabling the system as a whole to thrive in perpetuity (Argumedo, 2010; Johnson, 2014; Kimmerer, 2015; Chisholm Hatfield et al., 2018). Colonization interrupted these patterns of interaction between humans and nature, replacing them with often exploitative approaches to interacting with the land, such as: clear-cutting of forests, widespread pesticide use, hardening of shorelines, industrial farming systems, and extraction and burning of resources such as coal and oil. These western-European practices have had widespread impacts on landscapes, biodiversity, and the biosphere. Today in order to achieve equitable and sustainable conservation and coastal planning, it is crucial to re-center Indigenous knowledge of ecosystems, support Indigenous management of lands, and uplift Indigenous perspectives and concerns (Carroll, 2014).

The Great Lakes' history regarding Black and Brown communities continues to impact modern societal structures and patterns. During the region's industrial period many Black people moved to the area for work, recruited to be factory workers in the new industries of the 19th and 20th centuries. This was part of "The Great Migration," which entailed the movement of approximately six million African Americans out of the southern United States between 1910 and 1970, seeking to escape racist policies and discrimination and to find better economic conditions (Tolnay, 2003). Unfortunately, racism and injustice persisted in the Midwest, and Black and Brown populations have been treated unjustly for generations (Porter, 2022). Early "redlining" practices drove unfair patterns in housing locations and quality that persist today; explicitly constraining these communities to lower quality and environmentally dangerous areas (Aaronson et al., 2017). BIPOC communities have been pushed into low-lying areas that are vulnerable to flooding and also near industries that expose them to harmful pollutants and contaminants (Grineski et al., 2014).

More broadly, BIPOC communities have been excluded from Great Lakes recreation opportunities, white-dominated conservation spaces and efforts, and associated improved quality of life (Hughes et al., 2022; Porter, 2022). The Washington State Nature Conservancy has stated its awareness that “conservation is inextricably connected to racial equity and social justice” and that “efforts to conserve nature did and sometimes still do harm people… [which] has led to exclusion, displacement and inequitable benefits” (The Nature Conservancy in Washington, 2023). It is therefore crucial that equity, justice, and BIPOC perspectives become more thoroughly integrated into conservation work.

OUR PROJECT OBJECTIVES

The Nature Conservancy (TNC) aims to create a future where both humans and nature thrive (The Nature Conservancy). To achieve this goal, the Great Lakes chapter of TNC has chosen to emphasize natural infrastructure along with equity and justice in their work on coastal resilience. Our team (4 University of Michigan SEAS Master’s students) partnered with TNC to tackle the following objectives - to:

1. Identify social, cultural, and/or economic metrics that are relevant to coastal resilience assessment and planning, and that resonate with key decision makers;
2. Define “equitable conservation” through the lens of BIPOC conservation leaders in Great Lakes communities; with a specific focus on building local BIPOC leadership who will advance: (A) natural infrastructure, and (B) equity and justice in local coastal resilience assessment and planning;
3. Identify, describe, and map distinct sectors of select coastal communities to highlight and understand vulnerabilities and inequities;
4. Analyze local, state, and federal policies in the Great Lakes region that require or encourage consideration of: (A) natural infrastructure, and (B) equity and justice in coastal resilience assessment and planning;
5. Document and compare governance structures, laws and policies, funding, capacities, and the role of key “anchor” institutions in fostering collaboration across local, state and federal programs (both public and private), towards effective coastal resilience planning and implementation;
6. Develop case studies across a range of small-to-large Great Lakes coastal communities, that illustrate aspects of improved coastal resilience planning through a conservation lens. Make recommendations to TNC regarding increased emphasis on natural infrastructure, along with equity and justice.

Objectives 1, 2, and 3 were central to addressing the equity/justice dimension of the project. With these objectives, we sought to center the knowledge and experiences of BIPOC communities by connecting with and interviewing sustainability leaders in these communities. These interviews informed how we defined equitable conservation and coastal resilience for human communities. Objective 3 deepened our understanding of our locations of interest by mapping the spatial patterns of social structures and conditions.

Objectives 2 and 4 had a dual focus: infrastructure and equity/justice. Through objective 2 we sought to understand and support BIPOC community leaders' perceptions of incorporating equity and justice into coastal resilience work, as well as their thoughts on the potential for natural infrastructure. Objective 4 involved analyzing policies related to both of our main themes of natural infrastructure and equity/justice.

Objective 5 helped us to understand the broader scope of coastal resilience work in the region and expand the impact of TNC's focus on natural infrastructure, with consideration of equity and justice. By documenting governance structures, particularly anchor institutions, we hoped to encourage the collaboration and cohesion between disparate coastal resilience efforts in the Great Lakes.

Objective 6 combined components of many of the first five objectives to create a case study about our communities of interest that include both narrative and visual components. This case study is in our results section and communicates many of our findings in an applied manner, focusing on specific people, places, stories, and patterns. In addition, this case study will deepen TNC's knowledge of the specific regions by communicating the values and perspectives of community members and including relevant policies, governance structures, and maps.

METHODS

OBJECTIVE 1: **Identify social, cultural, and/or economic metrics that are relevant to coastal resilience assessment and planning, and that resonate with key decision-makers.**

To discern metrics, we completed a literature review of papers focused on indicators and metric selection, particularly concerning coastal resilience, equity, and natural infrastructure. We searched online using the University of Michigan online library and Google Scholar, and we managed our citations with Mendeley. We identified an initial list of 83 metrics, and then attributed each metric as being social, cultural, economic, or other; with notes about how it might be measured. We then narrowed the list to 31 by cutting out repetitive or less-relevant metrics and metrics that were not social, cultural, or economic.

Next, we iteratively grouped the 31 metrics into themes in order to narrow them down and reduce redundancy. We created the themes simply by looking for natural groupings in our list of metrics. The 7 themes were: Demographic/Socioeconomic Status; Access to Lake Resources; Great Lakes Literacy and Stewardship; Human Health; Flood Risk and Sewage Overflows; the Natural and Built Environment[5], and Other[6].

We then narrowed our scope to focus on metrics most relevant to municipalities and local planners. We did this because while there are many different actors within the realm of coastal resilience, municipalities are often ultimately the implementers of coastal resilience work. We attributed each metric with information in 4 categories (Liberati et al. 2020):

- Resonance with audiences
- Responsiveness to changes in the system / to the intervention
- Data availability for the indicator
- Realism of acquiring data for the indicator

OBJECTIVE 2: **Define "equitable conservation" through the lens of BIPOC conservation leaders in Great Lakes communities; with a specific focus on *building local BIPOC leadership* who will advance: (A) natural infrastructure, and (B) equity and justice in local coastal resilience assessment and planning.**

To gain a comprehensive understanding of what equitable conservation means in relation to coastal resilience assessment and planning, we reviewed a series of scholarly articles, reports, and essays. Two authors synthesized findings from these readings based on recurring topics and patterns observed. We wrote short descriptors and highlights of each reading into a shared document. We individually discerned key

[5] This theme is broad, but included metrics such as tree canopy cover; impervious surfaces; amount of vacant land; and development in hazardous areas.

[6] This theme was a catch-all for metrics that did not fit into other themes, such as: gentrification; housing; access to health insurance; and stability and growth of economy.

information from each reading, identified emerging themes, and then came together as a pair to compare literature analyses. We identified 17 emergent themes and condensed these to 5 major themes with sub-themes; removing overlap.

We also incorporated findings from our interviews (Objective 3) into the definition, as we asked interviewees precisely what equitable conservation means to them. We compared interviewee responses with relevant literature to look for commonality or unique elements. The interviewees were community leaders, environmental advocates, activists, and government officials with different ecological knowledge and experience levels (N=29 interviewees from 5 diverse Great Lakes communities). Respondents answered our question based on their background knowledge and experience on what equitable conservation and practices mean to them.

We crafted a discussion of the concept of "equitable conservation", covering: (1) Why equitable conservation is essential and why it should be conceptualized rather than defined; (2) Synthesis of highlights from the literature and how these relate to views of our interviewees; and (3) Themes essential to the conceptualization of equitable conservation and our conceptualization.

OBJECTIVE 3 (A): ***Document and compare*** **social structures and human well-being within coastal communities to help identify, describe, and map distinct sectors of select coastal communities, to highlight and understand vulnerabilities and inequities.**

We accomplished this objective in two stages, first through visiting, interviewing, and observing five representative Great Lakes coastal communities; and second by spatially mapping population demographics and environmental risk factors.

Interview Methodology

Site selection.— We used the following criteria to select five case study locations:

1. The set of locations represented as many Great Lakes coastlines as possible; the set represented a range of population sizes, including both large urban and smaller rural populations;
2. The set included places whose population is predominantly Black or other racialized minorities;
3. The set included places with substantial populations of Indigenous people;
4. The set represented communities with a range of racial diversities, from diverse to largely homogenous;
5. This set included communities with large populations of LGBTQ+ people;
6. The set represented places with and without economic diversity;
7. The set included places with varied degrees of urbanization and;
8. It was possible to coordinate travel to all locations from Ann Arbor, Michigan within our project logistical constraints.

We chose five locations: Gary, Indiana; Saugatuck, Michigan; Toledo, Ohio; Bayfield,

Wisconsin; and Milwaukee, Wisconsin (listed in no particular order). Of the three locations on Lake Michigan, we chose Gary due to its hardened industrial shorelines, historical relationship with US Steel as a central driving economic force, and a high percentage of communities of color. We chose Saugatuck due to seasonal tourism being its main economic driver, its cyclical population pattern as a crowded summer tourist destination with a small permanent community, and its reputation as an LGBTQ+-friendly town with a high percentage of LGBTQ+ people and LGBTQ+-owned businesses. We chose Milwaukee because of its large size, relatively prosperous economy, and relatively diverse population. We chose Bayfield because of nearby Potowatomi bands and their presence in and influence on the population, Bayfield's seasonal tourism economy, and its position on Lake Superior. Finally, we chose Toledo because of its placement on Lake Erie, its history as a crucial trading hub involved in a mix of industries, and its diverse population.

Interviewee selection.— In searching for people to interview, we wanted to capture stories and perspectives from both people in governmental positions who make decisions for a community and those impacted by these decisions without a direct hand in making them. We investigated each location's local Mayor's office and city environmental and commerce departments. We also searched for community groups with a social media presence on Instagram[7] and using various Google search terms. The local client contact also provided information on groups active in the area and interested in coastal resilience.

We asked each contact for any additional names or groups that may or may not disagree with their work. We sought access to people somehow tied to the community, but not solely environmentalists. We found historical, environmental, and local journalism groups; and several local and state officials. We determined the final list of interviewees based on who responded to our initial communications, and were willing to meet and be interviewed in the summer of 2022. Though we reached out to them, the two Potowatomi bands near Bayfield were unavailable to interview. The concurrent planning of protest movements related to scheduled oil pipeline construction in the area and the typical workloads of tribal government members likely impacted their capacity to meet. Still, we ultimately received valuable feedback on creating interviews that allow for more overlap between the roles of members of a government and those of a community despite not including tribal perspectives.[8]

Interview Design — We coordinated with our TNC client to discuss the tentative structure of the interview to produce ten rough, broad, draft questions. We revised these questions three times until we got a finalized version that consisted of 1 set of 6 questions for "Community Leaders" and a second set of 9 questions for "Federal, State, and Local Figures" with follow-up questions for each set. The first set was for community members and leaders, and the second set of questions was for government officials. Questions ranged from the relationship and perception people had of their

[7] A popular social media website and phone application owned by Meta, formerly Facebook

[8] Further explored in "Discussion" section

environment and coast, to what they knew from their local government on coastal resiliency efforts and their plans on improving community well-being. These questions were initially formulated around our six project objectives. We revised our questions four times to improve grammar and phrasing (if one sounded too broad), and to align our questions more with our 6 objectives (Table 1). Our interview design took on a semi-structured design which is a collection of data methods that is usually qualitative and questions are not set to a particular order. We wanted to provide the same thematic/ theoretical framework (which was on coastal-related issues, experiences, and their relationship with the environment) but at the same time allowing space to explore various facets of the research questions for people we were interviewing.

Interview Questions for "Community Leaders"	Ob. 1: Identify metrics	Ob. 2: Define equitable conservation	Ob. 3: Document & compare social structures & human well-being	Ob. 4: Analyze local, state, & federal policies	Ob. 5: Document & compare governance structures & policies
1. Tell me about yourself. Tell me about your organization. Tell me about your connection to Lake ____					
2. What are the biggest challenges that your community faces these days? Are there any challenges particularly related to the coast?					
3. Do you have a vision for the future of your local coastal area? What do you think good access to the coast, its resources, & the benefits of coastal ecosystem services looks like?					
4. What types of infrastructure are in your coastal area? Is there anything that is distinctive or uniquely important here?					
5. Do you see equity & conservation as relevant to one another?					
6. What are we missing? What else would you like to share?					
(2nd set of questions): Interview Questions for "Federal, State, & Local Figures"					

1. Tell us about your position How does your position relate to the coast/ Lake _Michigan____?					
2.What is challenging about working on (relevant tier)"state-wide" coastal management?					
3. Where is coastal health in your duties and priorities?					
4. What value does the coast provide to your community? (Economically, environmentally, socially, etc.) How valuable is the coast to your community?					
5. Do you have a vision for the future of your local coastal area? What do you think good access to the Lake & its benefits looks like?					
6. Have you seen some communities impacted in different ways by - {(pick 2) storms, natural events/processes like erosion, pollution, management decisions…}					
7. What types of infrastructure (or other approaches?) are top priority in approaching coastal management & coastal resilience?					
8. Do you plan to utilize funds from the new Infrastructure bill?					
9. Anything we missed?					

Table 1. Objectives addressed by each Interview Question. Any questions with no corresponding green boxes beside them are not applicable to a specific objective.

We gained an "exemption" through the Institutional Review Board, ensuring that our questions and project plan were within ethical procedures such as not studying the interview subjects themselves but rather seeking information from them on our topic of study. The process also ensures that questions are not emotionally triggering, biased, or offensive in any way.

Interview Process. — To confirm our interviewees' willingness to participate and establish trust, we offered a 10-30 minute video conversation before each interview. The goals of this conversation were for all parties to introduce themselves, for us to explain the project and answer questions, to confirm the interviewee's willing participation, and to schedule the interview itself. We did not schedule interviews via our introductory email exchange. Most but not all interviews were prefaced in this way, with

some persons declining to be interviewed and others being willing to immediately begin the interview. Of the 31 interviews offered, 29 interviews were accepted by interviewees[9]. The initial conversations and all virtual interviews took place online through Zoom Meetings[10].

Depending on the interviewee's availability and the travel timing, each interview was held either in person or over a video call. We recorded all interviews over Zoom or with our various mobile phones' audio recording software. After our interview analysis took place, all interview recordings were archived in written form on our team Google drive. Our interviews took place in various settings, from office buildings to nature centers to restaurant patios. We asked each interviewee for their consent to be recorded before beginning the interview questions. We then worked through our series of focal questions for every interviewee, asking follow-up questions depending on how fully they explored a topic in their response. Before the end of each interview, we stated that we would ask permission before including a direct quote from an interview in the final product of our research.

Interview analysis. — We utilized several approaches to extract themes and conclusions from each interview which aided in crafting compelling case studies. First, we created transcriptions from our zoom and audio recordings using an AI online service, Otter.[11]

Next, we distributed 6-8 interviews to each author to further clean the interviews, as the AI service did not transcribe with 100% accuracy. We wanted to ensure that transcripts captured all words mentioned in each interview recording. We split our interview data analysis into 3 phases of coding. "Coding" is an important part of the analytical process for social science qualitative analysis. Coding allows you to interpret, organize, and structure your observations and interpretations into meaningful themes. The first phase was categorized as "C1" on the interview document. It consisted of anything we thought was valuable and crucial to note, such as a person's understanding of the community. We also noted anything that stood out to us that seemed crucial to our understanding of place and community in this coding phase. We commented in the margins of an interview document for this phase first phase and all other phases onwards. For the second coding phase, we categorized these margin notes as "C2.x.x." This phase consisted of a more centralized focus on 13 parent codes that we developed. The parent codes were inspired by the literature review, our project objectives, and in consulting with other research teams. These provide a more granular level describing the community, its people, and their relationship with the coast and environment. This followed directly from the first coding phase, as anything that we highlighted in the first phase was an item to reevaluate or zoom in the second phase. Under each parent

[9] See Discussion section for reflections from declined interviews or interrupted communications between potential speakers and our team

[10] A virtual meetings software developed by the company Zoom Video Communications. Copyright @2023 Zoom Video Communications, Inc. All rights reserved

[11] An artificial intelligence software developed by the company Otter.ai. Copyright @2023, Otter.ai, Inc. All rights reserved

code, we listed child-codes, which were different ways that the parent code could show up in the interview. For example, “natural infrastructure” (a parent code) could show up in an interview as someone describing implementation of rain gardens (a child code). The third phase was extraction of themes. We reviewed all interview codes and identified patterns that occurred as broader narratives, to understand convergence of ideas and emerging themes from our interviews. We held internal brainstorming sessions to discuss and document each of our findings for phases 1 and 2. We organized these codes and emerging topics into 8 central themes. We finally condensed the themes into 3 overarching themes, based on commonalities and relationships.

Structured Observation Methodology

To help with understanding the various features of each location, we conducted a series of structured observations in at least one area of each category at each location, for a minimum of 3 observations in each location. Our categories were: coastal area, metropolitan area, and neighborhood area. Observations were structured by a list of questions selected to address our six objectives and aspects not represented by the interview questions, such as road conditions, the presence of parklands, and community makeup. Our question set was reviewed and edited in collaboration with the TNC client to ensure we captured desired aspects of each location.

We conducted field observations in teams of one to two authors. Observations were taken both in transit, as we drove around the target area, and at stationary locations like a park, beach, or another fixed point. We recorded observations on a paper worksheet that included: the observation questions, observer name, location, date, time, weather conditions, and the categorization of the area. We then transcribed observations from all locations into a spreadsheet for ease of analysis.

OBJECTIVE 3 (B): **Document and compare social structures and human well-being within coastal communities to help identify, describe, and *map distinct sectors* of select coastal communities, to highlight and understand vulnerabilities and inequities.**

Mapping Methodology

We developed a set of questions to guide our mapping explorations, which sought to investigate the spatial distribution of vulnerabilities and inequities in the communities. We were particularly interested in mapping coastal resilience and infrastructure as they relate to social vulnerability and inequity (the central project topics). The questions were:

- How do factors related to risk and justice overlay in our areas of interest?
- What are the implications for, and connections to, coastal resilience?
- Where is hard infrastructure in use?
- Where is natural infrastructure in use?

- What areas have historically been redlined?[12]
- Where do/did toxic industries exist?
- Where is flood risk? How does that overlay with demographics?
- Who has access to coasts and public/protected land?

Software and Georeferencing.— We used ArcGIS Pro 3.0.3 to organize, compile, and analyze each dataset of interest. All maps were georeferenced and displayed as NAD 1983 UTM Zones 15N, 16N, and 17N.

Analysis of Flood Risk and Social Vulnerability.— Tate et al. (2021) used the spatial analysis approach - Bivariate Local Indicators of Spatial Association - to map hotspots where high flood exposure and high social vulnerability converge, and to identify dominant indicators of social vulnerability within these places. To carry out a similar analysis, we downloaded Census Tract Boundaries from the Census website, the 2018 CDC Social Vulnerability Index (SVI) layer (from ESRI Living Atlas), and FEMA Flood Hazard Areas (2021, ESRI Living Atlas). We decided to use only the socioeconomic sub theme from the CDC SVI layer to reduce the number of factors included in a given area's vulnerability ranking.

We selected relevant census tracts for each of the 5 locations, then used those tracts to clip[13] the SVI data. We then reprojected the SVI data from their WGS 1984 Web Mercator projection to UTM zones 15N, 16N, or 17N (depending on the location). We then used those layers to clip the flood data (after applying the new projection).

We joined SVI data and FEMA flood risk data into one layer (using the FIPS code column). We decided to develop a visualization of areas where social vulnerability and flood risk were both high. We created a new column and calculated the percent of each tract with high flood risk. We then multiplied this percentage by percentages in the SVI, such as percent minority or percent poverty. Thus, each tract received a score ranging from 0% to 100%; the highest scores corresponded to the tracts with the highest social vulnerability and flood risk.

This analysis was completed for Gary, Toledo, and Milwaukee, but not for Saugatuck or Bayfield due to a lack of data availability.

OBJECTIVE 4: **Analyze local, state, and federal policies in the Great Lakes region that require or encourage consideration of (1) natural infrastructure and (2) equity and justice in coastal resilience assessment and planning.**

[12] Redlining here refers to the discriminatory practice of refusing loans to credit worthy applicants based on their race. This involved ranking neighborhoods based on socioeconomic characteristics. These rankings have had the effect of causing a decline in home ownership, house values, and credit scores in low ranked areas (Aaronson et al., 2017).

[13] This process of clipping refers to using the bounds of one map to "cut out" a section from another map, resulting in two maps of different sets of data that cover the exact same area.

Through a literature review and a subsequent conversation with a professor from the University of Michigan, we decided that the policy review objective needed to be narrowed in scope. The governmental structure in the Great Lakes Region is large and complex. The area is under the control of several governing bodies at all levels ranging from as large as international entities to as small as townships, with decision making abilities existing on every level. This results in significant complexities within the policy framework, making a complete Policy Review more arduous than this project could accommodate. Our scope was then narrowed to focus on the municipal Master Plan for each location, under the assumption that the municipal Master Plan would be representative of the future goals for the city.

We reviewed the existing municipal Master Plan for each study location. We looked for the presence of: coastal resilience planning, natural infrastructure, and green infrastructure; and mentions of equity in each plan. We assessed the degree to which coastal resilience and natural infrastructure were priorities for each location. We likewise assessed whether equity was an immediate goal.

OBJECTIVE 5: **Document and compare governance structures, laws and policies, funding, capacities, and the role of key "anchor" institutions in fostering collaboration across local, state and federal programs (both public and private), towards effective coastal resilience planning and implementation.**

Due to a similar discovery of the complexities of the governance structures in the Great Lakes region, the scope of our governance structure analysis was narrowed to focusing on identifying local anchor institutions who would have a mostly local impact as the higher levels of governance structures get more complex than this project could accommodate.

We utilized two approaches to evaluate the governance structures of each study location. Within our interviews we took note of governance organizations mentioned and then did follow-up research to establish their positions and roles in local governance. Secondly, we examined local government websites and Google searches to identify key groups and their roles in local governance.

OBJECTIVE 6:**Develop case studies for small to large Great Lakes coastal communities, to inform and influence coastal resilience planning. Make recommendations to TNC.**

Our case study was framed around three themes and their sub themes as they appeared in our five study locations. Our three broad themes are: Competing Interests and Ineffective Funding Structures; Structural Inequity; and Education and Awareness. These themes and subthemes were created by synthesizing parent codes and child codes from our interviews, and from our work on Great Lakes coastal metrics, our conceptualization of equitable conservation, and our investigations of policy and governance. As a team, we brainstormed ways to bring all of these concepts and

research into 3 broad themes that would encapsulate some of the most important narratives we observed in our study sites.[14] In writing about each location, we addressed 2-3 of our broad themes

In congruence with our data analysis of interviews, we came up with four findings from our study locations that discuss observations, equitable conservation, and the importance of master plans. We created and based three recommendations on our four findings and an emphasis on incorporating more equity and natural infrastructure in coastal planning.

[14] Discussed in detail under “Results: Case Reviews”

RESULTS

Metrics for Coastal Resilience

Introduction

There are many competing interests in the realm of coastal resilience and management, and a lack of consistent governance around the questions of: what to avoid? what to protect? how to accommodate?, and where and how to do managed retreat? Setting specific goals, such as to never develop in high risk areas, is important. The absence of clear goals impairs decision making. Metrics are required for tracking progress towards goals.

We explored metrics relevant to local and municipal coastal resilience assessment, planning, and implementation (with an eye towards natural infrastructure and equity). We defined our audience as practitioners engaged with coastal resilience, natural infrastructure, conservation, or equity and justice in Great Lakes coastal communities. The system of interest was defined as socio-ecological systems of coastal communities along the Great Lakes, consisting of bio-geo-physical components, and associated social actors and institutions. The Organization for Economic Co-operation and Development defines an indicator as “a quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect changes connected to an intervention, or to help assess the performance of a development actor.” Generally, metrics are defined as a composite measure based on two or more indicators. Many of our ‘metrics’ may thus be more accurately defined as indicators, but for simplicity we are referring to everything in the section as a metric.

Our selection of metrics reflects that coastal resilience may be best achieved through a marriage of bottom-up and top-down approaches. We emphasized the role of municipalities because, although they are not always the drivers, they are typically the implementers of coastal resilience work. To clarify how we defined social versus cultural metrics: social referred to an individual scale, whereas cultural referred to broader systems and the ways they reflect cultural values. Social and cultural dimensions play an important role in coastal resilience because coastal resilience includes the resilience of not only the natural environment but also linked human communities. Social and cultural factors shape a community’s ability to effectively manage its coastal areas and to respond to risks and disaster events. Additionally, improved coastal resilience benefits the community by decreasing risk. Finally, community buy-in is important to the success of efforts that contribute to coastal resilience such as pollution cleanup, policy enactment, land protection, funding of natural infrastructure projects, or ecosystem restoration.

List of Metrics:

Social

1. Use of Lake Resources – Park or Beach Visitation
2. Use of Lake Resources – Fishing Engagement and Reliance
3. Presence of Local Community Members Who Champion Coastal Resilience Work
4. Community Perception of the Coast

Cultural

5. Number of Programs or Institutions Related to Great Lakes Education and Stewardship
6. Coastal Resilience in Municipalities' Master Plans
7. Percent of Shoreline that is Hardened
8. Percent of the Shoreline that is Protected Public Land
9. Percent Landcover in a Municipality That is Impervious
10. Development in Hazardous Areas

Economic

11. Population Socioeconomic Composition
12. Real Estate Value

Health or Environmental

13. Hospital Data on Community Wellness
14. Number of Flooding Events or Sewage Overflow Events
15. Nearshore Sediment Processes - Erosion, Transport, Deposition

Social Metrics

1. Use of Lake Resources – Park/Beach Visitation

A community's or region's use of lake resources, is useful in assessing how much access a community has to the lake as well as how they value and steward it. Overuse or underuse could be cause for concern: overuse might lead to degradation, while underuse may reflect lack of access; lack of fishable, drinkable, and swimmable water; or lack of emotional connection with the lake. Higher rates of visitation to parks and beaches may be associated with higher rates of stewardship or care for the lake and local natural resources. Park or beach visitation may be correlated with overall rates of recreation on the lake; Garcia et al. (2021) used recreation as a social indicator to assess the value that Great Lakes communities attribute to local water resources and ecosystem services.

Resonance with audiences	Use of lake resources came up in all 29 interviews. Frequently mentioned uses of the lakes/coastlines include fishing, swimming, boating, drinking water, sailing, paddling, and recreation.
Responsiveness to changes in the system	This metric could be responsive to interventions that target public access, equitable access, and education. It might also be responsive to interventions that focus more specifically on

	ecosystem restoration (which may involve implementation of natural infrastructure) because people may be more inclined to visit areas that have well functioning ecosystems.
Data availability for the indicator	This metric may be measured through park or beach visitation. It could also be measured through marina usage or user fees.
Realism of acquiring data for the indicator	Data sources vary with location. Municipalities would likely have access to these data for their area if it is being collected.

Table 2. Park/Beach Visitation Metric Evaluation

2. Use of Lake Resources – Fishing Engagement and Reliance

Similar to park or beach visitation, fishing engagement is a measure of how involved the community is with the coast and lake. More engagement would likely lead to more care, concern, and connection. NOAA uses four fishing engagement indicators in their “Social Indicators for Coastal Communities”: commercial fishing engagement, commercial fishing reliance, recreational fishing engagement, and recreational fishing reliance. According to NOAA, fishing engagement and reliance indices are “used in NEPA (National Environmental Policy Act) and MSA (Metropolitan Statistical Area) assessments and to address environmental justice as required by Executive Order 12898" (NOAA Fisheries 2021). Additionally, NOAA states, "communities dependent upon commercial fishing are far more likely to be poor, have a larger percentage of minority and tribal populations, or have residents with less ‘personal capacity’ to respond to change, e.g., higher unemployment rates or lower educational attainment” (NOAA Fisheries 2021). Thus, fishing engagement is closely linked to social and cultural dimensions of coastal resilience and may be particularly important in tribal contexts.

Resonance with audiences	Fishing was discussed at every location in our interviews.
Responsiveness to changes in the system	Fishing engagement might increase if access was improved or if pollution decreased. Coastal resilience interventions such as wetland creation could lead to increases in fish populations and thus impact fishing engagement.
Data availability for the indicator	Every state in the Great Lakes has a recreational fishing "creel census program" with most effort focused along coastlines. Thus, there are decades of data on recreational fishing. For example, data for Michigan are available here:

	https://www.michigan.gov/dnr/managing-resources/fisheries/creel These data are not available for the Great Lakes, but the National Marine Fisheries Service's social indicator data portal has recreational and commercial fishing engagement data: https://www.st.nmfs.noaa.gov/data-and-tools/social-indicators/ The percentage of all communities in each region classified as medium, medium high, or highly engaged is presented for both recreational and commercial fishing. Expanding this effort to include the Great Lakes could be pursued.
Realism of acquiring data for the indicator	Possible. Sources are readily available.

Table 3. Fishing Engagement and Reliance Metric Evaluation

3. Presence of Local Community Members Who Champion Coastal Resilience Work

The existence of local champions pushing for improved coastal resilience often drives increased awareness, more action, and improved coastal resilience. Champions are emergent leaders who effect transformations within their organizations, communities, or industry sectors; and often have traits such as confidence, enthusiasm and persistence (Taylor et al. 2012). Community members can play a unique and important role alongside professionals in driving change, and can promote social learning and diffusion of practices among their personal and professional networks (Lindsay et al. 2019). Municipalities or conservation organizations should partner with these actors to maximize synergies and bolster their work. Working with local champions on coastal resilience initiatives can help these processes become more adaptive, participatory, and successful.

Resonance with audiences	Interviewees often referenced people in their communities who are leaders in the coastal and environmental realms.
Responsiveness to changes in the system	Increased focus on coastal resilience efforts and planning by municipalities may support the work of local champions or inspire new champions and projects.

Data availability for the indicator	There are not (known) datasets for this. Identification of local champions would come from talking to community members and leaders.
Realism of acquiring data for the indicator	Labor intensive but possible.

Table 4. Presence of Local Champions Metric Evaluation

4. Community Perception of the Coast

Community perception of the lake impacts whether people want to visit the lakeshore, the connection they feel to it, the level of care and concern they have for it, and ultimately stewardship action. Improved perception of the lake may lead to more community engagement with coastal resilience efforts. This metric seeks to understand how people view their coastal area across four areas: (1) perception of pollution , (2) accessibility , (3) ecosystem health, and (4) impact of policing on access to the lake.

Resonance with audiences	Perception of the lakes was brought up often in our interviews and varied greatly with location. In Toledo and Gary, people mentioned negative views of the lake due to industry, contamination, and algal blooms; whereas the general perception of the lake was more positive in Saugatuck, Bayfield, and Milwaukee. Residents in Gary and Milwaukee had concerns about the lake being off limits due to police presence.
Responsiveness to changes in the system	Perception of the lake could improve with effective coastal resilience efforts that seek to decrease pollution, improve public access, restore ecosystems, and increase community comfort in coastal areas.
Data availability for the indicator	This could be measured in a number of ways. The most obvious would be through a survey that asks people in the community what their perception of their local coastal areas are. It could also be indirectly measured through park or beach visitation rates, which likely would decrease if people see the area as more polluted, less accessible, etc.
Realism of acquiring data for the indicator	Although there are not ready-to-use datasets for this, acquiring data is realistic. A perception survey carried out every few years would be a practical approach.

Table 5. Community Perception of the Coast Metric Evaluation

Cultural Metrics

5. Number of Programs or Institutions Related to Great Lakes Education and Stewardship

Institutions and programs focused on Great Lakes education and stewardship can play an important role in fostering a culture that values coastal resilience. The assumption is that more programs would lead to more stewardship and awareness within a community, of issues related to coastal resilience, ecosystems, and conservation. Such programs and institutions may also increase community cohesion, as well as increasing connections with the coast and local ecosystems. An example program is Michigan Sea Grant's efforts to improve Great Lakes Literacy, which seek to educate people about the value of the Great Lakes, so they can effectively communicate with others and make informed decisions regarding Great Lakes stewardship and responsible resource use. Alternatively, the number of educational and outreach events that take place in a certain time frame could be used as a metric. Knowing which organizations are doing this work could also help municipalities or other actors support this work and provide the opportunity for fruitful partnerships.

Resonance with audiences	The importance and promise of education was a strong theme in our interviews in every location.
Responsiveness to changes in the system	This could be responsive to interventions that aim to bolster local programs and institutions related to conservation, equity, natural infrastructure, or coastal resilience.
Data availability for the indicator	Lacking. This would likely require municipalities to do their own research in their communities.
Realism of acquiring data for the indicator	Potentially difficult and time consuming but possible.

Table 6. Number of Programs or Institutions Related to Great Lakes Education and Stewardship Metric Evaluation

6. Coastal Resilience in Municipalities' Master Plans

Reference to coastal resilience within municipalities' master plans can indicate the degree to which local governments are considering coastal resilience, prioritizing actions to advance it, or allocating funding to it. Local governments ultimately play the key role in management of and planning for their local coastal areas (Norton 2018). Because implementation of coastal resilience work happens almost solely at the local or county level, if coastal resilience is not mentioned in a coastal municipality's master plan, then it is unlikely that any action toward it is being taken.

Resonance with audiences	Presence of coastal resilience within master plans was not a widespread theme in our interviews.

	However, many people mentioned a lack of awareness by local governments about things like natural infrastructure or impacts of climate change.
Responsiveness to changes in the system	This metric may be responsive to increasing awareness among government staff or the general community of the importance of coastal resilience efforts.
Data availability for the indicator	Municipalities can easily access and review their own master plans.
Realism of acquiring data for the indicator	Realistic.

Table 7. Coastal Resilience in Municipalities' Master Plans Metric Evaluation

7. Percent of Shoreline that is Hardened

Hardened shorelines are extensive and often undermine coastal hydro-geomorphic processes, whereas natural shorelines support ecosystem processes and habitats, while bolstering coastal resilience. Hard infrastructure in the Great Lakes often consists of piers, sea walls, levees, culverts, bulkheads, and other hardened structures (Sutton-Grier et al., 2015). This infrastructure alters natural hydro-geomorphic processes and associated habitats in rivermouths and wetlands, degrading conditions for fish reproduction and growth. Hard infrastructure can also encumber the connectivity and functionality of tributary floodplains, putting people and built structures at risk during flood events. Finally, hardening undermines natural erosion and deposition dynamics, which create beaches, dunes, and bluffs that are important wildlife habitat and recreational areas, and serve as a protective buffer for wind and high lake levels for areas further inland (Fischer 2014).

Coastal ecosystems such as wetlands, lakeplains, and rivermouth floodplains provide a host of services and benefits. Wetlands and floodplains function as carbon sinks as well as sinks for waste products. They also filter water, protect from erosion, and help control flooding. Coastal ecosystems are vital habitat for many migratory birds, and upstream and rivermouth habitats are critical for the life cycles of many fish species in the Great Lakes. Thus, the percent of shoreline that is hardened is an important metric for coastal resilience assessment and planning.

Resonance with audiences	Communities' perceptions of the benefits vs costs of hardened shorelines varied. Gary, Milwaukee, and Toledo have more hardened shoreline than Saugatuck and Bayfield. In Milwaukee, there were positive views on the amount of hardening because it was seen as necessary to manage local flood risk. Interviewees in Toledo and Milwaukee

	mentioned the importance of hardening for their respective ports. In Gary, there were negative perceptions of shoreline hardening and the subsequent lack of natural areas, particularly around the steel mill.
Responsiveness to changes in the system	This could be responsive to interventions that seek to protect or conserve shorelines, or implement natural infrastructure. This metric is not responsive in the short term, but is important, and is potentially responsive in the long term. Conversion from hardened to soft might be rare, but opportunities present themselves when old hard structures are in need of costly repairs or maintenance. New hard infrastructure can be also prevented.
Data availability for the indicator	NOAA's GIS dataset titled, "U.S. Great Lakes Hardened Shorelines Classification 2019," documents all segments of the US Great Lakes shoreline as artificial or natural, along with structure type and condition. It is a vector dataset and includes 35+ different shoreline type codes.
Realism of acquiring data for the indicator	Realistic. The NOAA dataset is open and available for download. Analysis would, however, require GIS skills which could be a barrier for some communities.

Table 8. Percent of Shoreline that is Hardened Metric Evaluation

8. Percent of the Shoreline that is Protected Public Land

The degree of access a community has to protected public land along their local coastline is important to equitable conservation. Protected public land along the coast is accessible at little to no cost and is an important means by which a community accesses and relates to natural spaces. Song et al. (2010) found that people valued longer contiguous stretches of beach over shorter ones. Strategically selecting land to conserve can connect pieces of land that are already protected to maximize total parcel size. Additionally, protected public land is likely to be less developed with few large structures or infrastructure that impede use or ecosystem processes; therefore, the percent of protected public land may be associated with the percent of the coastline that is natural (which has important coastal resilience implications).

Resonance with audiences	The importance of public accessible natural areas was a prominent interview theme. Many noted it as an important draw for them to move to certain areas - particularly in Bayfield and Saugatuck.
Responsiveness to changes in the system	This metric would be directly responsive to interventions that protect land or acquire land for

	protection along the coast, and has implications for coastal resilience.
Data availability for the indicator	Municipalities would have access to this information for their region. A variety of datasets exist that reflect different types of public and protected land in the Great Lakes, but none are all-encompassing. For example, the Michigan Department of Natural Resources has a Conservation and Recreation Lands GIS layer available for use.
Realism of acquiring data for the indicator	Realistic.

Table 9. Percent of Shoreline that is Public Protected Land Metric Evaluation

9. Percent Landcover That is Impervious

The amount of impervious surfaces in a community contributes to flood risk and is inverse to the amount of green space (a form of natural infrastructure). More impervious surfaces increase routing of precipitation to fast, surface runoff, thereby increasing stream stormflows; these can be harmful to humans and ecosystems. A higher proportion of impervious surface is likely correlated with less green space, which has equity implications, e.g., urban heat islands and less access to green space. Heckert and Rosan (2015) included the amount of impervious surfaces as an element in the creation of their Green Equity Index.

Resonance with audiences	Impervious surfaces were a big topic in Milwaukee, and there is some work being done by various Milwaukee organizations to decrease the amount of pavement in the city. This was also mentioned as a high priority by the city of Milwaukee's Environmental Collaboration Office.
Responsiveness to changes in the system	Amount of impervious surfaces may respond to interventions that seek to decrease flood risk by increasing natural landcover. Additionally, in Rest Belt areas where abandoned factories and buildings are being removed, some green spaces are being reclaimed.
Data availability for the indicator	NOAA's "Impervious Surface Analysis Tool" calculates the percentage of impervious surface area within user-selected geographic areas such as watersheds, municipalities, and subdivisions.
Realism of acquiring data for the indicator	Realistic. The NOAA dataset is open and available for download. Analysis would, however, require GIS skills which could be a barrier for some

	communities.

Table 10. Percent Landcover that is Impervious Metric Evaluation

10. Development in Hazardous Areas

Either residential or commercial development in hazardous areas can greatly decrease coastal resilience in multiple ways. Hazardous areas include high flood risk zones and high erosion areas. Land use planning that prevents development in hazardous areas is vital to hazard mitigation in coastal communities (Peacock 2010). Prevention of development in these areas not only reduces damage to man-made structures, but also can preserve sensitive environmental areas that might deliver significant hazard mitigation services. Development in hazardous areas can also hinder natural coastal systems' resilience to climate change impacts, such as: interrupting natural processes (e.g., sediment transport or deposition), reducing available habitat, and impacting ecosystems that act as natural buffers to storms (e.g., wetlands and bluffs). Tracking development in hazardous areas may be important for carrying out managed shoreline retreat - for example, rerouting roads or relocating homes built by rapidly eroding shorelines.

Resonance with audiences	Improper development along coasts and in hazardous areas came up in interviews in Saugatuck, Milwaukee, Toledo, and Gary. Particularly in Saugatuck, improper development is seen as a significant issue because of high political pressure to privatize coastal areas for residential development.
Responsiveness to changes in the system	Interventions to lessen new development in hazardous areas include: (1) coastal resilience policies and planning that regulate this development, (2) increased education about the harms and risks of development in hazardous areas, (3) increased protected areas, and (4) programs for managed shoreline retreat.
Data availability for the indicator	There is no central data source for development in hazardous areas. Municipalities should have data on where development is located in their jurisdiction. The Federal Emergency Management Agency (FEMA) has initiated a coastal analysis and mapping study in the Great Lakes that includes coastal storm surge elevations for the U.S. shoreline of the Great Lakes and will provides estimates of coastal flood hazards.

	(https://www.greatlakescoast.org/great-lakes-coastal-analysis-and-mapping/) Additionally, the US Army Corps of Engineers (USACE) in partnership with FEMA is developing a wind surge risk assessment for the Great Lakes region, which will have mapping products. (https://www.greatlakescoast.org/great-lakes-coastal-analysis-and-mapping/wind-surge-study/) These datasets could be used in conjunction with local data on development.
Realism of acquiring data for the indicator	Not easy, but possible. This would take effort by municipalities to bring together multiple data sources. A lower frequency of monitoring (for example every 5 years) could offset the effort required.

Table 11. Development in Hazardous Areas Metric Evaluation

Economic Metrics

11. Population Socioeconomic Composition

Coastal resilience can impact and be impacted by the socioeconomic conditions of a coastal community. We recommend that population socioeconomic condition be tracked through population composition and percent low income. Population composition includes race, marital status, age, and ability to speak English. Both of these sub-metrics were included in NOAA's "Social Indicators for Coastal Communities" and are social metrics relevant to equity. As established by the The Commission of the European Communities (2000), coastal ecological conditions are closely linked to social conditions. Heckert and Rosan (2015) used percent low income and percent minority as metrics in their creation of a Green Infrastructure Equity Index, which aids planners in more equitably allocating green infrastructure projects to communities most in need. Additionally, the New York Department of State's "Monitoring Natural and Nature Based Shoreline Features" report (2020) identifies indicators to track the performance and benefits of different shoreline treatments. The report states, "with limited resources, the two demographic EJ indicators most relevant to shoreline features are (1) percent low income and (2) percent minority." Ultimately, it is important to include demographic and socioeconomic data in order to track environmental justice outcomes.

Resonance with audiences	Vulnerability of, and disproportionate impacts on, impoverished and marginalized populations came up in interviews at every location.

Responsiveness to changes in the system	These metrics may be indirectly responsive to changes in coastal resilience. Improving socioeconomic conditions will involve much more than coastal resilience efforts, but the two phenomena are related. The Commission of the European Communities (2000) has documented how degradation of the natural environment intensifies social stressors. Interventions that restore ecosystem functionality would improve coastal resilience and alleviate social stressors.
Data availability for the indicator	Census data
Realism of acquiring data for the indicator	Very realistic - census data is reputable and openly available.

Table 12. Population Socioeconomic Composition Metric Evaluation

12. Real Estate Value

Real Estate Value (REV) is related to factors such as gentrification, urban sprawl, and monetary resources; and has implications for coastal resilience. High REV may lead to better structures, better maintenance, and more taxes for municipal programs. On the other hand, it can also be indicative of gentrification and related displacement. If REV is low, this likely indicates poverty, a lack of funding for coastal resilience efforts, and a lack of capacity to recover from disaster events. Thus, it is important to plan for mixed REV along the coast.

NOAA's Social Indicators for Coastal Communities includes the following variables:

- Housing Characteristics - A measure of infrastructure vulnerability to coastal hazards including median rent and mortgage, number of rooms, and presence of mobile homes.
- Housing Disruption - Represents displacement that may occur due to rising home values and rents
- Retiree Migration - Characterizes communities with a higher concentration of retirees and elderly people in the population; including households with inhabitants over 65 years, population receiving social security or retirement income, and workforce participation. A high rank indicates a population more vulnerable to gentrification as retirees seek out the amenities of coastal living.
- Urban Sprawl - Describes areas experiencing gentrification through increasing population density, proximity to urban centers, home values and the cost of living.

Real estate value captures many of the dynamics that these indicators seek to track, and thus may be a good umbrella metric.

Resonance with audiences	Wealth and gentrification along coastlines was a prevalent topic in our interviews for Saugatuck and Milwaukee. The lack of capacity for impoverished communities to recover from events such as flooding was prominent in Gary and Milwaukee.
Responsiveness to changes in the system	Coastal real estate value may respond to policies that reduce gentrification and promote mixed use mixed income neighborhoods a safe distance from the coast. Additionally, if coastal properties are are susceptible to storms and damage then property values may decrease.
Data availability for the indicator	Municipalities likely have access to real estate values, but real estate value datasets are also available through sources such as ESRI Living Atlas, which is free and open source.
Realism of acquiring data for the indicator	Realistic

Table 13. Real Estate Value Metric Evaluation

Environmental and Health Metrics

13. Hospital Data on Community Wellness

Data on community health and exposure to toxins can provide important information about the state of coastal resilience in a region. There is potential to work with hospitals or public health departments to obtain data on community incidence of disease or illness. Hospitals are interested and invested in preventative measures, which may include coastal resilience and natural infrastructure interventions, such as reduction of sewer overflows into waterways or onto beaches. Municipalities or conservation organizations could work with hospitals to track progress in local wellness related to coastal resilience interventions.

There is an important equity component to this pertaining to questions about who is becoming sick and whether some groups are disproportionately exposed and impacted. The question of who is reliant on nearshore fishing and who might lack awareness of or access to information about illness risks and contamination levels is also relevant here. For example, people of lower socioeconomic status may be more likely to fish near the shore if they cannot afford a boat to travel further out on the lake, and nearly all Great Lakes Areas of Concern are in former industrial areas in the littoral zone along the coastline (Minns et al., 1994). This could lead to these populations being exposed to contamination at higher rates. These communities may also lack awareness of contamination levels. In an interview in Saugatuck, an interviewee expressed concern that impoverished communities and migrant communities relied on fishing in the

Kalamazoo river, which is polluted with PCBs from historic paper mill effluents, and community members lacked awareness of the dangers of that contamination.

Resonance with audiences	Concern about illness risks at beaches and contamination in fish were prevalent in interviews. In Milwaukee and Toledo, there was concern about algal blooms and cryptosporidium outbreaks. In Saugatuck, interviewees expressed concern about contaminant levels in fish.
Responsiveness to changes in the system	Natural infrastructure or coastal resilience interventions could have impacts on pollution and ecosystem functioning, and thus human health risks.
Data availability for the indicator	Hospitals have community wellness survey data that relates to their hospital treatment data, and municipalities could work with individual hospitals to obtain this data. The "Recommended Human Health Indicators for Assessment of Progress on the Great Lakes Water Quality Agreement" report suggests using fecal indicator organisms (Brodkin et al., 2014). These may be tracked via National Weather Service Great Lakes Beach Hazards. There is also a survey by the Great Lakes Beach Association and The International Joint Commission (IJC) Health Professional Advisory Board, which seeks to "assess the bi-national extent, experience and effects of Beach Sanitary Surveys (USA)/Environmental Health and Safety Surveys (CANADA) in the Great Lakes." Finally, there is the Michigan Department of Environment, Great Lakes, and Energy (EGLE) runs the BeachGuard System, which is "a public resource that provides information for Michigan beaches including water quality sampling results and beach advisories and closures."
Realism of acquiring data for the indicator	Data are available.

Table 14. Hospital Data on Community Wellness Metric Evaluation

14. Number of Flooding Events or Sewage Overflow Events

The number of flooding and sewage overflow events reflects how local infrastructure is functioning and may be reflective of local management practices and investments. A high frequency of these events may indicate a need for more natural infrastructure or hybridized approaches. Flooding events and sewage overflows can also have significant equity implications, and sewage overflows can have negative impacts on nearshore ecosystems and lead to issues such as eutrophication. In our interviews (in multiple locations) people talked about the disproportionate impacts that different communities faced as a result of both flooding and sewage overflow events. Fewer flooding, and overflow events may lead to less harm to both humans and ecosystems. Hybrid natural and hard infrastructure projects could contribute to fixing these issues, and thus these metrics may be responsive to coastal resilience interventions.

Resonance with audiences	Interviewees in all 5 locations talked about flooding, and sewage overflows were a big topic in Gary, Milwaukee, and Toledo.
Responsiveness to changes in the system	The amount of flooding and sewage overflow events should be responsive to coastal resilience efforts that target infrastructure. The Milwaukee Metropolitan Sewage District decreased the number of sewage overflow events from about 50 per year to about two per year with infrastructure-focused interventions.
Data availability for the indicator	Municipalities should have access to this data
Realism of acquiring data for the indicator	Realistic.

Table 15. Number of Flooding Events or Sewage Overflow Events Metric Evaluation

15. Nearshore Sediment Processes: Erosion, Transport, and Deposition

Erosion, transport, and deposition dynamically occur in littoral cells along the coast, and beaches are continuously formed through these processes as sand is eroded from dunes and bluffs, transported parallel to the shoreline, and deposited at an adjacent beach over a long timescale (Fisher & Hansen, 2014). Coastal resilience requires that humans support rather than undermine this system. Restored coastal wetlands can trap more sediment, and projects that use natural infrastructure can mitigate coastal erosion and wetland vulnerability (Liu et al. 2021). The deposition of sediment along coastlines is essential to building formations like dunes and marshes, which protect coastal communities from storms and changing water levels. An Index of Sediment Budget Alteration would help show how local ecosystem processes are linked between different municipalities.

Resonance with audiences	Interviewees in all 5 locations were concerned about erosion in their local coastal areas.
Responsiveness to changes in the system	Restoration of coastal ecosystems, protection of natural areas, prevention of shoreline hardening, and use of natural infrastructure would bolster natural depositional processes and mitigate erosion.
Data availability for the indicator	There is not a large-scale database that tracks sediment deposition processes and patterns. Michigan's Department of Environment, Great Lakes, and Energy (EGLE) provides maps of high risk erosion areas within the state.
Realism of acquiring data for the indicator	Not currently realistic.

Table 16. Nearshore Sediment Processes: Erosion, Transport, and Deposition Metric Evaluation

Defining Equitable Conservation

Introduction

Throughout United States history, the perspectives of marginalized communities; including people of color, Indigenous people, and other minority communities, have been largely disregarded. This has been particularly true within the conservation and environmental movements. Conservation has historically been carried out for the benefit of privileged white people; to the historic detriment of other communities - particularly Indigenous peoples, who were displaced, and not involving communities of color or low incomes. It is important to give credit, acknowledge, and support displaced or ignored communities that have not received the proper platform, space, or resources to live in a clean environment where their cultural practices are allowed to exist and thrive.

A pluralistic conceptualization of equitable conservation requires inclusion of voices from people with diverse experiences. Therefore, rather than focusing on a definition of equitable conservation that is all-encompassing; we here put forward a broader conceptualization. We will conceptualize what equitable conservation looks like in practice and how it might be achieved; through a combination of literature review, review of findings from our fieldwork (i.e., interviews in our communities of interest), and final synthesis and reflection.

We extracted unique sets of themes from our literature review and our interviews. These themes constitute a list of elements important to keep in mind whenever conservation is being done so that equity can be facilitated and maximized. The themes

are summarized below (Table 17 & 18), followed by a concise conceptualization of equitable conservation, and then our in-depth reports of literature and interviews.

Key Literature Themes

Theme	Summary
Clarify How Equity is Defined and Used	Conservation organizations should thoroughly understand their definition of equity and clarify how this definition translates into practice.
Understand and Respect Partner Communities	Reciprocity, trust, and governance structure and practice contribute to understanding and demonstrating respect for partner communities. Providing space for listening leads to deeper understanding of communities and thus respectful partnerships.
Obtain Free, Prior, and Informed Consent	Consent by communities to conservation programming should be 'free, prior, and informed.' The power that governments or NGOs hold must not be wielded to extract consent.
Recognize and Account for Negative Impacts	Conservation groups must recognize the adverse effects that proposed conservation actions can potentially have on local people. Harms can include physical displacement; as well as the erasure of stories, practices, and knowledge (particularly in the Indigenous context). In some cases, conservation can intensify gentrification.
Include all Perspectives and Voices	Outsiders cannot fully define equity or justice for a given community because they lack community members' perspectives, which are rooted in culture and history. Recognizing and including indigenous and local knowledge within conservation has become a key focus for developing resource management processes and governance systems.

Table 17. Key Equitable Conservation Literature Themes

Key Interview Themes

Theme	Summary
Assure Public Access	The issue of access to healthy conservation spaces is most pressing for groups of people at a disadvantage economically, socially, and physically. This may be because people live further away from where conserved space is situated, people feel less welcomed, can't afford admission, lack transportation, or the space is inaccessible to various physical abilities.

Understand and Counter Racism, Injustice, and Past Harms	Racism and historical injustice continue to shape access to conservation spaces because of where these are located, who they have been created by and for, and who feel comfortable visiting them.
Represent and Include Diverse Perspectives	Greater diversity in staffing, committees, and advisory boards in white-dominated conservation spaces is needed, and is crucial to increase access for all and advance equitable conservation.
Incorporate Indigenous Perspectives	Partnerships with Indigenous tribes and the incorporation of their perspectives into conservation planning processes are crucial. It is also essential to support Indigenous partnerships in order to carry out conservation in ways that are meaningful and beneficial to these communities.
Center Equity in Programs	Government offices and non-profit organizations are in the early stages of incorporating more equity and racial diversity into environmental projects and programming. Allocation of funding to initiate educational programs that enhance equitable conservation is gaining traction in the governmental sector as well.
Challenge Privatization and Gentrification	Access can become undermined when land is privatized, particularly for socioeconomically disadvantaged groups. The creation of parks in disadvantaged areas can raise land values and lead to gentrification and displacement of residents.

Table 18. Key Equitable Conservation Interview Themes

Conceptualization of Equitable Conservation

Four broad ideas encapsulate the themes listed in the above tables and together provide a succinct conceptualization of equitable conservation. These are: (1) equitable distribution of benefits, (2) equitable distribution of harms, (3) meaningful inclusion of all perspectives, and (4) importance of holistic background research. To clarify why we choose the first two broad ideas, environmental justice is sometimes defined as the equitable distribution of benefits and harms (Wolch et al., 2014). Conservation can have both positive and negative effects on communities and centering this approach from the field of environmental justice can advance equity and justice in conservation programs. Meaningful inclusion of all perspectives is crucial to undermine narrow, traditional approaches to conservation that are informed only by specific western worldviews and tend to cater to privileged groups.[15] Meaningful inclusion of diverse perspectives must

[15] Specifically, conservation has been deeply informed by the traditional western worldview that sees humans and nature as separate.

also include consent from communities that are impacted by conservation programs. Finally, holistic background research involves scholarly work that clarifies an organization's theoretical approach to equitable conservation, along with background research that seeks to understand the histories and values of specific communities. This is a first step in effective community engagement and relationship building; these are at the core of equitable conservation.

Literature Review: Addressing Equity in Conservation

Clarify How Equity is Defined and Used

Conservation organizations must clarify how they understand and define equity, and how they will apply this definition within their practices. Explicitly doing so allows organizations to thoroughly and uniformly understand what their conception of equity looks like and how this translates into practice (Friedman, 2018). For example, the Washington State Chapter of The Nature Conservancy has done an excellent job of defining equity; acknowledging historical and current harms and making commitments to address these issues in their "Washington Equity Statement." They recognize that conservation efforts have resulted in exclusion, displacement, and inequitable benefits; and that TNC "benefits from white-dominant culture and operates comfortably in an unjust, racist society." Some of their commitments include: better reflecting the full diversity of the state on their staff and board; ensuring that conservation efforts advance racial, social, and economic justice; and respecting and supporting rights and autonomy of Indigenous peoples.

Understand and Respect Partner Communities

Reciprocity, trust, and governance structure and practice contribute to understanding and demonstrating respect for partner communities. Throughout history, the erasure of knowledge of Indigenous and Black communities has been evident through different avenues, such as non-inclusive governance structures (policy implementation) and biased resource allocation (White, 2018). Listening to and incorporating Indigenous and Black knowledge into governance structure and allowing environmental spaces to be autonomous for these groups, enables people to practice reciprocity, respect, and trust. According to Dawson et al. (2021), findings suggest that equitable conservation; which empowers, supports, and allows space for environmental stewardship of Indigenous groups; represents a primary pathway to effective and long-term conservation of biodiversity especially when it is spelled out in policy. By employing these "pathways," which describe possible processes through which different forms of governance are associated with certain combinations of outcomes, both social and ecological, equitable conservation fosters the practice of reciprocity, respect, and trust in governance structure and relationship building (Dawson et al., 2021).

In recent years, progress has been made in acknowledging and incorporating Indigenous and Black thought in management plans and environmental programming. Emerging frameworks incorporate conceptions, perceptions, and expectations (CPE) from various voices within communities (Fabre et al., 2021). CPE highlights common foundational perceptions around the intersection of human and environmental well-

being, and expectations about the efficiency of surveillance, rule compliance, and community involvement. A community environmental group called Detroit Town Farms adopted a similar framework (White, 2018). They held listening sessions and found ways to involve more community members in their decision-making. As a result, their food system is fully sovereign. In addition, the White House released the first of its kind "...Indigenous Knowledge Guidance for Federal Agencies" in late 2022 that states and recognizes the importance of incorporation of Indigenous Knowledge and implementation in federal decision making. This was made possible by engaging and listening to more than 100 Federally recognized tribes through roundtables, conferences, and public listening sessions in addition to holding consultations (whitehouse.gov).

A spatial equity index is a mapping tool to help practitioners understand the characteristics and equity challenges of partner communities. Zhu et al. (2019) described the importance of identifying which geographic parts of a community most need investment and intervention, and suggest doing so through spatial analysis. Such analysis can combine social attributes like: wealth, minority status, percentage of children and elderly groups in the total population, and education level; in conjunction with environmental variables such as: vegetation coverage, impervious surfaces, or water surfaces; to identify areas most in need (e.g., where social vulnerability is high and green space is low). Along these lines, Zhu et al. (2019) argued for a need-based conceptualization of equity, stating that "communities with the highest need have the most potential to benefit" from interventions. While this method may add depth to the understanding of a community, it is not a substitute for approaches that involve having conversations with community members and forming relationships.

Obtain Free, Prior, and Informed Consent

"Free, Prior, and Informed Consent" (FPIC) has become a central concept in international human rights discourse and can play an essential role in facilitating self-determination for Indigenous peoples. According to the UN Sub-Commission on the Promotion and Protection of Human Rights (2004), procedurally, FPIC "requires processes that allow and support meaningful choices by Indigenous peoples about their development path" and "respects their legitimate authority to require that third parties enter into an equal and respectful relationship with them" (Hanna and Vanclay 2013). FPIC is a right that specifically pertains to Indigenous peoples, but the idea that consent should have the qualities of being 'free, prior, and informed' can and should also be applied when working with other marginalized groups.

Consent is important in multiple levels of conservation. Due to partnerships between Indigenous tribes and the federal government in the North Pacific, both historical and contemporary conservation practices are recognized and utilized by regional and global practitioners that work on marine planning and protection (Ban et al., 2018). For First Nations and Indigenous communities already doing environmental work, supporting them leads to a more inclusive approach towards conservation; which also empowers local communities and represents a major long-term and effective pathway to biodiversity planning and conservation. Government has effectively partnered with both

Indigenous Peoples and Local Communities (IPLCs) and has been a pillar in advancing toward a more comprehensive decision-making process (Dawson et al., 2021). It is important to note that the model of IPLCs can be transferred to other regions, and can provide an effective framework toward effective and long-lasting indigenous sustainability and conservation.

Conservation organizations have greater power than many local people they interact with; therefore, this power must not be wielded to extract consent. To ensure this, conservation practitioners must understand and clarify their positionality concerning race, class, gender, and nationality; as well as the power and influence they hold in different settings. This power must not be misused, and Dietsch et al. (2021) recommended actively seeking opportunities to share power. Doing so may include delegating roles or tasks or lifting up what people with less power have to say. Furthermore, as Dietsch et al. (2021) note, it is crucial that conservationists not overlook their positionality as stakeholders with specific interests and biases that influence their work. Additionally, Hockley et al. (2018) suggest voluntary conservation easements as a path toward proper consent, as Free, Prior, and Informed Consent is impossible without freedom of action. In other words, communities should always be free to refuse conservation programs.

Recognize and Account for Negative Impacts

Conservation groups must recognize adverse effects that conservation actions can potentially have. In order to create equitable conservation practices, harms must not be ignored, but instead acknowledged and minimized to the greatest extent possible. For conservation to truly be fair and equitable, local people should experience no negative impacts. Conservation efforts should never exacerbate poverty and people should be compensated for any imposed costs (Friedman et al., 2018; Hockley et al., 2018). Common costs and harms of conservation involve: displacement of people (Dowie, 2009; Zerah, 2013), alteration of livelihoods and traditions (Kamoto et al. 2013), institution of capitalist markets (West, 2006; Dowie, 2009), decreased freedom and agency of local people (Zerah 2013), increased policing and violence (Massé, 2013), decreased access to resources and increased conflict over resources (Kamoto et al., 2013), increased conflicts with wildlife (Dowie, 2009), and imposition of western conceptions of humans and nature as separate entities (West, 2006).

Physical displacement and subsequent erasure of stories, practices, and knowledge result from prioritization of industrial and capitalistic ways of living, with associated gentrification. As Ismael et al. (2017) stated, "successive colonial and apartheid regimes have produced and sustained often counterproductive and ineffective economies in environmental relations in South Africa and these instances have become critical to understanding environmental processes." Even though this is taking place in South Africa, a similar extractive system, driven by capital and industrial gain, is having parallel impacts and negative effects on Great Lakes communities. Another example of community displacement is the Rahui community in French Polynesia (Fabre et al., 2021). For generations, the Tautira district, a Polynesian beach village indigenous to the area, has prevented the Rahui people from providing input in resource management. In

addition, they have also prevented them from participating in environmental decision-making. More recently, across the Pacific Islands there has been a push towards integrating and implementing Indigenous knowledge in management of marine protected areas (MPAs). Although this is in the Pacific Islands, environmental organizations and local governments can learn what other countries are doing to make amends with communities that have been historically marginalized.

Include all Perspectives and Voices

Outsiders cannot fully define equity, justice, or equitable conservation for a given community because they lack community members' perspectives, which are rooted in culture and history. Therefore, recognizing and including Indigenous and local knowledge has become a key focus for developing resource management processes and governance systems within conservation. This work occurs through forming partnerships between government systems. An example is expansion of environmental programs by the Gixxatla First Nations to include meaningful engagement in regulatory review, environmental monitoring, and impact research, in partnership with environmental non-governmental organizations (ENGOs) (Butler et al., 2021). Dawson et al. (2021) also mentioned that recognition of local practices and institutions can shape decision-making and increase the legitimacy of “Indigenous Peoples and Local Communities” (IPLC’s). At the same time, Indigenous groups maintain ownership of, and actively practice, traditional ecological knowledge and practices, thus resisting the erasure of culture.

Findings from Interviews

We asked interviewees what equitable conservation practices mean to them and what their lived experiences looked like in conjunction with the term. In the Community Leaders section of the interviews, we examined whether interviewees thought equity and conservation were relevant to each other. We used follow-up questions to parse out how the two concepts can be aligned and if examples of equitable conservation were found in the interviewee’s experience.[16] In this section, we discuss our primary findings, and highlight general definitions and current ongoing practices that people are incorporating as a result of their growing awareness of equitable conservation.

All of our interviewees agreed that equity and conservation are relevant to one another. However, some could not expand on why they thought so. The following sections will examine how interviewee responses brought these concepts together. The major interview themes were: public access, historical injustice, Indigenous perspectives, equity, representation, and privatization.

[16] In Question 6 of the “Community Leaders” set , we asked, “Do you see equity and conservation as relevant to one another?” (Q.6). If we needed further clarification of their response, we asked: “If so, have you seen this happen in your community?” and “Do you have ideas about how equity and conservation work can be brought together?” We collected > 20 responses that varied from in-depth answers about equitable conservation and practices, to just emphasizing that equity and conservation work together.

Assure Public Access

Public access to green and blue spaces was the most commonly referenced theme. Equity and conservation are relevant to one another because it is important that everyone, regardless of socioeconomic status, has access to nature and green spaces. A crucial part of access is physical, but there are also critical non-physical dimensions such as comfort (i.e., feeling welcome and safe), cost, and awareness of public natural areas.

In Toledo, Gary, and Milwaukee, we found that lack of public transportation is a barrier that keeps diverse communities of people from accessing the big lake. In all three locations, many children in those communities have never visited their respective Great Lake, though their city is on the coast. In Milwaukee, one interviewee stated, “there are parks nearby, and there is a man-made lagoon in one of the parks. Some of my students thought the lagoon was the lake.”

Additionally, concern that cost of admission could undermine accessibility to conserved spaces for low-income groups was widespread. In Gary, access to conserved areas must be protected for all and “a parking fee might constitute a threat” for low-income community members. There is an emphasis that conservation is seen as inequitable because experiencing natural parks and dunes is an issue for people that cannot afford to pay the added fees.

People expressed the importance of accessibility to conserved areas for individuals with limiting physical abilities. In Milwaukee, we heard about the importance of paved trails and trail options with gentle elevation gradients accessible to all physical ability levels. In Saugatuck, mobility is an issue because visiting local parks and dunes requires both a car and the ability to walk. People who have disabilities or lack personal transportation thus do not have the same access to these natural areas. In Bayfield, the Apostle Islands National Lakeshore is working on making their islands accessible in terms of transportation, and Meyers Beach is building a wheelchair ramp that goes down to the lake to improve accessibility.

Understand and Counter Racism, Injustice, and Past Harms

Historic (and ongoing) patterns of racism and injustice are directly tied to public access to conservation spaces, since decision-making and city planning have long prioritized predominantly white and affluent communities. The unjust history of conservation must be acknowledged and understood to improve the future quality of life for communities of color. A member of the Milwaukee Riverwalk Tour Project, explained, "equitable conservation is accessible, acknowledges the past, and acknowledges who historically has been kept from public lands and feeling comfortable out there. So equitable conservation needs to involve environmental justice and equal access to the land for all people." Another interviewee in Milwaukee explained that trying to divorce equity and conservation from one another can have harmful consequences and that conservation needs to serve communities in ways that are meaningful to them. They stated, "people who live in this neighborhood aren't going out and hiking the Appalachian Trail or

anything like that, like, so it's like, what does nature look like here for people, and how do we conserve our resources?"

Even when natural spaces are conserved and physically accessible for the public, they can feel exclusionary to people of color and low income. An interviewee in Gary explained,

> "It's kind of understood, you're not welcome. In some of the nature preserves that are open and have trails in the middle of neighborhoods, the people around them have traditionally felt that they weren't supposed to go in there."

Another critical theme involving injustice was the impact of policing. In both Gary and Milwaukee, members of the Black community—feel less comfortable going to natural spaces like parks or beaches because of harassment by police.

Represent and Include Diverse Perspectives

Representing and including BIPOC perspectives on community advisory boards and environmental city planning groups will help promote these communities' needs and incorporate their perspectives into decision-making. For example, in Milwaukee, the Citizens Advisory Council for the Area of Concern Program reconstructed itself to more accurately reflect demographics of the community it serves, and now also pays community members for their time served on the board. They also highlighted the importance of talking to communities early in the design process of projects rather than after all major decisions have been made.

Multiple people referenced the whiteness of the environmental movement and talked about the importance of hiring environmental educators and practitioners who are not white. Hiring people from underrepresented groups is integral to helping more people feel welcome and making environmental spaces accessible to all. The environmental realm has historically been white-dominated, which continues to contribute to the exclusion of marginalized groups.

Despite the history of largely undermining and ignoring Black voices in the conservation and non-profit world, groups are now starting to recognize the importance of including their voices through planning and practices. Diverse voices and perspectives need to be included to broaden the scope of knowledge and approaches to conservation.

Incorporate Indigenous Perspectives

Respectful engagement with tribes is critical for building long-term relationships and effective conservation plans. Respectful engagement starts with recognition, collaboration, and general respect towards partnerships with Indigenous groups such as the Bad River Band and Red Cliff Band in Bayfield, Wisconsin. According to the Lake Superior Collaborative, these ideals are of the highest importance within the organization. They added that their organization is in the early stages of figuring out how to incorporate tribal involvement and carefully add their perspectives into the

Collaborative's approach to conservation. For example, they are involving Indigenous thought leaders in editing their action plans and giving feedback. Based on feedback to date, the collaborative is now utilizing the term "stewardship" instead of "natural resource management" to conceptualize nature as a living entity rather than an object.

Incorporating more than one perspective in how nature is viewed can expand the way we think about conservation. The collaborative stated:

> "Especially when talking about involving more Indigenous knowledge, I think that's something we need to do more of. That's something I don't have a lot of knowledge on. I want to explore more, because a lot of times when we think about invasive species or weedy plants, we're just looking at it from one perspective, but other cultures and people might be looking at it differently. There might be benefits to hearing the way that other people think about some of the ways we do conservation."

Collaborating with Indigenous groups is crucial to strengthen relationships that have been historically nonexistent or very weak within the conservation field. For example, Alex Faber mentioned that Superior Rivers Watershed Association acts almost as an extension of the Bad River Watershed Association, "which is integrated heavily with the [Bad River] tribe" and is not considered a conservation organization but more of being involved in the community of Bayfield and Ashland. The Superior Rivers Watershed Association is also aware that they are situated in ceded territory, and they base their decisions and actions in accordance with the Bad River tribe.

Center Equity in Programs

In government and NGO conservation programs, progress is being made acknowledging injustice, emphasizing equity, and working to improve access for marginalized groups. For example, an interviewee who works at a non-profit organization voiced that environmental groups have begun making strides in incorporating more equity and racial diversity in their projects and planning. They commented:

> "I believe in equity and equitable conservation. Especially historically, natural areas in underserved communities, they've been kind of kept away from the communities a lot. And that's why we're dealing right now with not having good accessible natural areas, because they've been kept away from the communities for so long."

The interviewee also expressed that their organization needs to start creating more action plans to implement BIPOC perspectives. They stated that by understanding how people from different backgrounds and cultures view plants and biotic life, we can learn to be open-minded about how environmentalism is shaped and implemented.

The Ohio Coastal Management Program is focused on the educational component of equitable conservation.[17] The program is funding DEIJA (Diversity, Equity, Inclusion, Justice, and Accessibility) education initiatives which focus more on bringing in kids from low-income communities to experience the outdoors. In one example, staff members are dedicated to including and providing educational resources to the migrant communities that move to the area of Toledo for agricultural work. The community is being empowered and educated through direct engagement in water science, data collection, and analysis.

The Planning and Development Division of the Milwaukee County Parks Department uses equity-oriented, spatial analysis to focus interventions on communities most in need. The department explained that they use an equity index that includes factors such as the Center for Disease Control's Social Vulnerability Index, crime rate, and tree cover. This allows them to prioritize areas in the county that are most in need of intervention and thus can benefit the most. They further explained, "if we have $5 to spend anywhere in the system, let's spend it in the highest equity needed area first, and make the most difference, because there just are other options for other folks that have more access or privilege."

Challenge Privatization and Gentrification

It is essential to have public land that does not require admission so that everyone has access to it (and to the lakeshore) regardless of whether they own land. A major concern is public land that is open and accessible to all in the face of increasing privatization and gentrification. In Milwaukee, there is increasing pressure to privatize sections of the lakefront which can lead to more development in the form of both built structures and hard infrastructure near the shore, as well as driving up cost of land. This also limits public access to the shore, creating a detachment to all blue and green spaces that communities need for physical and mental well-being.

In Saugatuck, property values are continuing to rise, and wealth inequality is continuing to grow. Equitable conservation has unique meanings in Saugatuck compared to other study locations, since other locations placed more emphasis on lack of racial representation and equity. In Saugatuck, one interviewee explained that the issues around access and environmental justice have more to do with wealth inequity and disparity and who has the privilege of accessing natural spaces. In Saugatuck, home value and household income are highest downtown near the water and along the coast.

Disadvantaged communities that do not have access to conserved spaces are less likely to care about environmental education and green spaces because there is no environment for them to experience. A community member from Toledo explained, "affluent people, they're the ones who want parks." People who are affluent and want parks to be placed near their communities have the luxury of spending time outdoors and having green spaces nearby. Equitable conservation must prioritize equitable access to natural areas despite the economic disadvantage communities face.

[17] Scudder Mackey, Chief of Coastal Management in Toledo, Ohio

Discussion of Equitable Conservation

Here we highlight a few key points from our research into conceptualizing equitable conservation. The explicit inclusion of equity in city programming, both through education and technology, is promising. It is specifically interesting that the incorporation of inclusion is happening at both city, state, and federal levels as most of the drivers of change happen in these two tiers.

We were also inspired by the partnerships we saw between Indigenous tribes and non-profit governmental organizations. These partnerships amplify Indigenous voices and provide space for tribes to continue important work. Prioritizing this collaboration is crucial to the work of repairing past harms and rebuilding conservation in an equitable way.

Traditional western science has generationally ignored Indigenous and Black ways of living and knowing environmental practices. One ignored Indigenous ideology and belief is that nature and people function as one living entity. On the contrary, traditional western science has historically viewed nature and people as separate “functioning” entities not to be mixed when it comes to researching best ways to protect nature. Towards equitable conservation we must no longer view nature as distinct but rather as coexisting with people; as one complex, multi-disciplinary system. This way, we are incorporating diverse perspectives, voices, and practices that can aid in better finding solutions to nature during a time of climate change all while catering to community needs in the environmental/conservation world.

We recognize some limitations of our study. First, we were able to read and find a lot of literature on Indigenous perspectives about conservation, but found very little on Black American perspectives. Additionally, much of our literature review focused on international conservation rather than on conservation in the US, and specifically in urban areas in the US. Thus there was a mismatch between the focus of our literature review and our interviews because we found out that there were not enough empirical studies in the United States that highlighted equitable coastal management and planning.

A strong conceptualization of equitable conservation has some key implications for conservation programs. Each of our implications requires listening to and engaging with community members for holistic and just conservation management. These implications are explained below:

- Environmental justice requires that harms be equitably distributed. Conservation management should recognize unintended negative impacts of conservation. If conservation is to be equitable, not only its benefits but also its harms must be distributed in a just way. This could look like an analysis of potential costs and harms of conservation projects for different stakeholder groups prior to their initiation, as well as obtaining input from different stakeholders about what they perceive potential negative impacts to be.

- The way that conservation organizations initiate project planning needs to change in order to enhance equity. This shift in management requires partnering with communities early enough in project processes that they have input on big decisions and not just small ones. This enables truer consent, transparency, and better relationships, and could help rectify harms of the past in which community voices were not heard. Public listening sessions could facilitate this type of change.
- One approach to conservation will not benefit all communities equally or in the same way. A central priority for improved management will be to determine how conservation can be beneficial for different communities that have different needs and values. Focus groups or surveys could help conservation organizations understand what different communities want out of conservation projects, and thus better meet those communities' needs.

Ultimately, equitable conservation should seek to undo or break generational racism and displacement through a shift of conservation ideology and practice. While there have been many instances of conservation undermining equity and justice, conservation can promote equity if it is done well.

Case Study

Our case reviews were informed by our research on relevant Great Lakes coastal metrics and equitable conservation, our interviews and observations, and our investigations into coastal policy and governance. We have chosen to highlight a few central themes per case, but in reality most themes are found in every case.

We begin each case review with a description of the location and then delve into the ways in which two or three themes played out in that location, based on findings from our interviews and structured observations. The three central themes were: Factors Impacting Project Success, Structural Inequity, and Education and Awareness; each theme also had subthemes (Table 19). All themes and subthemes played an important role for each location and impacted the overall well-being of the community, in relation to the coast.

Themes	**Sub-themes**
Factors Impacting Project Success	● Conflicting interests and trade-offs exist between developing or preserving coastlines and ecosystems ● Current grant and funding structures limit coastal resilience programs,especially at smaller scales

	● Government allocation of funding discourages effective problem solving in coastal resilience efforts
Structural Inequity	● Historic patterns of racism continue to shape access and risk exposure ● Historic patterns of economic development largely shape how communities were built and how current decisions are made ● Degraded infrastructure and the effects of climate change compound one another to undermine community resilience
Education and Awareness	● Educational opportunities (academic & community outreach) and local news are important to community knowledge and awareness of problems and opportunities ● There is awareness of natural infrastructure but implementation is facing several obstacles

Table 19. Overarching Themes and Sub-Themes from Case Interviews & Structured Observations.

Saugatuck, Michigan

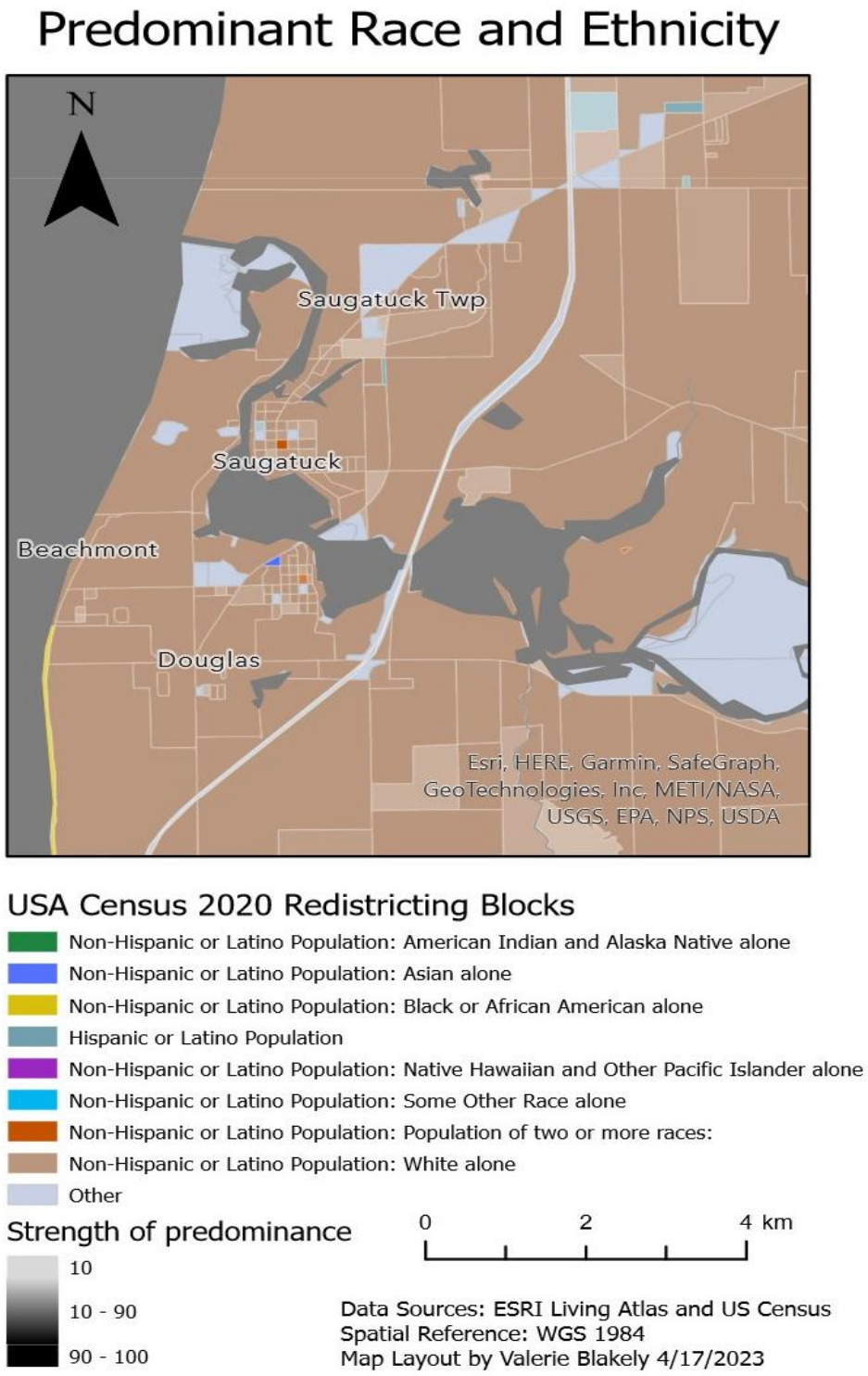

Figure 1. Predominant Race and Ethnicity in Saugatuck, MI (US Census 2020)

2022 Median Household Income

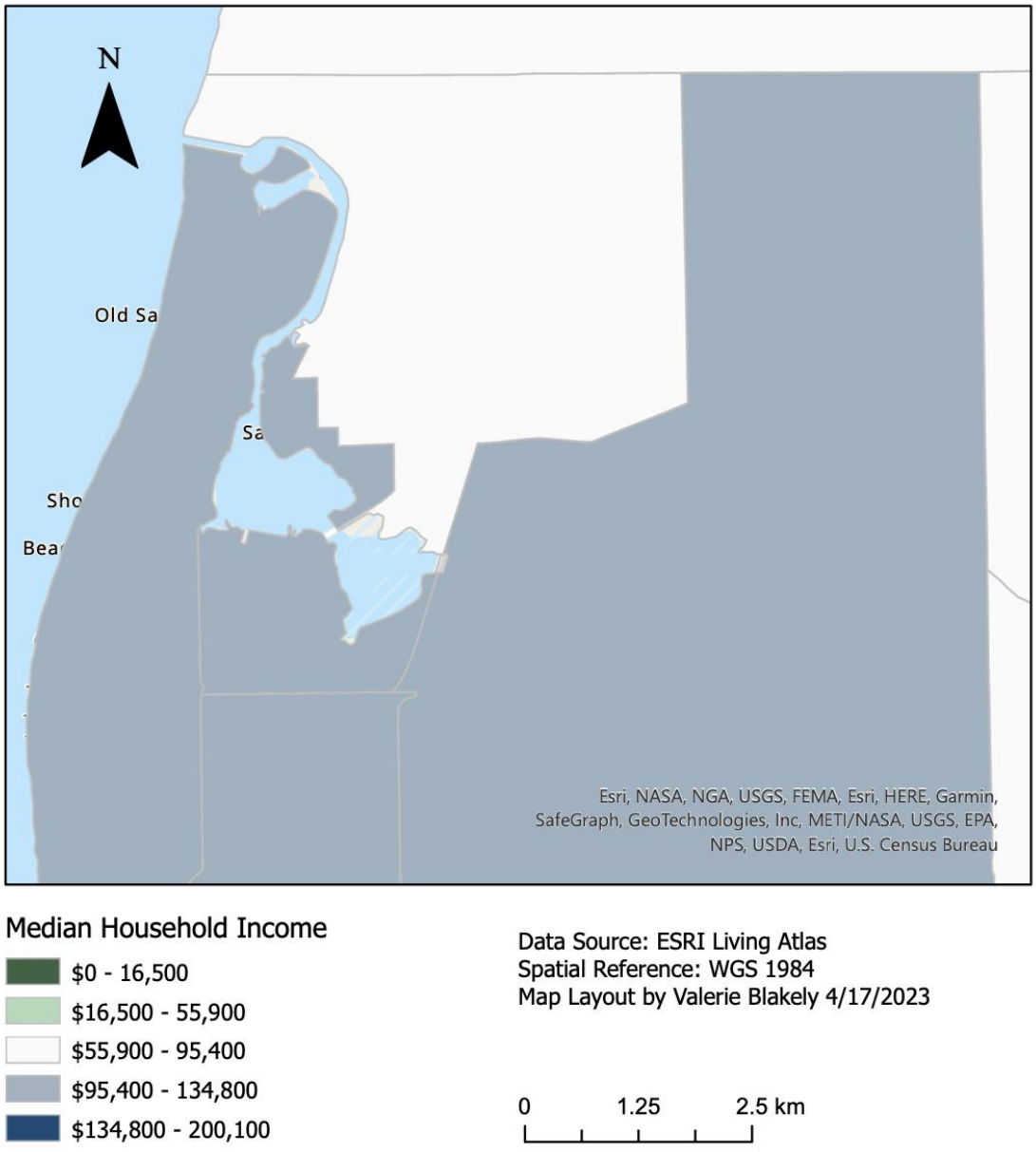

Figure 2. Median Household Income in Saugatuck, MI

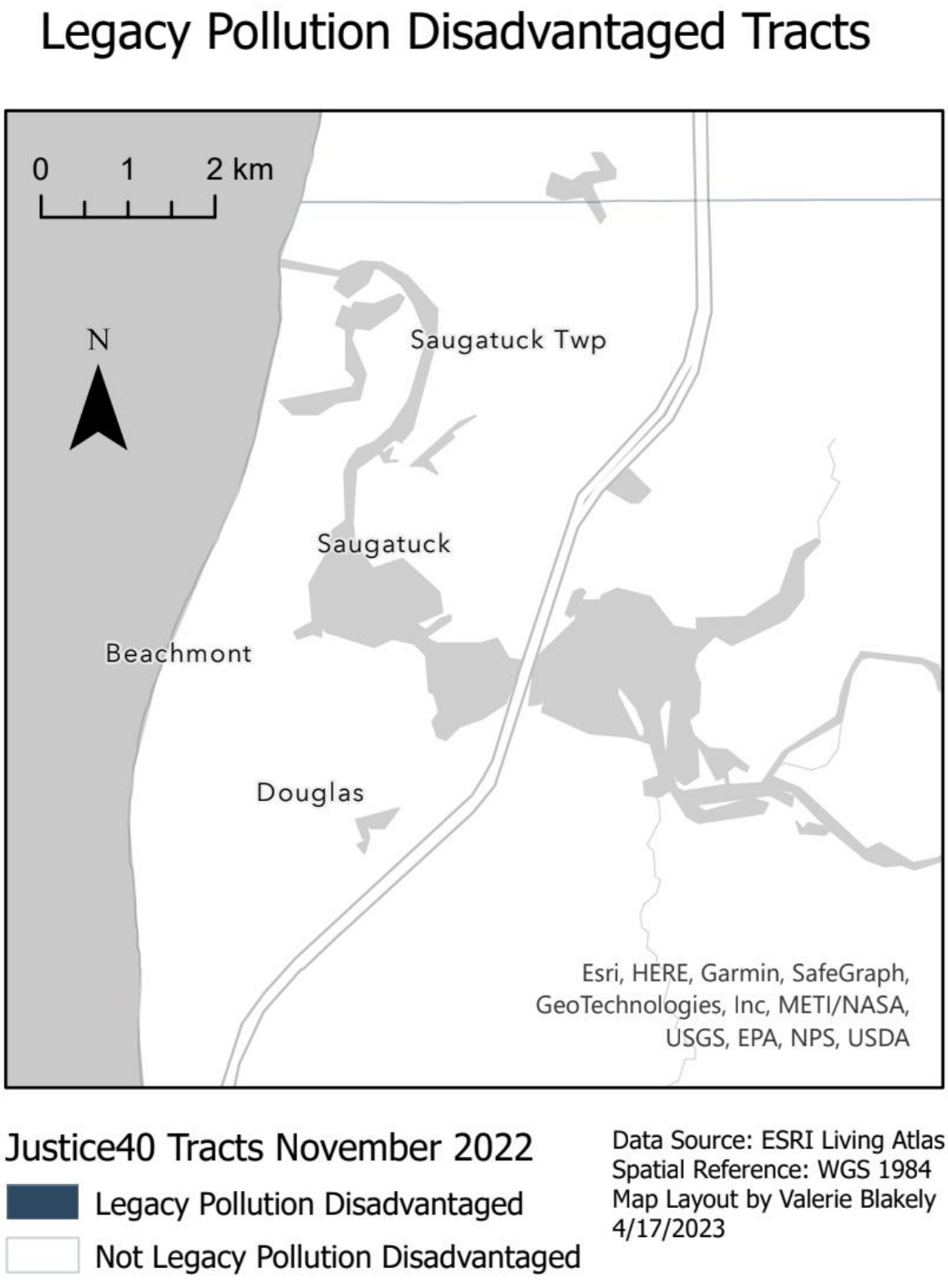

Figure 3: Legacy Pollution Disadvantaged Tracts in Saugatuck, MI. . A Census Tract is considered to be Legacy Pollution Disadvantaged if they: have at least one abandoned mine land; formerly used defense sites; are at or above the 90th percentile for proximity to hazardous waste facilities;

proximity to Superfund sites (National Priorities List (NPL)); or proximity to Risk Management Plan (RMP) facilities & are at or above the 65th percentile for low income.

Saugatuck is a small picturesque seasonal tourist town of about 900 people on the eastern shore of Lake Michigan. The Kalamazoo River runs through Saugatuck, providing a variety of recreational opportunities such as fishing, boating, and kayaking. The city is also well-known for its sand dunes. Saugatuck Dunes State Park and Oval Beach are popular attractions that offer scenic views and hiking trails, which garner visitors from all over the world. Historically, a large part of Saugatuck's economy involved harvesting and shipping fruits. Today, the economy is primarily driven by tourism, and it is known for its art galleries, theaters, and music festivals. It is home to the Ox-Bow School of Art, which is affiliated with the Art Institute of Chicago. The city is known for its LGBTQ-friendly community and hosts the annual Saugatuck Gay Pride Festival, which attracts tourists from all over the country. The median age in Saugatuck is 55 years, and the median income is $105,024, which is significantly higher than the states' median income of $63,498.

Findings

Structural Inequity.— Industry has not majorly contributed to Saugatuck's economy but, as the most downstream city on the Kalamazoo River, the industries of the watershed still impact this tourism hub. Equity is undermined as these communities are disproportionately exposed to the dangers from PCBs introduced into the river from paper mills located further inland. The Kalamazoo River, hailed by our interviewees as essential to the city, was deemed a superfund site in the 1960s due to Polychlorinated Biphenyl (PCB) contamination. Some cleanup has occurred, but residents are still urged to not eat fish from the river as they may not be safe for human consumption. This restriction, however, is not closely followed as we witnessed people fishing in the River during our visit. One interviewee mentioned the reliance on subsistence fishing for many of the lower income residents and migrant communities in the area, sharing that many either do not know about the advisory or cannot afford to follow it.

Despite this restriction, Saugatuck's tourism industry "is king here," according to one of our interviewees. The city and its visitors value its natural areas and time spent outdoors connecting to nature which makes natural infrastructure a more attractive option for its city design. Beaches and businesses along the Kalamazoo River bring a diverse selection of people into this small city. Swimming and boating are very important to the city's culture, and maintaining a small-town character appears in their master plan. Many interviewees took pride in Oval Beach being ranked as one of the top 25 beaches in the world by Condé Nast Traveler magazine. The area boasts hiking trails-both in the State Park for tourists, and lesser-known trails favored by locals.

Reliance on tourism impacts housing availability and cost, which was a common complaint in interviews. The wealth divide in the city pushes lower income residents farther from the city, its amenities, and conserved areas along the coast. Housing in Saugatuck is limited and expensive. Between the conversion of many existing homes into short-term rentals and the subsequently steep real-estate prices, people wishing to

become long-term residents lack any affordable options. This affects local businesses as well, which struggle to find employees because many people cannot afford to live in the city. One interviewee shared that this high cost of living harms the retention of current residents looking to transition between homes. Even with a modest income, many cannot afford to stay in the area.

Factors Impacting Project Success —Saugatuck has embraced tourism while valuing conservation, but the two are at odds with each other. There is continual pressure to develop natural spaces, mainly for private residences and commercial, tourism-related ventures. At the same time, if it were not for the presence of beautiful conserved natural spaces, tourism would suffer. The loss of public land to private developments creates equity problems due to the loss of public access to the shoreline. The various conservation designations along the lakefront are the only thing protecting that land from development pressures. Many proposed projects, like a new truck stop to be built along the highway, have come under scrutiny and have faced legal challenges in order to preserve existing conservation areas in the city. Most recently, there is a proposed marina at the outlet of the Kalamazoo River to Lake Michigan. Community conservation organizations are currently fighting this development, as it threatens protected areas and rare dune ecosystems along Lake Michigan. This development is in direct opposition to the stated objectives in the city's master plan and violates local zoning ordinances.

Wealth in the city intensifies the conflict between conservation and development as both ventures have significant support from residents. The conservation side of the 'fight' ultimately values and protects natural infrastructure, whereas the development side prioritizes benefiting the local economy which usually bends away from conserving these natural features. This conflict makes it harder to utilize natural infrastructure in part because the higher level of funding may lead to decision-makers looking for development options that do not incorporate natural infrastructure. Our interviewees shared that many in the city simply rebuilt their properties and installed higher seawalls after a flooding or storm event because the private landowners could afford it. This mindset coupled with the wealth in Saugatuck hinders the adoption of natural infrastructure because it is overlooked in favor of quick hard fixes and the continued damage to these fixes is negligible as the repeated cost of rebuilding is not a constraining factor to many of those impacted.

Bayfield, Wisconsin

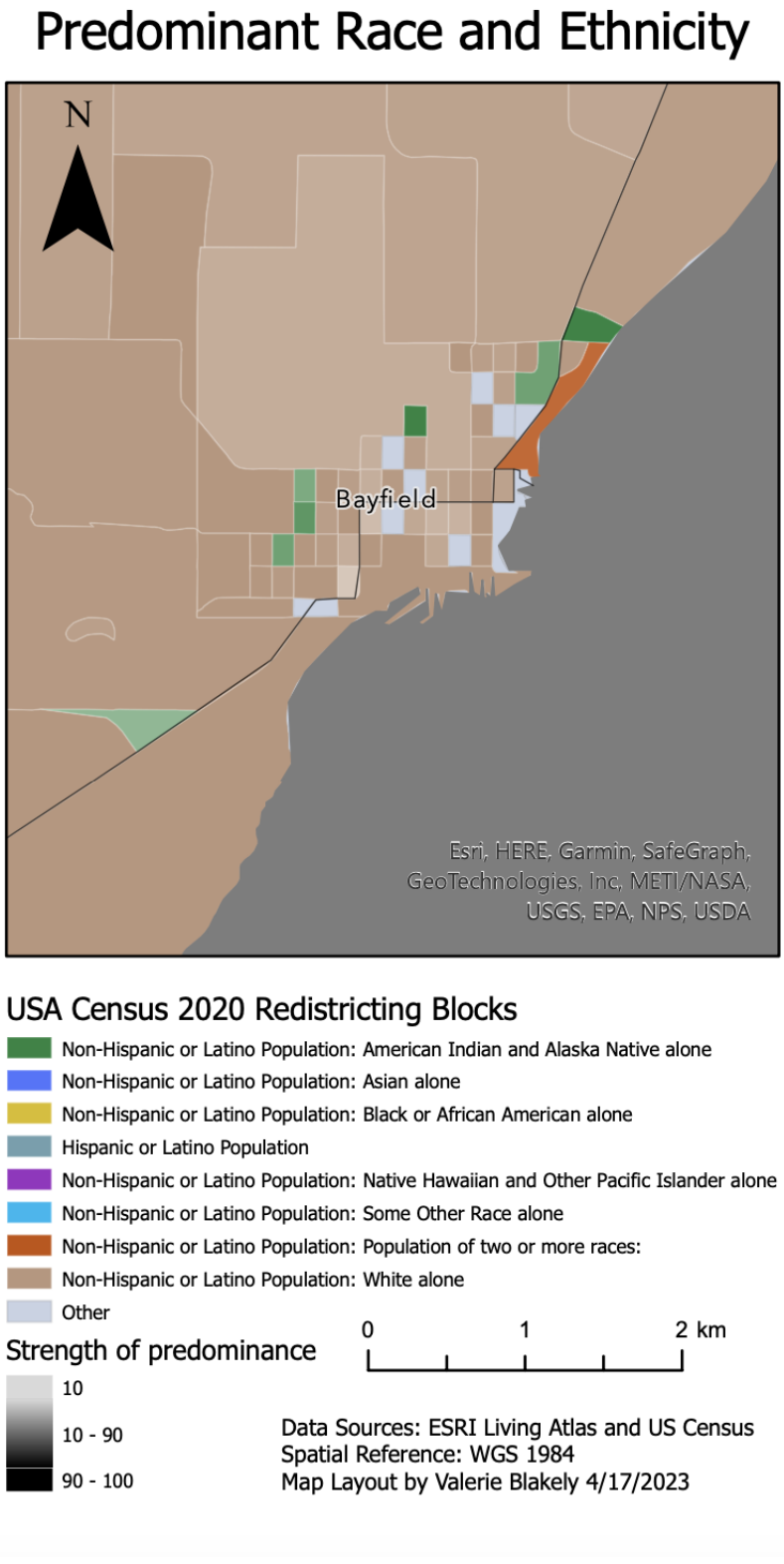

Figure 4. Predominant Race and Ethnicity in Bayfield, WI (US Census 2020)

2022 Median Household Income

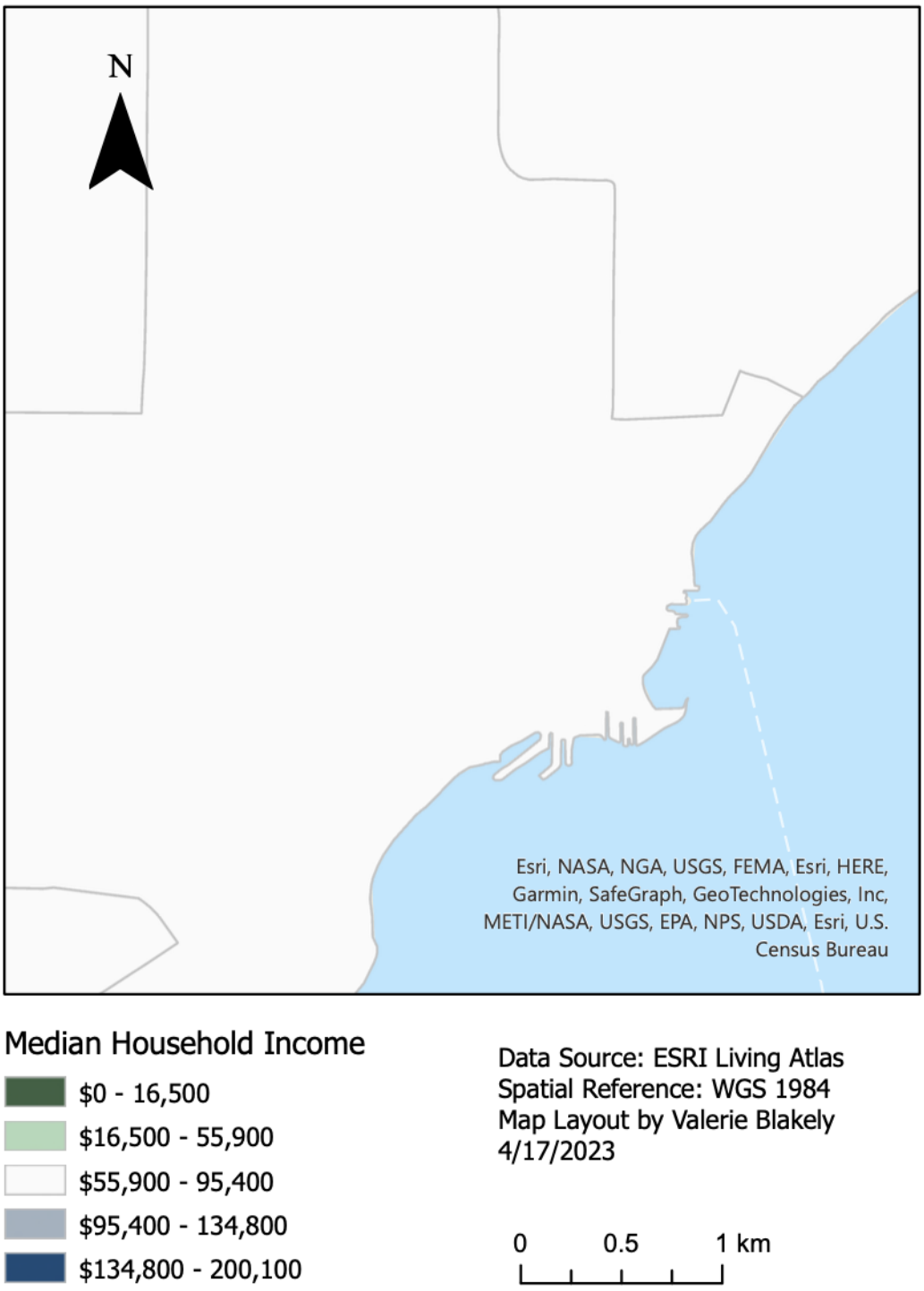

Figure 5. Median Household Income in Bayfield, WI

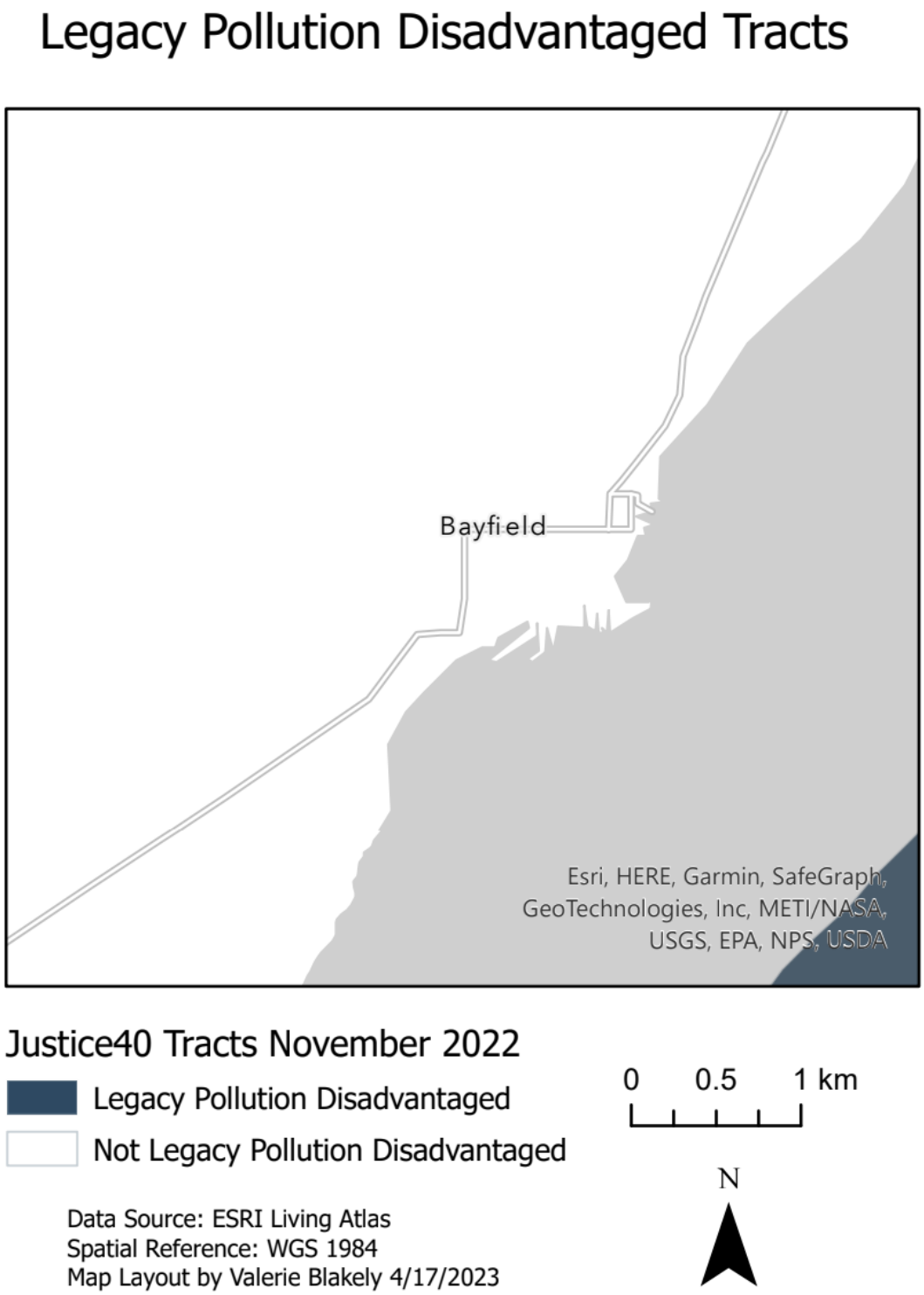

Figure 6. Legacy Pollution Disadvantaged Tracts in Bayfield, WI. A Census Tract is considered to be Legacy Pollution Disadvantaged if they: have at least one abandoned mine land; formerly used defense sites; are at or above the 90th percentile for proximity to hazardous waste facilities; proximity to Superfund sites (National Priorities List (NPL)); or proximity to Risk Management Plan (RMP) facilities & are at or above the 65th percentile for low income.

Bayfield, Wisconsin, is a beautiful, small coastal city in Northern Wisconsin on the southwestern coast of Lake Superior. It is home to the 22 Apostle Islands and the Apostle Islands National Lakeshore, making tourism an important industry in the area. Madeline Island, the only Apostle Island accessible by car, is a popular tourist destination for visitors from all walks of life. It provides an escape into nature, with several secluded cabins for rent and access to quiet beaches on the shores of Lake Superior. The city is surrounded by rural farmland and forests, and is often referred to as the Berry Capital of Wisconsin. The area is well known for its plentiful artesian wells, with many residents choosing to source their drinking water from the wells. Neighborhoods and a popular strip with tourist shops and restaurants make up the downtown area.

With a population of 584 as of the 2020 Census, Bayfield was the smallest location in our study. The median age was approximately 63 years, with 48% of the population being 65 or older, making this population the oldest in our study. The median household income was $77,583 USD, and the city had a 10% poverty rate, which was .8% lower than the state of Wisconsin average. The city is predominantly white, with 80% of the population reporting being only white. This location also has a relatively substantial Indigenous population, with 10% of the population reporting being American Indian or Alaska Native, standing out among our study locations.

Findings

Factors Impacting Project Success —Funding is one of the biggest challenges Bayfield faces in planning for and implementing coastal resilience. Bayfield's small geographic size and modest population result in a smaller tax base and lower priority for state funding, which makes it difficult to acquire the necessary funding for city projects. We heard from several residents that funding and grant writing was one of the biggest hurdles to improvement in the area. Much of the available federal or state funds go to larger cities, with more capacity to design and support more extensive projects, leaving Bayfield with much smaller portions. Bayfield's small stature also makes qualifying for larger grants much more difficult as many grants have a sizable minimum funding requirement that many necessary projects in Bayfield cannot meet. This limits the number of grants that can be applied for when smaller projects need to be completed. Projects related to both natural infrastructure and equity are undermined by the lack of ability to procure funding.

Many organizations lack the planning capacity to apply for grants due to the timelines of applications and the preference for shovel-ready projects. For many small organizations, this preference poses several challenges. For many grants, the timeline from announcement to due date tends to be quite short. These grants also tend to favor projects that have completed all the necessary prior research and are ready to break ground, also known as 'shovel-ready' projects. For a project to be shovel-ready, extensive planning, research, and pre-work must be completed before beginning the application process. The necessary pre-work requires funding and time that the short grant window does not provide. Community organizations in Bayfield have a lot of ideas for projects, however they lack the funding and labor capacity to transform these ideas

into shovel-ready projects. This serves as another hurdle to the implementation of natural infrastructure projects in the city.

The grant writing process also requires a certain amount of knowledge and experience that does not exist within many organizations. Organization staff often lack experience in grant writing and tracking, making the process much harder and slower to complete. Interviewees shared that Bayfield is a close-knit community, with several of its residents financially supporting projects when possible, but as such a small community, support is limited by the finances and knowledge they possess.

Organizations have come together to overcome hurdles presented by minimum funding requirements. One interviewee shared that several organizations like the Wisconsin Department of Natural Resources and the local tribes partnered to combine enough projects on one application to qualify for a larger grant. This has seen some success but is still difficult, requiring additional collaboration, and several projects with similar timelines and themes. This need to combine projects places Bayfield in a unique position of giving the Indigenous tribes in the area more of an active role in the city's planning processes, which has positive equity implications.

Education and Awareness.—Bayfield incorporated both natural infrastructure and equity into their long-term city planning in 2019. The city's Comprehensive Plan published that year prioritized using alternatives to hard infrastructure in any new construction projects, and lists implementation of green infrastructure, stormwater management, and conservation of natural areas as main concerns in each sector of the city. It also included equity, resilience, and sustainability as core values. The plan details what steps the city should take to progress toward their stated goals by 2025, to make meeting their 2029 goals possible.

Many residents were not familiar with the term "natural infrastructure" but supported and embraced implementation of natural solutions to impending climate change. Only a few people expressed interest in natural solutions to flood management, despite flooding being a massive problem for the area. Recent large-scale flood events have cut off many communities around Bayfield completely from the rest of the surrounding area, exposing is a significant threat due to the area's vulnerable, aging population. Flood management has equity implications for the vulnerable populations in the city because flooding creates the inability to access basic resources, hospitals, and emergency services. Recent floods have led many residents to believe that the city's traditional methods of flood management are no longer going to work and alternative management practices should be investigated, which could include natural infrastructure.

A current inability to disseminate local information in Bayfield poses a significant barrier to effective decision-making for residents and organizations in the area. The city's local newspaper was historically responsible for tracking down and sharing local news daily, but due to a decline in subscribers, the newspaper now only has one journalist covering local news and only publishes two papers a week. This has led to a significant decrease in local news access due to a reduction in coverage and overall information

dissemination. One interviewee shared that they have to contact a friend who works with the county to gain insight into what is happening in the area because there is no one sharing this information. Access to accurate and timely information is integral to awareness of issues around coastal resilience issues and projects related to natural infrastructure and equity. Ultimately, a lack of local news undermines the ability to make informed decisions about health and resilience in the city.

Gary, Indiana

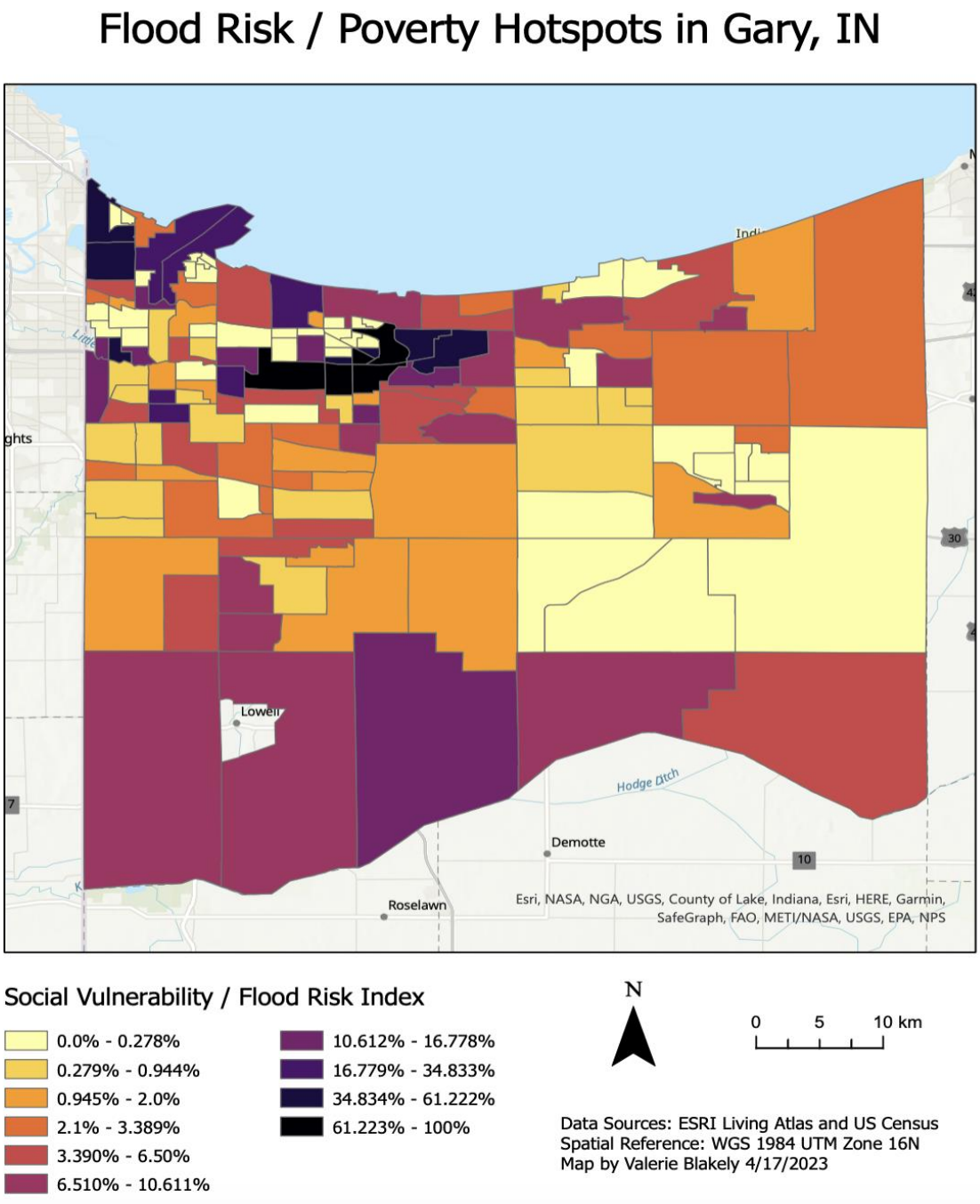

Figure 7. Flood Risk and Poverty Hotspots in Gary, IN (US Census 2020)

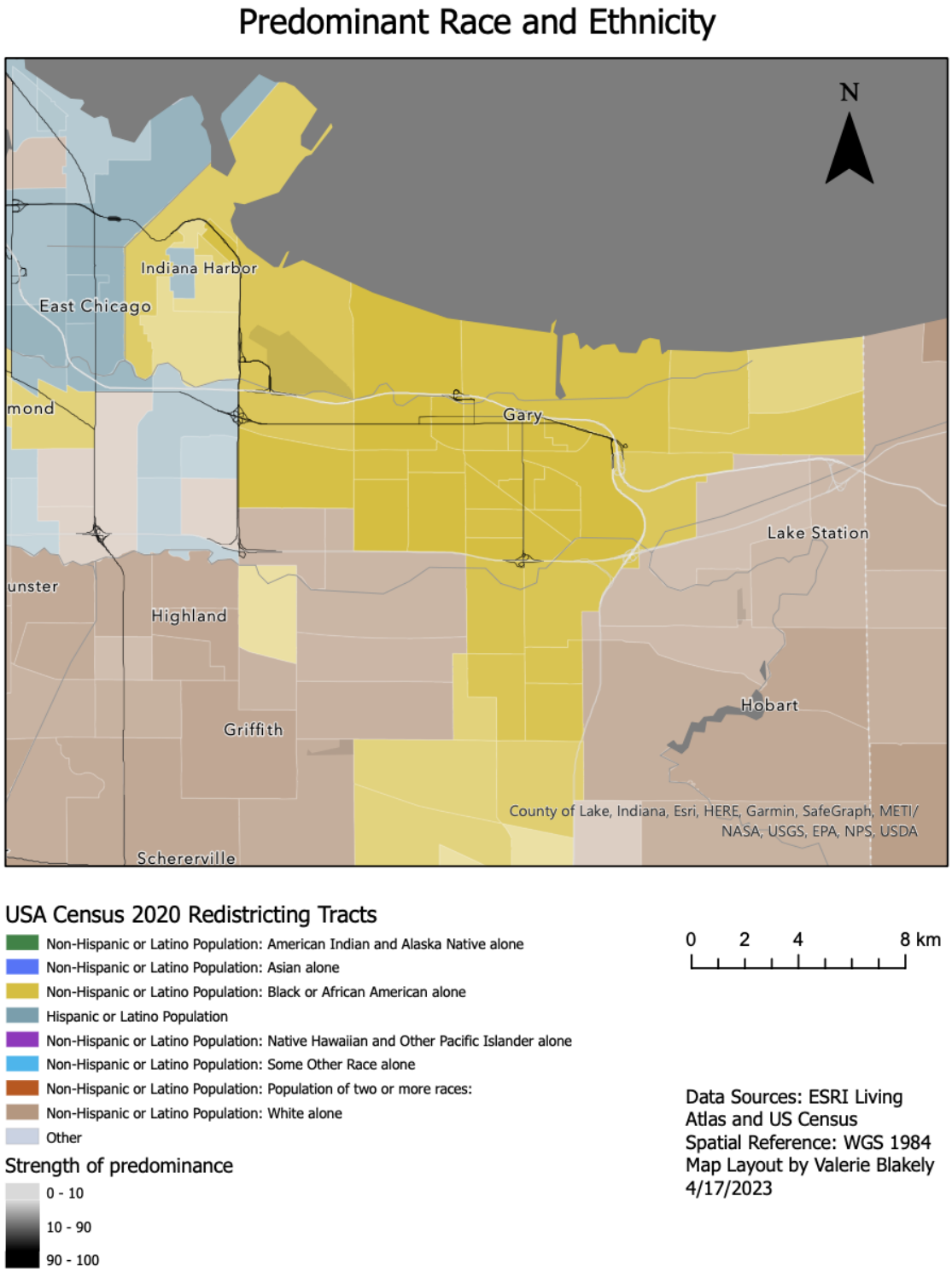

Figure 8. Predominant Race and Ethnicity in Gary, IN (US Census 2020)

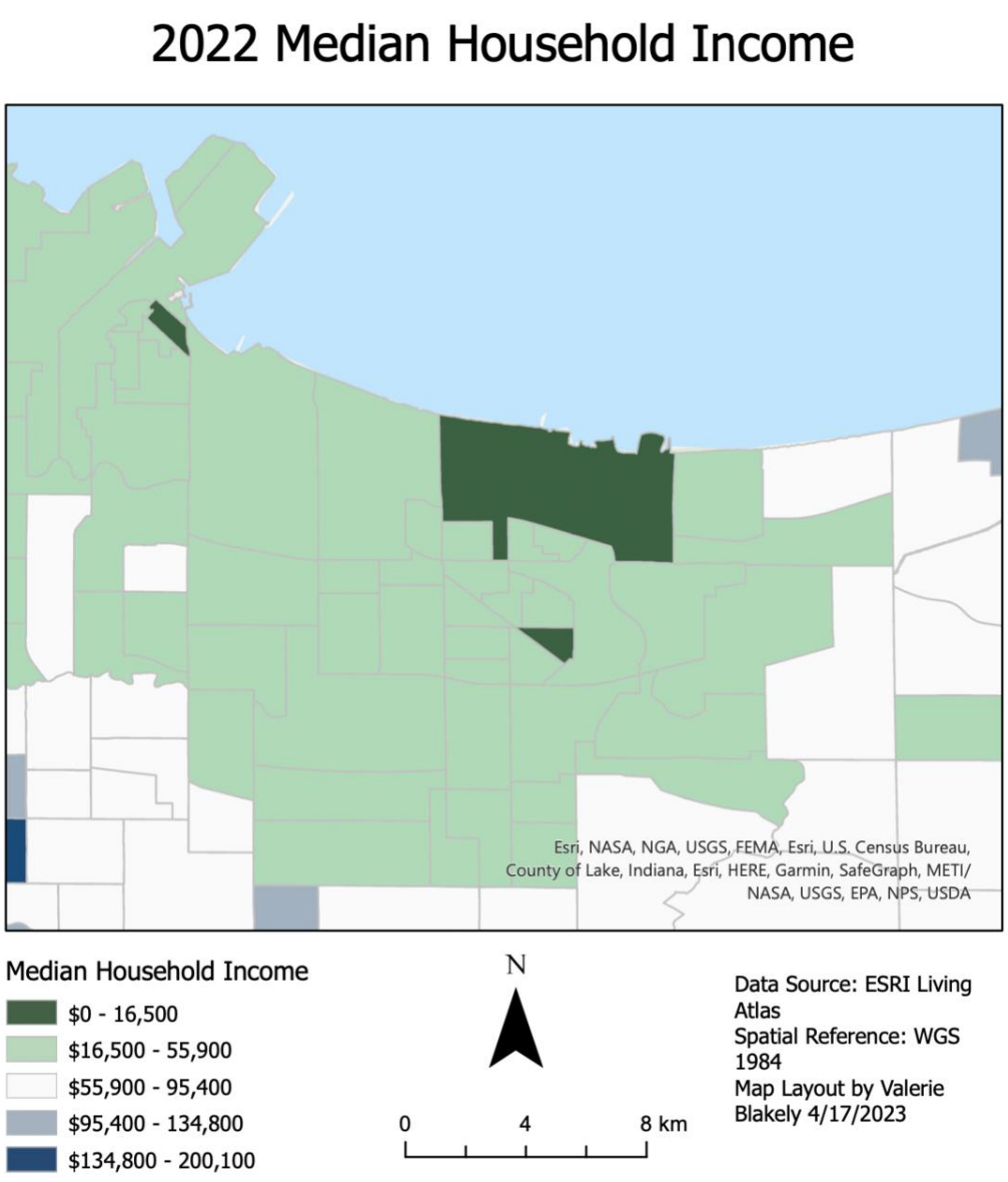

Figure 9. Median Household Income in Gary, IN

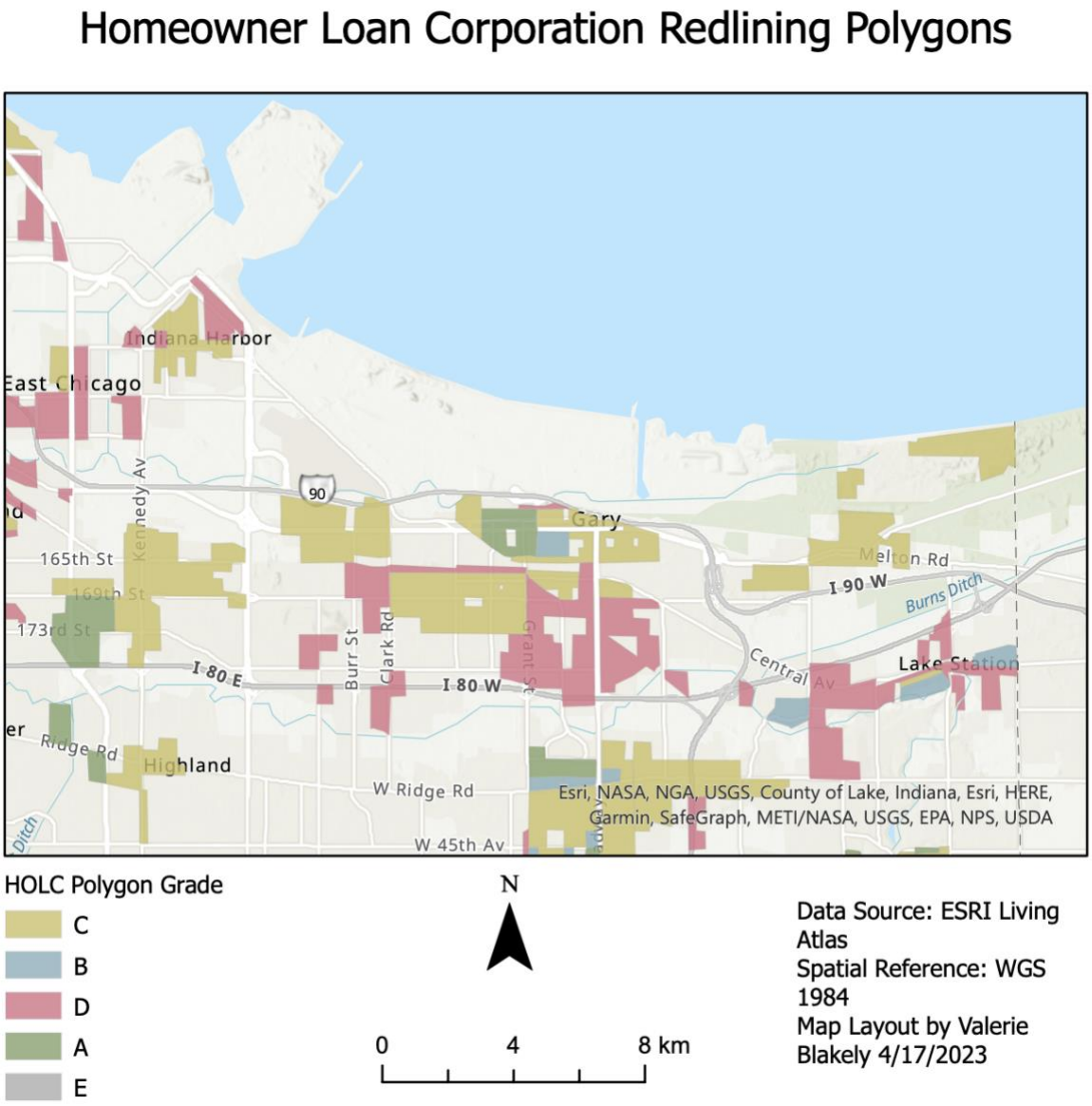

Figure 10. HOLC Redlining Grades in Gary, IN. HOLC = Homeowner Loan Corporation. Neighborhoods were assigned one of four color-coded letter grades: D = "hazardous," C = "definitely declining," B = "still desirable," and A = "best."

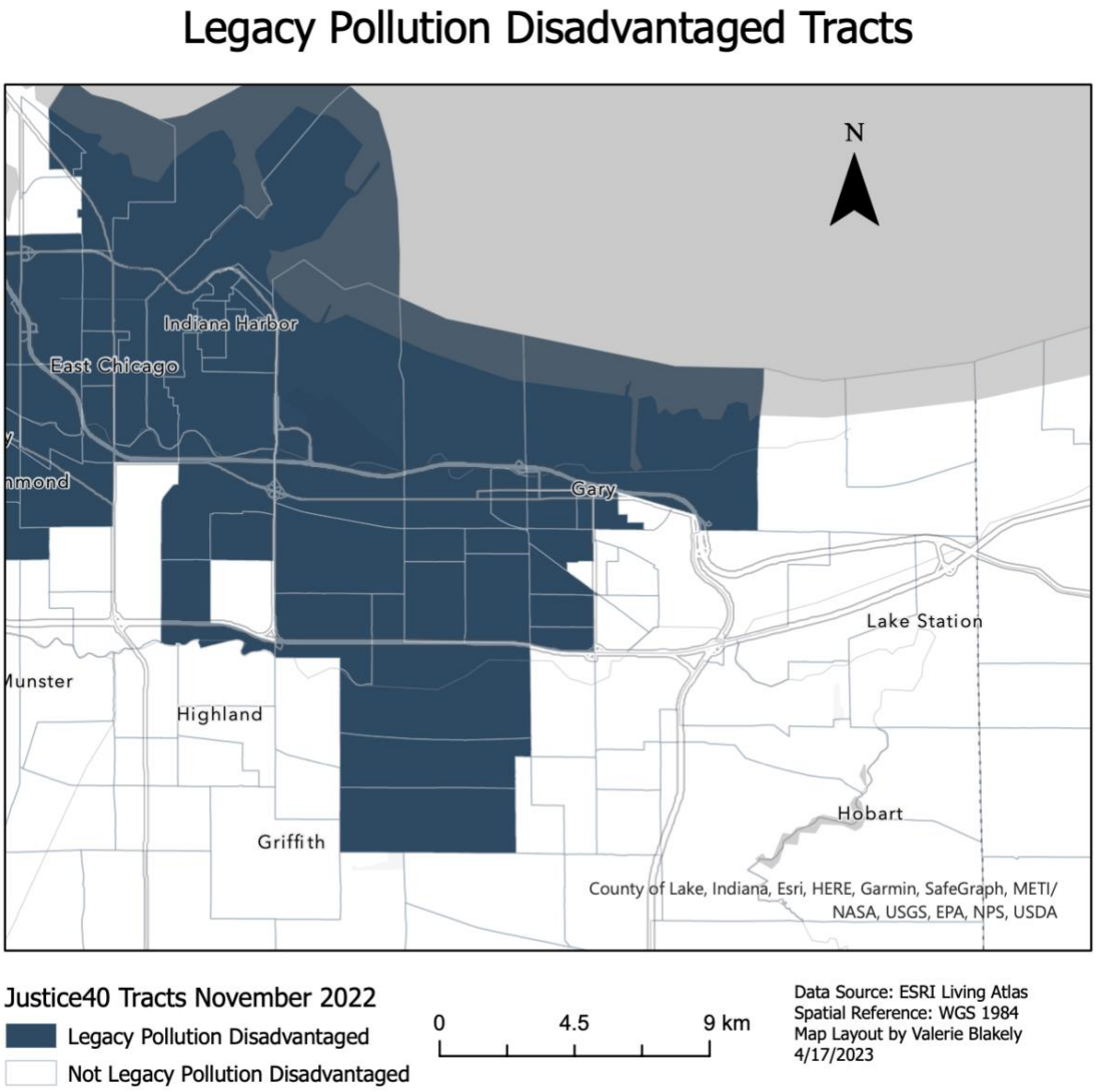

Figure 11. Legacy Pollution Disadvantaged Tracts in Gary, IN. . A Census Tract is considered to be Legacy Pollution Disadvantaged if they: have at least one abandoned mine land; formerly used defense sites; are at or above the 90th percentile for proximity to hazardous waste facilities; proximity to Superfund sites (National Priorities List (NPL)); or proximity to Risk Management Plan (RMP) facilities & are at or above the 65th percentile for low income.

Gary is situated at the southern tip of Lake Michigan and is well-known for being a rust belt industry town, having beautiful beaches, and being home to one of the rarest butterflies in the world. In addition to West and Porter beaches, Gary's neighboring natural gem is Indiana Dunes National Park, which receives more than 2 million visitors annually (nps.gov). According to the 2020 U.S. Census, 78% of the population was black or African American, 13% was White or Caucasian, roughly 9% were Hispanic or Latino, and the rest were other races or a mix of races. In 2020, the average income per household was approximately $31,000; ranking below the average income of U.S

households. Compared to our other four study sites, Gary was the third biggest city, with roughly 69,000 residents (nps.gov).

In 1906 Gary, Indiana was founded by and named for Gary Works, later the U.S Steel Corporation: one of the first major U.S steel companies in the world, and which impacted and displaced the Black community economically throughout generations (Gary.gov). For most of its 20th Century history, Gary's economy was dominated by steel-making. Due to Gary relying on one source of capital, which eventually experienced national and global competition, its steel-industry economy declined in the 1980s. As a result, hundreds of Black working-class families entered poverty. Many white people fled the city (termed white flight), diminishing the tax base and leaving the city further devastated as the steel mill industry further shrunk. Black and other minority residents remained, as they did not have the resources to move as did their white counterparts. Uneven patterns of investment led to a patchwork of natural and urban landscapes across the city. In our observations, we noted various train lines (some in use and some abandoned), abandoned industrial buildings, and unkept sidewalks. There was also once a functioning water park and community center, but they are now empty and unkempt. To this day, Gary continues to experience the after-effects of disinvestment and economic decline.

Findings

Structural Inequity.—Structural inequity is illustrated through the lens of historic patterns of racism since the founding of Gary and is evident through the inequities that the community faces as a result of flooding events catalyzed by climate change. An interviewee mentioned that several families experience mold and other toxins that come from flooded basements. In addition, community members mentioned that most could not afford flood insurance (compared to their wealthier neighbors outside the city limits) because Gary is an impoverished coastal city; as climate change is further increasing the rate and intensity of floods. As mentioned by an interviewee in Gary, for the benefit of wealthy residents, the United States Army Corps of Engineers installed gray infrastructure around Gary to control flooding in affluent areas. A community organizer in Gary mentioned that the lower income neighborhoods carry the additional burden of being surrounded by gray infrastructure that helps in mitigating flooding for the affluent areas:

> “So what they did was the Army Corps of Engineers built higher dams and levees to prevent that from happening and they use a good portion of Gary up near Marshalltown near my old neighborhood. There's like a, like, a flood area, like an emergency flood area. Unfortunately, it takes up quite a bit of real estate in Gary for the sake of other communities.”

After flash floods in 2008, many people in Gary were unable to rebuild their homes due to lack of funding and city infrastructure, which intensifies economic inequity and leaves communities of color at a disadvantage.

Environmental racism and injustice are embedded in institutions which have negative impacts on communities of color and thus impact their connection to green spaces. An environmental and social justice advocate we spoke to emphasized, Gary was and is still experiencing environmental racism, which has been embedded in the many core institutional systems. An example of an institution is policing of conservation spaces. In natural areas that are conserved for the public, invasive policing can often create a sense of exclusion to people of color and low-income groups. An interview in Gary explained that in some of the nature preserves that are open and have trails in the middle of neighborhoods, the people that lived around them have traditionally felt that they were not supposed to go to those green spaces because of constant harassment by police. Another institution that contributes to environmental racism is the placement of the steel industry in Gary creating continued pollution. As voiced by several community members, nearshore Lake Michigan waters are contaminated with pollutants from the steel mills, making it unattractive and unsafe for residents to use the beaches, leading to these spaces becoming inaccessible due to health concerns.

Due to the industrial revolution and the plethora of steel mills emitting water pollutants and greenhouse gasses for decades, along with the already added stress of the gray infrastructure in place, Gary residents suffer from air and water pollution and resulting environmental health issues, displacement, and subsequent poverty. A Program Director from The Nature Conservancy chapter in Northwest Indiana stated that access to the local Calumet River is an issue because of pollution from industry dumping toxic chemicals in the water. They mentioned that distance and transportation also contribute to inaccessibility, since people of color have to drive to get to green spaces such as beaches.

The city's Master Plan, titled "Gary Green Infrastructure Plan," shows that the city has done research and recognizes the importance for the implementation of green infrastructure in their community. They also recognize that due to social and economic circumstances, it is difficult to incorporate green infrastructure. Additionally, the Plan delves into the existing conservation projects and existing conditions their green spaces are in to help the readers contextualize what is happening in their community. The master plan also goes in depth outlining and explaining 3 distinct purposes for implementation of green infrastructure. The three purposes are: environmental conservation, stormwater management, and beautification and recreation purposes. They also include zoning and permitting guidelines for implementation of infrastructure and provide a financial analysis that outlines management, funding, and financial strategies to successfully make this project a reality.

Education and Awareness.— Gary's youth lack opportunities to learn about their local coastal environment and are not aware of issues endangering it. Several schools are shutting down due to lack of funding; further exacerbating the lack of young people understanding and experiencing existing green spaces; this will ultimately lead to an almost nonexistent relationship between people and the environment. A high school educator from Gary told us about her experience in public education, explaining, "[the students] had never really looked at any trail... They didn't know about the native plants

here in the region or the butterflies or anything… I think we live in such a beautifully diverse biome system and ecosystem. And yet we're not interacting with it at all. We're one of the greenest cities. We have 56 parks in the city of Gary- the city of Gary is only 57 miles long." The lack of not implementing better awareness in schools about the environment leads to an educational inequity for the youth as they do not have the knowledge of what green and blue spaces are nearby nor do they know what issues those places are experiencing as they are being affected by the intensifying effects of climate change.

An environmental conservation organization titled "Brown Faces Green Spaces" has recently created a platform that connects culture to nature and its history to the outdoors as a means to educate and connect people to green spaces (BrownFacesGreenSpaces). They achieve this by holding community activities in the outdoors such as bonfires and sharing narratives of the people who live in Gary, hold workshops outside and virtually, partner with the Douglas H. Center to inform families on environmental education, and among other creative ways to bring communities together. Although there are some conservation collectives such as Brown Faces Green Spaces that are starting to do this crucial work in Gary, we believe that there is still more to do in the local government sector by bringing justice to people being displaced by lack of education, funding, and heavy industry affecting their livelihoods.

The dominance of Chicagoan news and lack of local information sources hinders the ability for Gary residents to learn what is happening regarding their community, coasts, and green spaces. This has a direct relationship with how community members are educated on topics pertinent to their area. According to a community leader, a large number of people do not know that the relatively new Ivanhoe Nature Preserve exists nearby. They also suggested that the community would benefit from a news syndicate specifically catered to Gary. They Informed us,"...In the recent past, our newspaper… *The Post-Tribune*, they left the city of Gary… They've been [here] for… 80 years, most of the city's history… and ultimately, they got acquired by *The Chicago Tribune*. And now it's… hard to know…what's just happening in our community." By having a local news syndicate, people can access this knowledge, as well as the recreational resources near them and the green spaces they have in their backyard. Without this access, residents are less likely to know what environmental and coastal issues are close to home and how they can be affected by them.

Toledo, Ohio

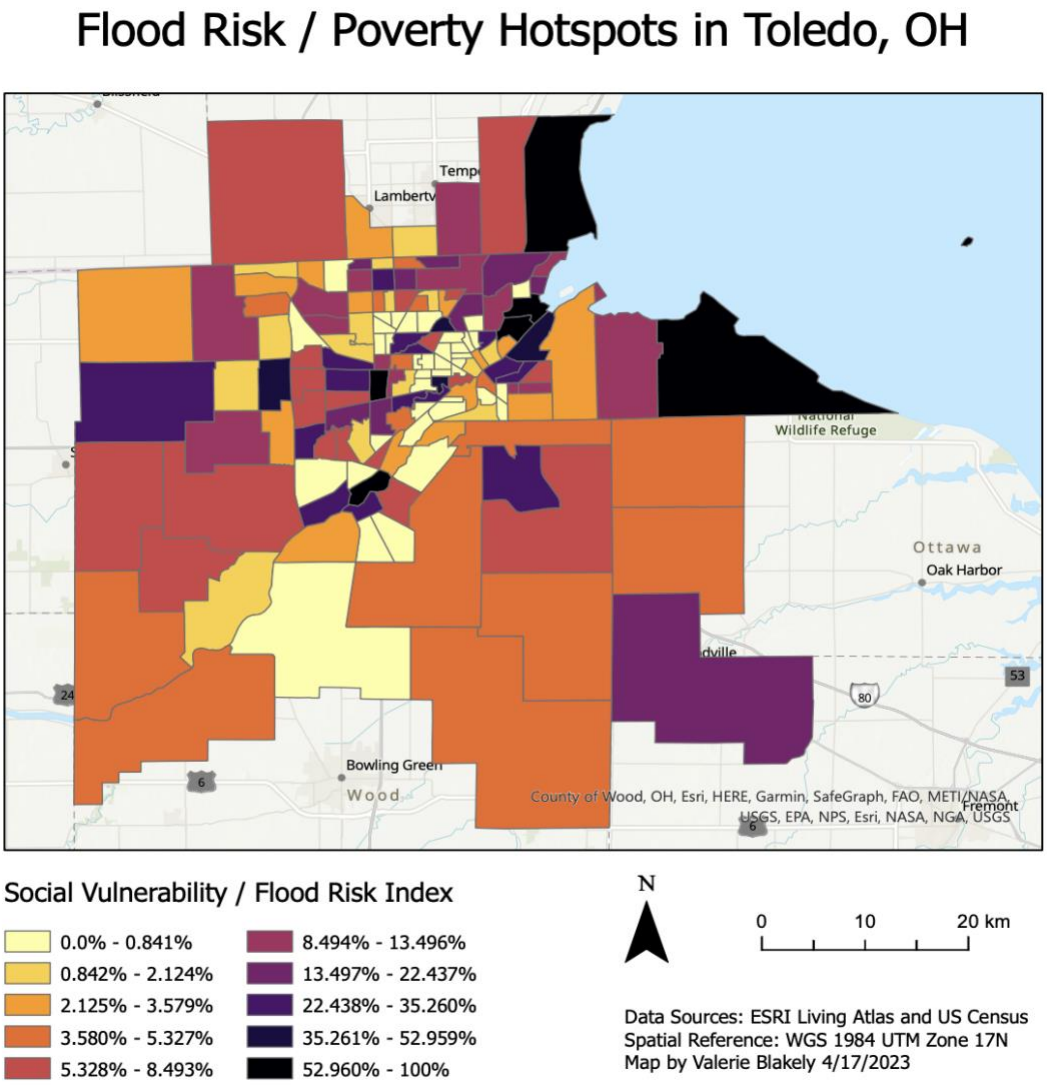

Figure 12. Flood Risk / Poverty Hotspots in Toledo, OH

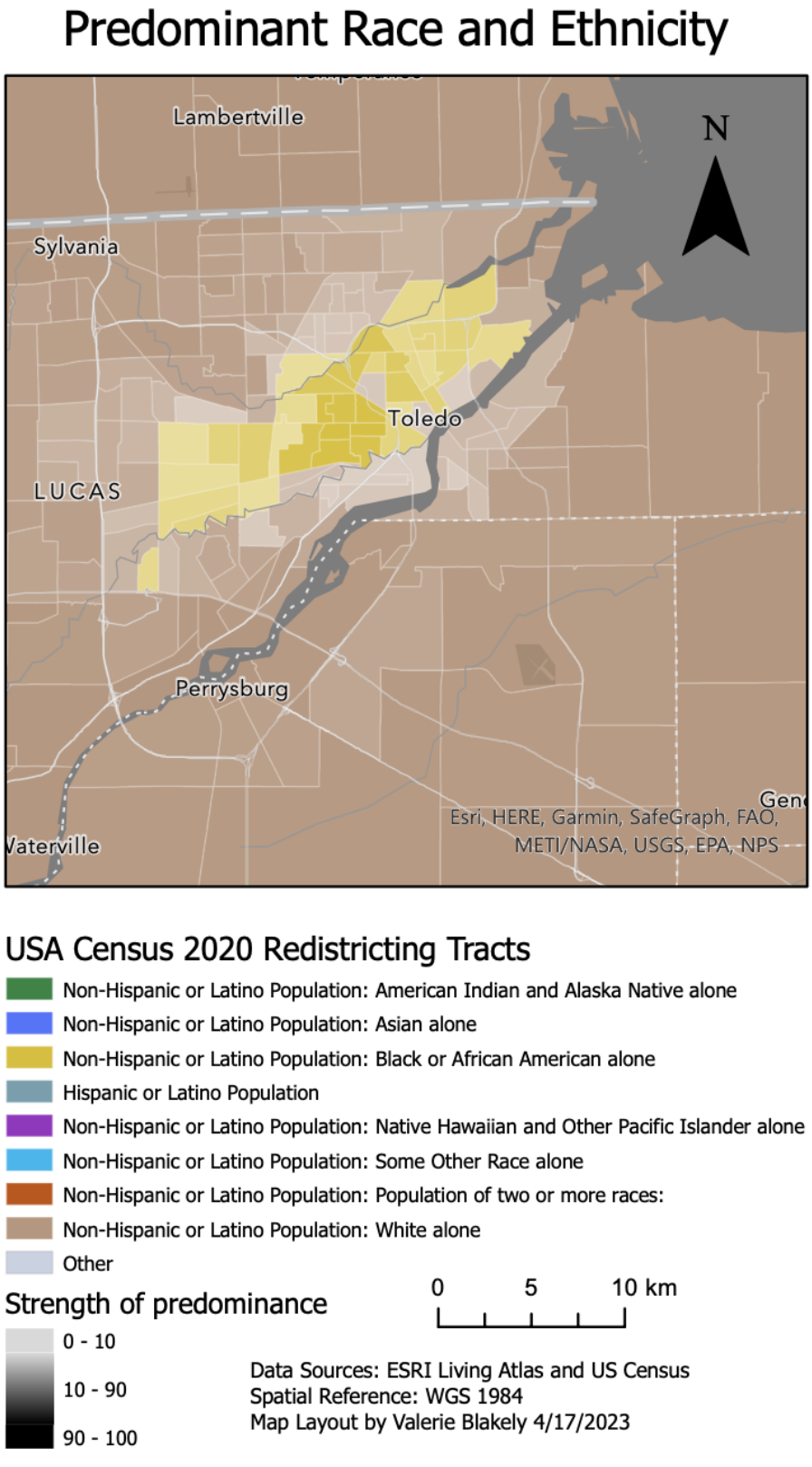

Figure 13. Predominant Race and Ethnicity in Toledo, OH (US Census 2020)

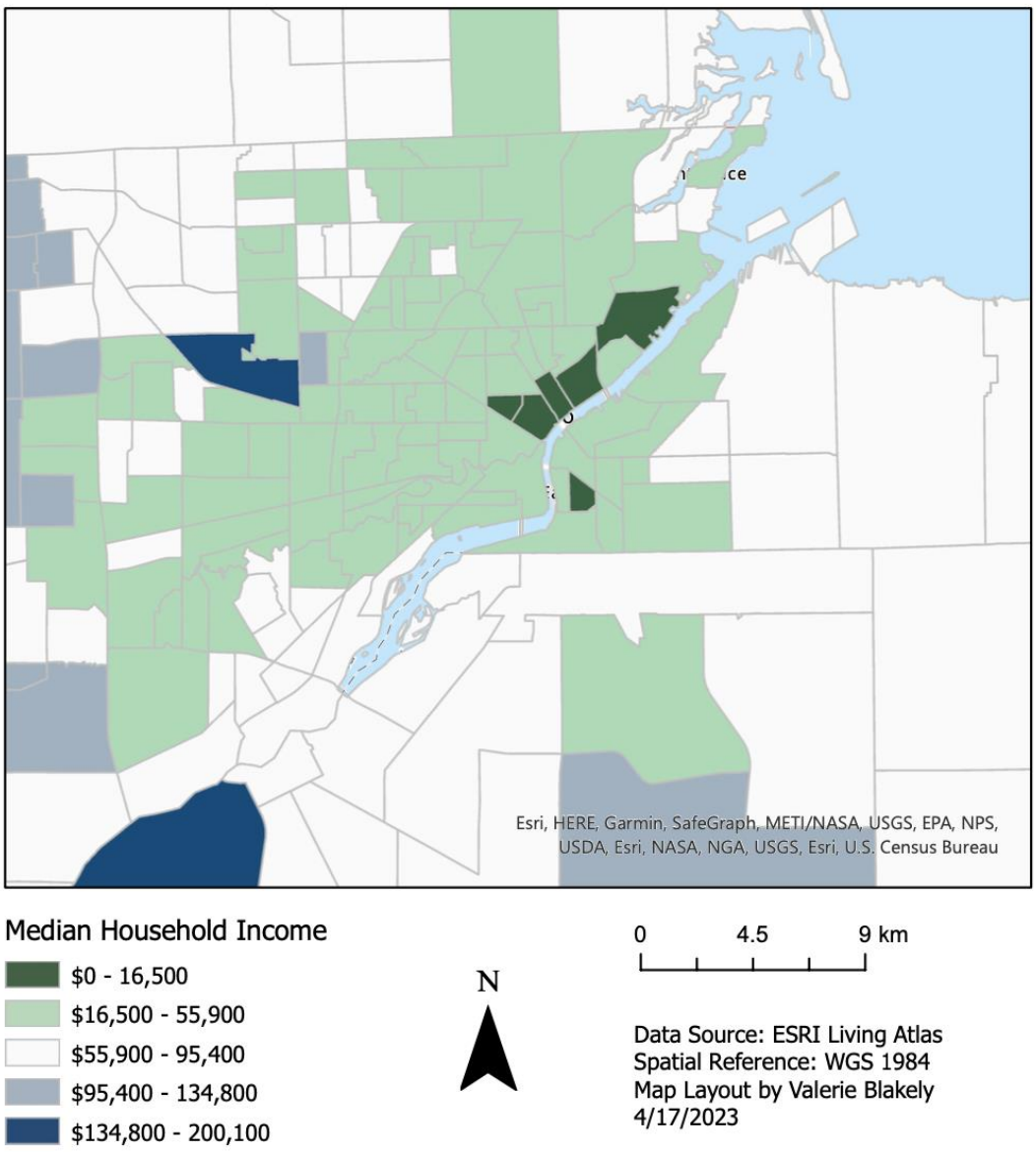

Figure 14. Median Household Income in Toledo, OH

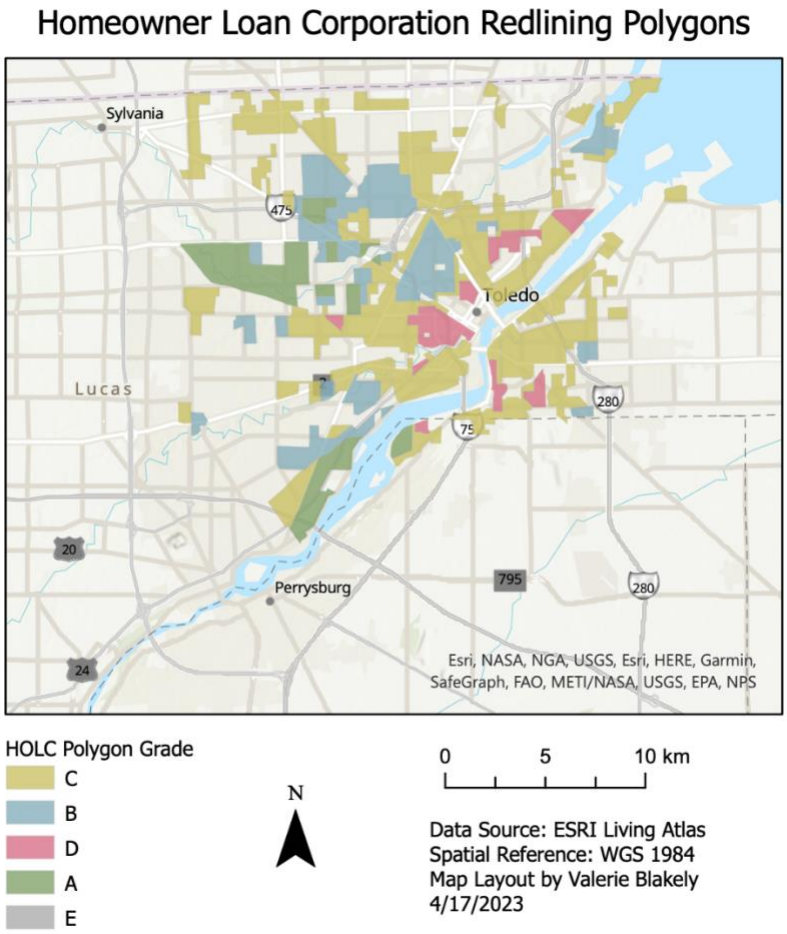

Figure 15. HOLC Redlining Grades in Toledo, OH. HOLC = Homeowner Loan Corporation. Neighborhoods were assigned one of four color-coded letter grades: D = "hazardous," C = "definitely declining," B = "still desirable," and A = "best."

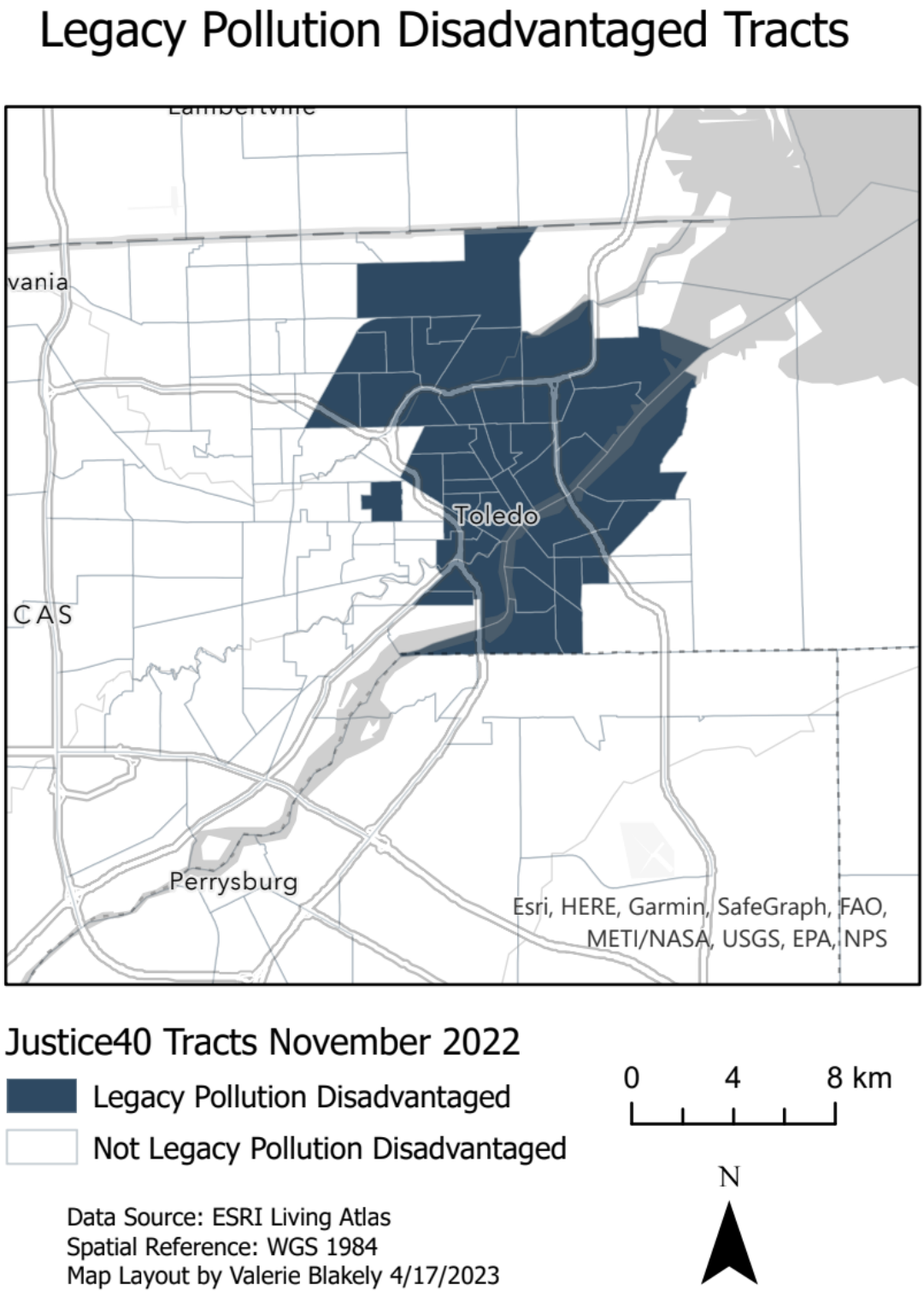

Figure 16. Legacy Pollution Disadvantaged Tracts in Toledo, OH. . A Census Tract is considered to be Legacy Pollution Disadvantaged if they: have at least one abandoned mine land; formerly used defense sites; are at or above the 90th percentile for proximity to hazardous waste facilities; proximity to Superfund sites (National Priorities List (NPL)); or proximity to Risk Management Plan (RMP) facilities & are at or above the 65th percentile for low income.

The coastal city of Toledo sits on the banks of the Maumee River, at the edge of the former Great Black Swamp, once a vast system of wetlands leading to Lake Erie in northwest Ohio. These swamps and marshes were drained by the end of the 19th century to make way for railways and agriculture, and the city has since developed around a variety of industries. Today Toledo is a highly developed, industrial landscape. This urbanization was evidenced by a 2021 exploration of urban heat in Toledo that found very high temperatures concentrated in downtown areas. Urban heat stress was highest in neighborhoods with residents of color and lower median household incomes. As of the 2020 census, the racial demographics of Toledoans were approximately: 61% White, 28% African American, 9% Hispanic or Latino, 7% mixed race, 0.3% Native Americans Alaskans or Hawaiians, and 1.3% Asian.

Incorporated in 1836, Toledo emerged as an important trading hub and became an industrial center throughout the rest of the century, with both glass and automotive companies enjoying notable success. This “Glass city” connects shipping from the lakes with the Erie Canal and railways spanning the US. Currently, its harbors play a significant economic role in the city’s ongoing recovery from contractions in the American automobile industry in the 2000s, the effects of which are still playing out. The Port of Toledo moved more than 11 million short tons of cargo in 2021, processing approximately 8% of all shipped material in the Great Lakes-St. Lawrence Seaway and contributing $669 million USD to the regional economy.

Findings

Education and Awareness.- Natural infrastructure and nature-based solutions are often implemented, or at least, considered in Toledo to solve a visible pressing problem, rather than for their own sake or inherent value. One of our interviewees presented one such challenge-plus-opportunity saying, “a lot of [sediment] is coming off the farm fields, maybe there's an opportunity to return [dredged sediment] to farm fields. Or maybe there's an ability to make wetlands out of the dredge material.” Programs made by local lawmakers took nutrient-rich material dredged up from the harbor with nowhere to put it and processed it into fertilizer for farmers in the area. This is a nature-based solution that appears born from the area's past problems with enriched runoff and the destruction of coastal wetlands to make room for a larger harbor, both of which have contributed to disastrous harmful algal blooms in Lake Erie. Through efforts at wetland restoration and erosion control, Toledo seeks a better environmental equilibrium than their past status quo, but this appears to be through a reactive problem-solving-mindset, as opposed to a proactive vision of the future that promotes the resilience they are looking for.

This narrow scope of this problem-solving and absence of a strong proactive desire to establish natural infrastructure has led to fewer funded natural infrastructure projects. One project mentioned by an interviewee entailed “…restoring chains of islands and absorbing some [lake] energy, and being strategic about, placement of structures and… riprap…” to protect more of their shoreline from erosion. When natural infrastructure

was strategically and financially feasible here, hardened approaches were still part of the solution. When natural solutions were neither financially nor temporally feasible, as is the case for landowners applying for short-term shore protection ahead of a storm, natural infrastructure have not been part of the conversation; rather, owners only consider what is most effective at avoiding short-term catastrophe. This short-term approach may temporarily protect segments of shoreline in their current form but it also supports the past financial decision to build valuable assets close enough to the shoreline that they are put at risk when the shoreline changes naturally. Natural infrastructure can be implemented to decrease negative impacts of erosion and return to a natural shoreline. Its interruption of a "typical shoreline" will likely change the pattern of landowners maintaining high value buildings close to the shore, but in exchange for this behavioral and financial disruption, natural infrastructure more directly addresses the root problem of catastrophic erosion and prevents risk in the long term. When assessing environmental problems, looking at the broader context of natural processes like nearshore sediment cycling, as opposed to localized erosion at one location can lead to valuable insight regarding more sustainable and lower risk solutions like applying natural infrastructure, though these benefits may be discarded when resources like seed money, community investment, and time are limited. The value inherent in solving problems using this kind of broad scope includes not only lower erosion risk, but also the ecosystem benefits delivered to the landscape when natural infrastructure is used as a solution.

Factors Impacting Project Success - Toledo is an example of a city where environmental and equity interests compete for funding with both neutral and directly opposing interests. When asked about the current state of, and potential for, improved public transportation in the area, our interviewees mentioned road quality as a common worry, where, "...the running joke is… 'we can't even fix our roads'. So if we can't fix our roads, how can we do the whole transportation system?" In this case, construction costs required for a reimagining of the city's transportation network to include effective public transit from low-income communities to the lakeshore conflict with the less costly, short-term task of repairing potholes in the current network. The latter improves the state of individual driving in the city, but diverts investment away from a long-term investment that can improve the transit system as a whole and increase equitable access to and education about green spaces.

Government funding and decisions are restricted by legislators' terms and time-cycles, creating only short-lived support for projects that, when focused on building community capacity and coastal resilience, require long-term investments and trust. Ohio's Department of Natural Resources currently grapples with how to fund natural shoreline projects for sediment management, to reduce the percentage of hardened shoreline while still addressing erosion. One of our interviewees explained the dilemma, "the thing about nature-based shorelines is that they will require more long-term maintenance… The federal government really can't commit much more than… two years of funding. By law, the state of Ohio…can't commit any more than two years… We work on a biannual budget, and unless it's appropriated by the legislature, I can't say I'm gonna fund this for 10 years... Municipalities are also limited the same way." The high demand for even hard infrastructure protection by private landowners requires more funding than is

currently effectively allocated, even with respect to federal safety nets. Current efforts to bridge this funding gap in Ohio include their Senate Bill 51 passed in 2019, that lets people create a community private-public partnership that can bring in private and public dollars to pay for shoreline protection structures in areas with varied incomes. Solutions to capacity gaps like this and more will be sorely needed to fund natural infrastructure that often has a higher upfront price. The way governance is structured to provide funding for only short periods at a time also creates funding gaps that struggle to cover short term protections, much less align with the long-term support that sustainable solutions like natural infrastructure require to be successful.

The sporadic nature of state government budgeting makes the long-term implementation of environmental restoration more difficult. This applies both to standard project funding and a hot-button issue's ability to remain relevant and generate momentum that the public can translate to political support. The US or a state's government cannot serve all public interests, especially concerning environmental degradation and remediation, when those interests also conflict with private interests and investments. Similar to Toledo's negotiation between problem solving in the short term versus the long term, most energy towards implementing natural infrastructure seems directed towards discovering common ground and compromise.

Powerful industries also influence what barriers exist to improving coastal resilience. Ohio presents a prime example of tension between environmental resource protection and extraction in its dominant agricultural sector. According to an interviewee, in Ohio, "one of the constants is the state legislature,...- since 1803, is dominated, I think, largely by rural interests, because we are… from the beginning an agricultural state… you have to ameliorate or come to some sort of accommodation with colleagues in the ag community." When agricultural interests conflict with environmental health interests, just like when hard infrastructure is found to be cheaper than natural infrastructure, environmentally friendly initiatives become much harder to implement. Any investment in the environment that also disrupts agriculture will experience more push-back, and require more collaboration and compromise in a state with a history of a strong agricultural industry than in a state without one. For example, Ohio agreed to hit a target of a 40% reduction of the amount of phosphorus running off into Lake Erie by 2025. That number is unlikely to be reached, due to the region's long standing history of agricultural runoff going into the Lake and an unwillingness to antagonize a powerful industry. Instead of being viewed as a priority amidst opposition, investments in natural infrastructure in Toledo manifest from governmental collaborations with "strong partners along the coast", both environmental NGOs, ports, and municipalities. This approach favors practical and short-term action, but offers relatively sparse opportunities to realize long-term sustainability goals and improvements to sustainability.

Milwaukee, Wisconsin

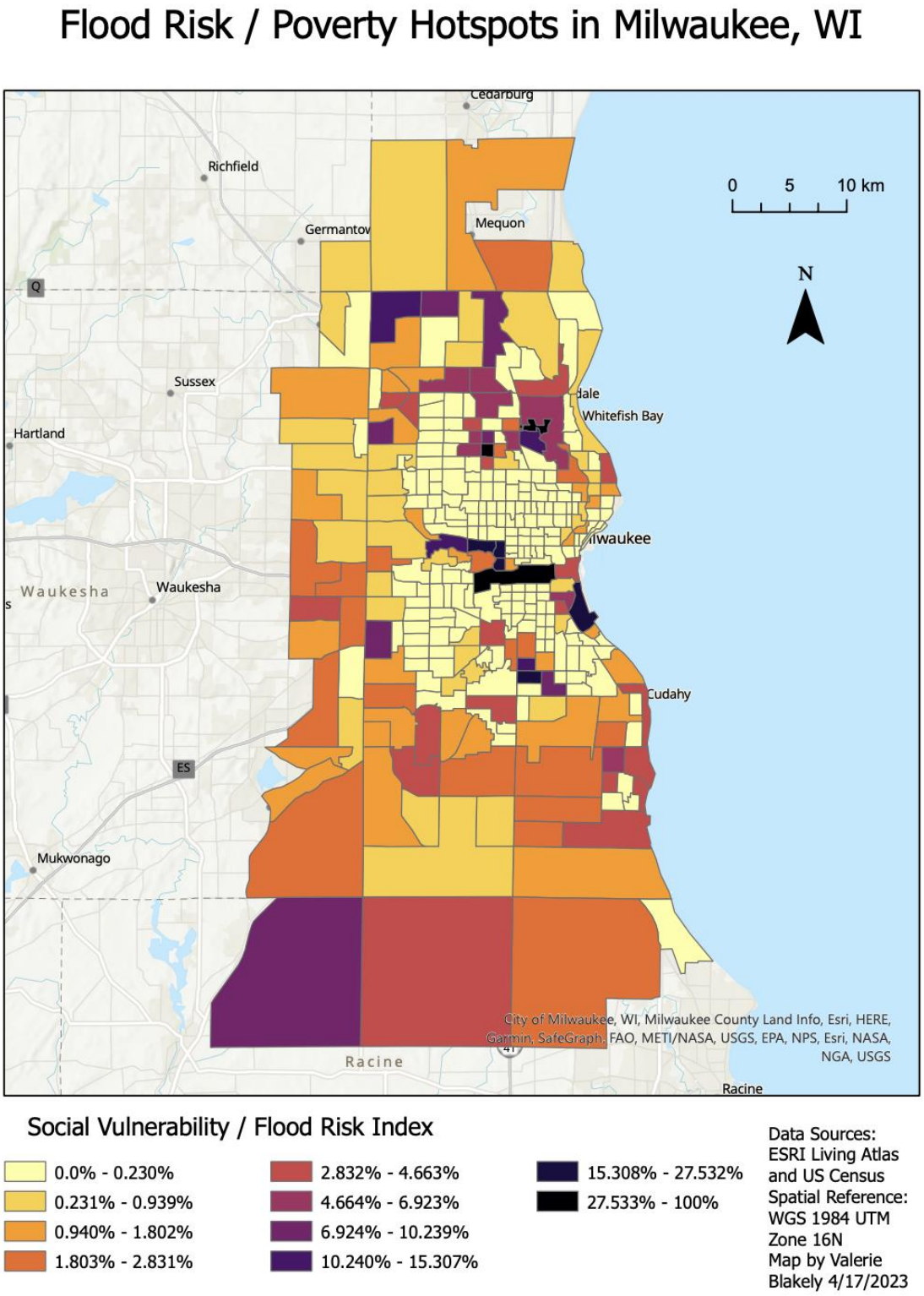

Figure 17. Flood Risk and Poverty Hotspots in Milwaukee, WI

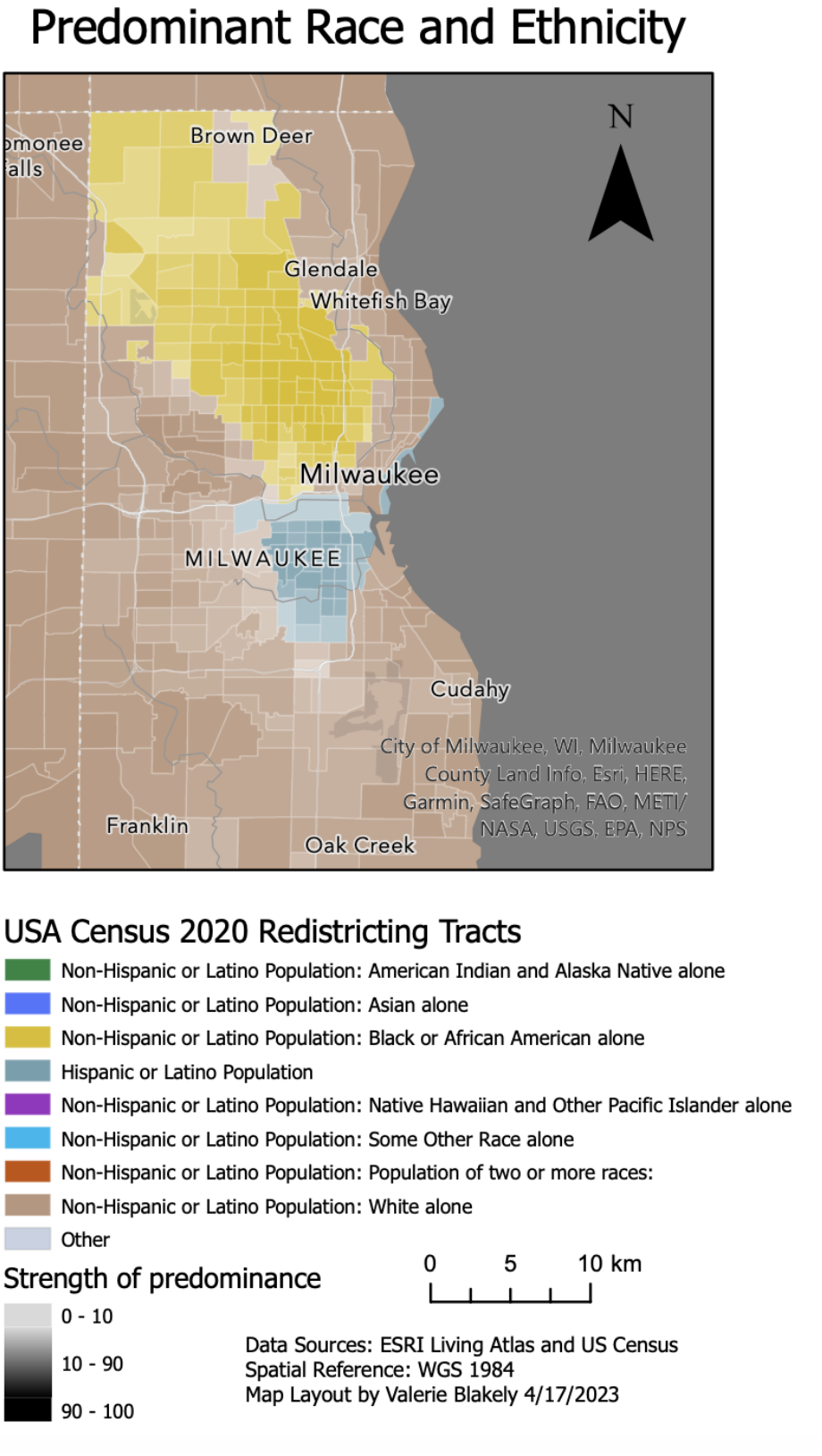

Figure 18: Race and Ethnicity distribution in Milwaukee, WI

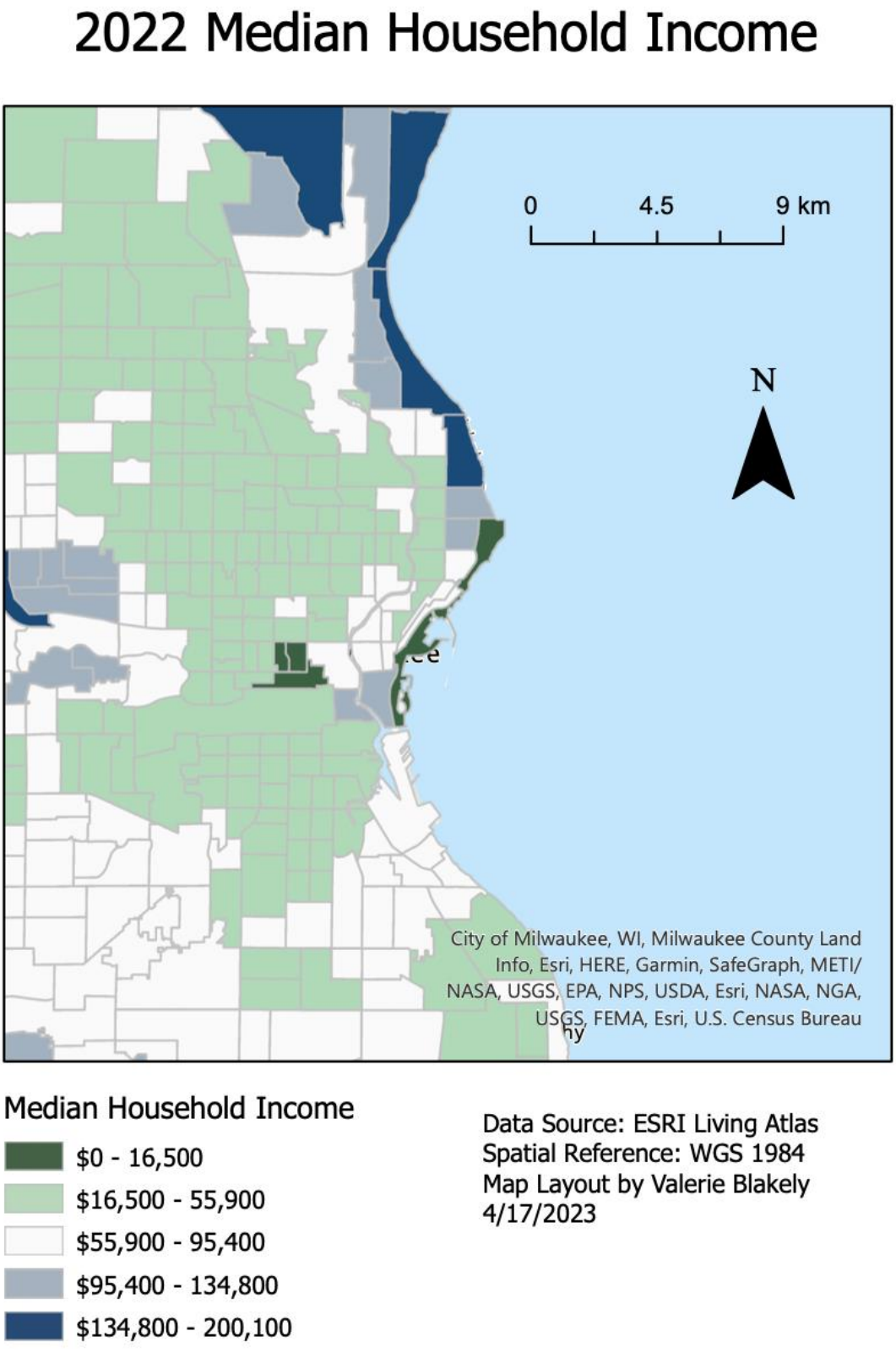

Figure 19. Median Household Income Distribution in Milwaukee, WI

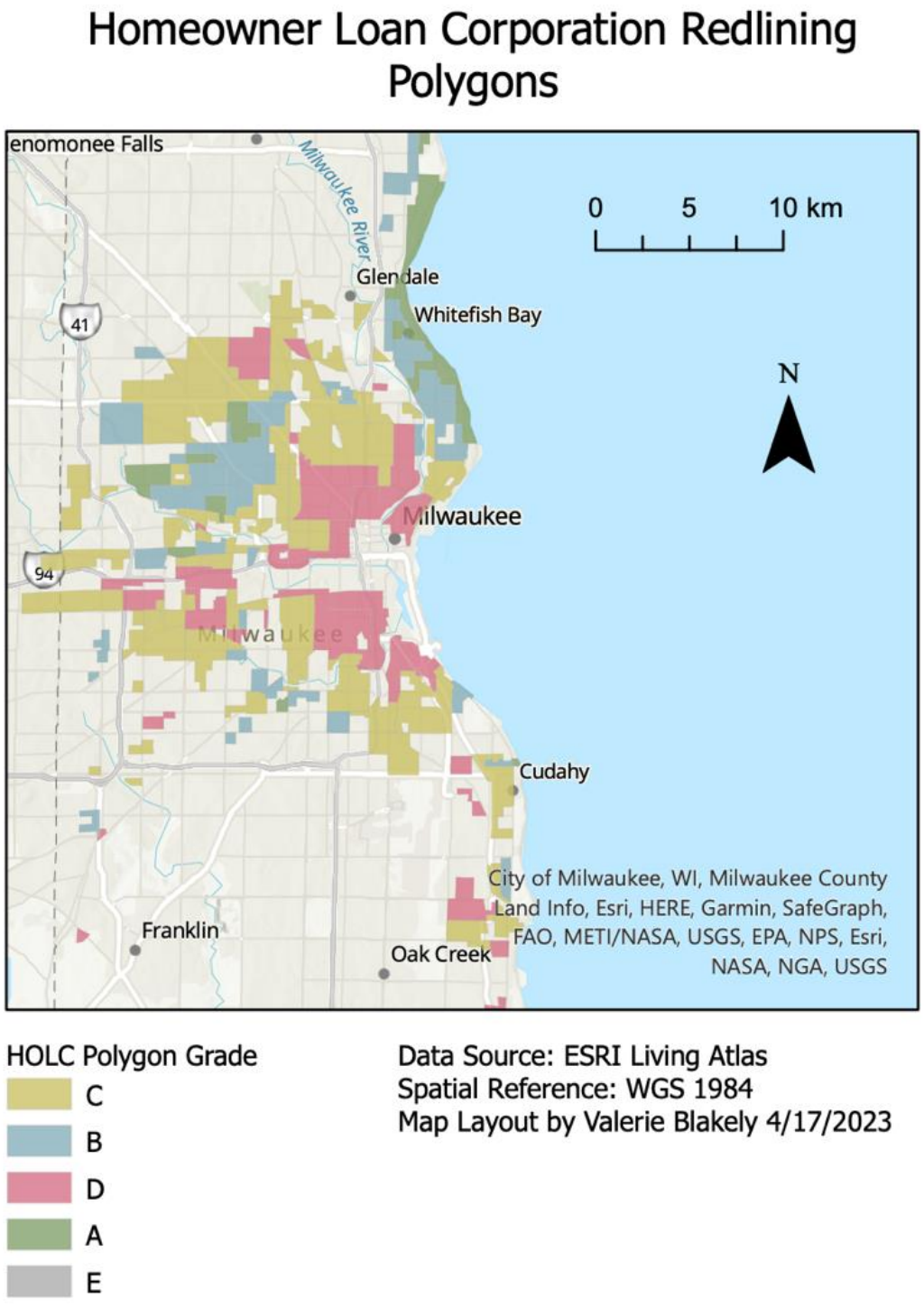

Figure 20. Map depicting redlining grades in Milwaukee. HOLC = Homeowner Loan Corporation. Neighborhoods were assigned one of four color-coded letter grades: D = "hazardous," C = "definitely declining," B = "still desirable," and A = "best."

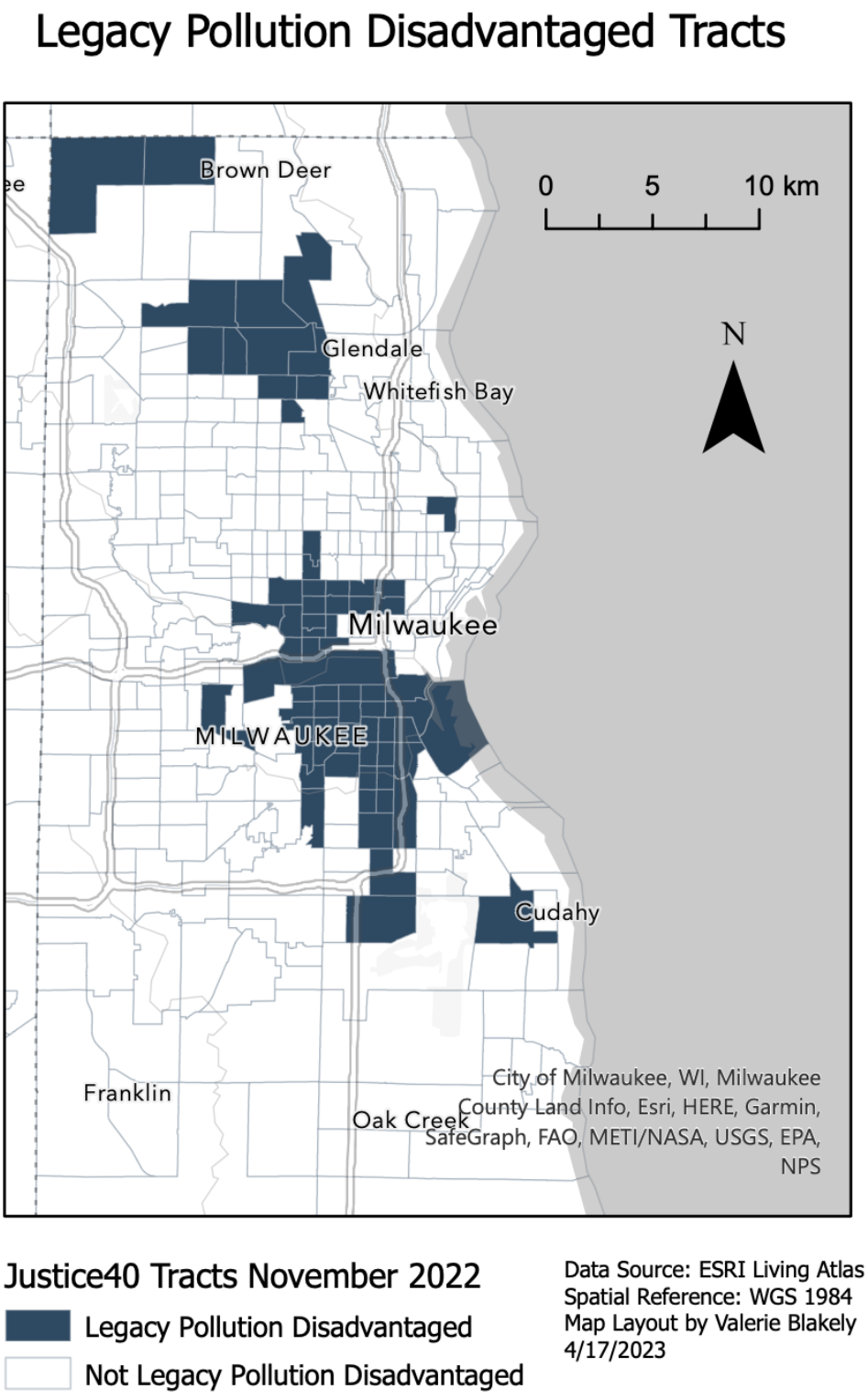

Figure 21. Legacy Pollution Disadvantaged Tracts in Milwaukee. . A Census Tract is considered to be Legacy Pollution Disadvantaged if they: have at least one abandoned mine land; formerly used defense sites; are at or above the 90th percentile for proximity to hazardous waste facilities; proximity to Superfund sites (National Priorities List (NPL)); or proximity to Risk Management Plan (RMP) facilities & are at or above the 65th percentile for low income.

Milwaukee, Wisconsin lies on the western shore of Lake Michigan at the confluence of three rivers: the Menomonee, the Kinnikinnick, and the Milwaukee. Steep bluffs along the lake shore begin about a mile north of downtown. Milwaukee was the largest of our study locations, with a racially mixed population of about 570,000. According to the 2020 census, the city's demographic makeup was 38% Black or African American, 36% White, 20% Hispanic or Latino, 5% Asian, 0.9% Native American, and 9% other races.

Milwaukee is a port city with a long history of fur trading, commerce, and shipping. Similar to other cities in the Midwest, it experienced an industrial boom in the late 19th and early 20th centuries, followed by industrial decline, and is now in the process of rebuilding. In the late 1800s, the city became a hub for shipping wheat, as Wisconsin was a major wheat producer and Milwaukee's port provided access to Great Lakes transport. A brewing industry, which is prominent to this day in Milwaukee, grew out of the wheat trade. The processing of barley and hops helped the city become home to Schlitz, Pabst, and Miller brewing companies, and made Milwaukee the number one beer producing city in the world for many years. Milwaukee's Menomonee River Valley, which flanks the Menomonee River and divides the north and south sides of the city, has historically been home to manufacturing, stockyards, shipping, and other heavy industry. As a result it has been a primary area of pollution and degradation. Foreign competition grew during the mid-20th century and Milwaukee's manufacturing sector began to decline. Since 1970, Milwaukee has experienced a 40% decrease in manufacturing jobs, which has harmed its middle class (Orum 2019). Today poverty persists, particularly in the inner city, and Milwaukee is one of the most racially segregated cities in the country.

The city is in the process of recreating itself both socially and economically. Extensive work has been done to clean up pollution in the rivers. Buildings–including restaurants and apartments–increasingly face the river rather than it being at their backs, and the Milwaukee RiverWalk stretches for 20 blocks through downtown, centering the water as a place to visit and admire. The city also has demonstrated a strong commitment to developing a "blue economy" through approaches such as integrated water management, water related industry, water education, and water stewardship, and is regarded as a leader in this way in the Great Lakes region (Katt and Waldhuetter). Milwaukee is also currently ranked as a global city and is home to the international headquarters of six Fortune 500 companies.

Our Findings

Structural Inequity.— Despite Milwaukee's leadership and success, entrenched systemic patterns of racism, and discrimination shape access to green space and risk of exposure to flooding and pollution. Many of our interviewees reiterated the strong degree of racial segregation. Much of the Black population is concentrated north of the Menomonee Valley with the Hispanic and Latino population concentrated close to its southern bank (Figure 18). The white population is primarily located along the coast and

in the suburbs, and median household income is highest along the coast. This pattern has consolidated populations of color in the inner city with limited access to water and green space, and a lack of access to public transportation reinforces this problem.

Race continues to play a strong role in determining access to the lake through geography, transportation, and discrimination. One interviewee mentioned that many of the kids they work with (who are primarily from minority communities) have never even visited Lake Michigan. Another remarked that kids who live only ten minutes from the lake have never seen it. On top of this, it was noted that police harassment keeps people of color from visiting the lakefront. Another interviewee stated, “there are a lot of people in the city that don't feel like they can even go to the lakefront because they get harassed by the police and really the county sheriff more than anything.” This kind of intimidation represents an important dimension of access that is not just physical and undermines marginalized communities’ ability to spend time in, and build relationships with, natural spaces.

These same populations with restricted lake access have also, in many cases, been placed at greater risk of exposure to flooding, basement sewer backups, pollution, and urban heat. Polluting industries were disproportionately located alongside low-income and minority communities, due to real-estate redlining or lack of community capacities (i.e., legal, financial, political) to resist their imposed neighborhood placement. Because these communities tend to be in dense urban environments with fewer trees and less green space, they are exposed to the urban heat island effect. Census tracts displayed a moderate correlation between heat and income according to a 2019 study by NPR.[18] This lack of urban greenery in Milwaukee's landscape and its high proportion of impervious surfaces intensify the impacts of flooding and basement sewer backups. Some of these inner-city areas are in historic floodplains with outdated, combined sewer systems, which can often become overwhelmed during storm events. Furthermore, disadvantaged communities often lack the financial means to fully recover from flood events (Houston et al. 2020). This results in issues such as mold and sewage in basements, leading to serious long-term health effects for already disadvantaged populations.

Education and Awareness.—Education and awareness play a crucial role in coastal resilience, particularly with regard to human health risks and community action. Over the past few decades, MMSD has made significant progress in decreasing the number of sewage overflow events from over 50 per year to about two per year. One interviewee noted, however, that an important catalyst to this improvement was putting pressure on MMSD through the local newspaper, *The Milwaukee Journal Sentinel*. They explained that local news no longer covers overflows and environmental health hazards and went on to say, “[it’s] a public health issue… now we have overflows, and they don't even cover it in the news. And people need to know that if they're deciding whether they're going to swim that day, or go fishing that day or go paddling that day, they

[18] The urban heat island effect occurs when natural landcover is replaced with pavement, buildings, and other impermeable manmade materials and absorb and trap heat, leading to higher daytime temperatures, reduced nighttime cooling, and higher air-pollution levels.

should know that there's sewage over there." This creates an injustice to the community as a whole because they do not know that their water is contaminated and has harmful effects to their well-being.

Despite the lake being the source of the city's drinking water, multiple interviewees noted that there is a lack of awareness among the general public about where their drinking water comes from and the importance of keeping the lake clean. Milwaukee has had issues with Cryptosporidium and Cyanobacteria contaminating its water supply, and education about protecting the public water supply is vital for public health. Additionally, any community action and support around coastal resilience issues has to begin with a basic awareness among residents about what problems exist in the first place.

Improved education and awareness have propelled much of the progress that has occurred around water in Milwaukee. Milwaukee has a significant number of NGOs that focus on water, natural infrastructure, the environment, education, and equity. For example, Milwaukee Riverkeeper is a science-based, advocacy organization working for swimmable and fishable rivers throughout the Milwaukee River Basin. They lead river clean ups, carry out water quality monitoring, and host learning events. Milwaukee is also making headway with cleaning up its Area of Concern and restoring habitats, and these efforts will only be strengthened by education and strong stewardship partnerships. The Citizens Advisory Council for the Area of Concern Program recently made a big step towards equity by restructuring itself to more accurately represent community demographics.

Factors Impacting Project Success —Inconsistencies between departments' timelines or funding structures and ecosystem processes undermine effective coastal resilience management in Milwaukee. For example, one interviewee in the Milwaukee County Parks Department explained that the lack of a committed year-to-year capital budget prevents the department from taking action fast enough to resolve collapsing slopes, failing breakwaters, and other highly vulnerable beach areas. Their department is often thus put in the position of being reactionary, rather than proactive, which leads to more problems down the road. They also noted that coastal degradation is a big challenge because it does not "respect the line of where we are investing," but rather continues to undermine work that has already been done along shorelines. This points to a mismatch between the work that departments are able to do and the ecosystem processes and dynamics that they are working with.

The process of visioning and implementing comprehensive coastal resilience work is impaired by the governance dynamic that comprises coastal resilience programs. First, MMSD lacks the authority to control people and entities upstream who continue to pollute and degrade Milwaukee's water resources. An MMSD Project Manager explained that they are trying to coordinate with nearly 30 regional municipalities in order to address these upstream issues but that doing so has been challenging because there are "28 different voices and diverse needs." Just as better collaboration is needed among municipalities, NGOs would also benefit from improved

communication. One interviewee explained that, as NGOs with specific missions experience “scope creep” and try to take on more things, they increasingly compete with one another for the same parts of limited funding. The city and county are the two most influential actors in the realm of coastal resilience work, but state and federal governments are important as well, especially in terms of funding, and NGOs are also vital actors. All of these entities have different capabilities and priorities, and do not necessarily work effectively together, which creates messiness. For example, when the state does not allow for flexibility in how the city uses funding, this can greatly impair the city’s ability to respond to issues. This was seen in Milwaukee in the context of funding restrictions around lead pipe replacements. Additionally, a member of the city’s Environmental Collaboration Office noted that a unified coastal management plan has not been completed for the city. This has led to obstacles when applying for federal funding, and conversations are ongoing about whether the eventual plan should recommend more shoreline hardening or greater emphasis on nature-based solutions.

Despite challenges, Milwaukee has seen some important successes. Milwaukee is the lead city in adopting a Blue Economy approach, which they detail in their “Water Centric city Framework” and the Milwaukee Metropolitan Sewage District (MMSD) has been a leader in progressive water management (Katt and Waldheutter). In 2012, MMSD won a Water Prize from the US Water Alliance for its holistic approach to addressing algal blooms in Lake Michigan; and treating water quality as a broad, interconnected issue spanning ecological, economic, political, and cultural realms. Significant progress with implementation of green infrastructure in the city is also being driven in part by requirements from the Wisconsin Department of Natural Resources, and the county uses a spatial equity index to prioritize investments in disadvantaged communities. While significant progress is still to be made with regard to natural infrastructure and equity, both are top of mind for many within the environmental realm and the local government in Milwaukee.

DISCUSSION

Findings

We identified a pattern in how Gary's, Toledo's and Milwaukee's community priorities are shifting that corresponded with a regional gradient in evolving excitement and support for natural infrastructure projects. During the past few centuries, many cities in the industrial Midwest turned their backs on their waterways, so to speak, using them solely for industrial purposes such as dumping grounds and shipping corridors. These three case cities illustrated a gradient of evolution beyond their historic identification with industry, and towards valuing and elevating their natural resources. The beginning stage, best represented in Gary, involves a discontent with the status quo of community exploitation at the hands of local industry and the desire to reclaim their identity and return to nearby natural spaces. Barriers to reclaiming natural spaces take many different forms, such as the struggle to build community connection and organize, which is exacerbated by a recent decline in local story-tellers and journalism. Equitable access to natural spaces is limited by the lack of transportation to natural areas, like the nearby Indiana Dunes National Park, and lack of upkeep of community parks due to budget constraints. Toledo shows signs of a second stage where natural spaces near to communities exist and are widely used, but people are still fighting against systemic disconnection from the local ecosystem, and local laws and priorities often favor resource-intensive business needs over rehabilitating polluted natural resources. People in both Gary and Toledo identified a disconnect between their communities and their nearby natural resources that was tied to a lack of environmental education and access when young. Milwaukee has experienced these stages but has recently made progress reorienting itself toward its waterways, creating protections for its natural resources, expanding government investment in natural infrastructure, and incorporating equity into their management efforts. In each location, we found different barriers to creating equitable access to natural spaces and resources, starting with lack of awareness of these spaces, and the evolutionary gradient reflected the stage at which that community had addressed those barriers and was willing to direct attention and resources in support of their local environment. Identifying where other legacy industrialized communities along the Great Lakes lie on this gradient of coastal connection would inform the effectiveness of advocacy for natural infrastructure, because prolonged maintenance of natural infrastructure requires community support and engagement. Supporting an area's coastal resilience may be well served through strategies that improve community communication and connection with natural spaces, and establish the political and legislative groundwork to allow for investments of natural infrastructure in the near future.

Each conservation organization needs to conceptualize what equitable conservation means, in context of their mission, and how their work affects the health and livelihood of communities that are at a disadvantage. The organization's approach should seek to undo or break generational racism and displacement, through a shift in conservation ideology and practice. We generally found agreement among actors about the need to address historical harms and incorporate meaningful inclusion of all perspectives into

decision-making and organizational programming. The State of Ohio's Coastal Management Program is currently implementing more meaningful inclusion by focusing on bringing youth with low socio-economic status to the outdoors and educating them about nature through Project Wild and Aquatic Wild Programs. Environmental organizations in Bayfield such as Superior Rivers Watershed Association incorporate Indigenous representatives, such as the Bad River Band of the Lake Superior Tribe of Chippewa Indians, into their decision-making and action planning, and design meetings explicitly to hold space for both entities to collaborate. This effort is mindful of historical harms that the Indigenous tribes have experienced with past conservation groups and so treat the Watershed Association as a continuation of the current work Indigenous tribes are doing instead of as a separate entity. Although we found advancements in terms of understanding and incorporating a more just conservation approach at several of our study locations, there is certainly more work to be done. Effectively integrating equitable conservation into environmental programming is a new concept but is gaining traction in many of the organizations we spoke with.

Norton (2008) argued that municipal (or township) Master Plans are the foundation for implementation of coastal resilience measures. These plans provide a chance for city officials to think long term about what they would like their city to look like in the future. Master Plans are a representation of a city's goals and values and serve as a formal blueprint for development, transportation, and zoning. Presence or absence of attention to coastal resilience programs, natural infrastructure, and improved equity in a community's Master Plan illustrates if these are understood and prioritized. If they are heavily focused on, like in Bayfield, this indicates that the city is actively looking to implement natural infrastructure and will choose to develop and engage in conservation in a more equitable manner. If the Master Plan focuses on other improvements, and fails to mention these ideas, it is less likely that they are placing emphasis on natural infrastructure and equity in the city's or township's management decisions.

Master Plans are a good place to outline implementation of the social, cultural, and economic metrics discussed above. The measurement of many of our suggested metrics requires specific planning and data collection that should be defined within the Master Plan. The incorporation of these metrics in the Plan are a first step in demonstrating the municipal (or township) commitment to coastal resilience in city planning. Because there are so many different actors and competing interests in the realm of coastal resilience planning and management, it is important to set specific goals and to track progress towards them, and metrics are crucial to doing so.

We found that the level of engagement between the community and governing bodies often determines what values, goals, and priorities are included in the Master Plan. In Saugatuck, we saw a high level of interaction between residents and the local government. Residents value the conservation of natural areas and this is reflected in the contents of the city's Master Plan. In Gary, however, we saw much less interaction between local government and communities, and this lack of local input is reflected in the contents of the Master Plan. The Plan focuses heavily on economic development and rezoning the city to encourage economic prosperity, with very little mention of

community desires and conservation or valuing equitable actions. Communication between local government and communities is important for effective government and we noticed that local news outlets can play a large role in facilitating this communication. Porter (2022) illustrates how critical local journalism is “to social cohesion, resilience, and vitality”. In places like Gary, the lack of local news dissemination makes spreading awareness of mass meetings and comment sessions more difficult. If the community is unaware of the correct forums to voice their thoughts, the lines of communication are broken.

Limitations

We were only able to make one, several-day trip to each of our case locations. Access to more diverse and in-depth perspectives, from different fields of expertise and age demographics would have created more holistic research, not simply dependent on perspectives from mostly older, environmental professionals. In retrospect we would have liked to have interviewed community members that worked in industries such as the steel mills in Gary, and to have heard from voices of youth in underserved communities who either are connected or not connected to surrounding coastal ecosystems. Understanding the wants, needs, and desires of the community enhances coastal action plans and policy on top of providing diverse perspectives that can contribute to higher and novel rates of ideas and solutions to environmental issues.

Another limitation was our lack of capturing Indigenous perspectives, especially unfortunate as they have been historically ignored, undermined, and displaced through implementation of traditional, white-centric conservation. With prior investment in relationships and assistance in speaking with Indigenous tribes such as the Bad River Tribe and Red Cliff Band, inclusion of Indigenous voices in this research would have been possible. These specific tribes are heavily involved in the Line 5 Movement; their staffs are scheduled over-capacity, creating another barrier to converse and build connection with them.

We also acknowledge that more in depth research into governance structures and cultures in each location would have revealed more details about the political and logistical landscape regarding natural infrastructure, equity, and justice. Our limited timeframe to visit each location hindered our ability to develop the relationships and conduct the deep analysis that would be necessary to gain an in-depth understanding of that landscape.

Recommendations

In order to advance coastal resilience and conservation, while implementing natural infrastructure and equity; we have crafted the following recommendations. Implementation of these recommendations will require engagement with communities at all levels. Facilitating and nurturing strong partnerships at the governmental and community level with a focus on nature, and equitable access and benefits should be at the core of coastal resiliency efforts.

Recommendation 1

Build relationships with and support local entities in conservation, educational, and funding opportunities. Knowledge of the organizations and goals in the target area is integral to fostering the most effective coalition of organizations.

We have identified several ways to do this:

- Utilize social media to help connect with local environmental organizations.
- Identify and connect with state parks, national parks, metro parks, local universities and regional Sea Grant offices in target areas. These are local anchor institutions that can offer significant insight on the areas and bring resources to bear for initiatives in communities of interest.
- Identify and connect with regional Councils of Governments (COG's). These tend to operate at a sub-Great Lakes shoreline scale. They can bring the backbone support resources to smaller communities as well as help knit together shared community efforts. They also can work with municipalities to integrate environmental and city/county planning.
- Connect and communicate with local Port Authorities in target coastal areas. Port Authorities have far reaching connections to city planning.
    - For example, the Toledo Port Authority is involved in many aspects of the city. In addition to port operations, dredging, and shipping operations; they are also responsible for a current project which consists of creating wetlands on a floodplain in Duck Creek which is a major tributary to Maumee Bay, and restoring wetlands near Clark and Delaware Islands.

This support should prioritize natural resources, environmental educational opportunities, and local news in communities at risk of coastal erosion and degradation, especially those of color. Hosting workshops and engaging activities for communities to understand their local environment through initiating partnerships or supporting ongoing efforts will bring people together to build and share concerns for their coasts. This will help increase prioritization on city agendas. This will further leverage and strengthen the relationship the people have with the green and blue spaces that they are surrounded by. Another way to connect with coastal communities is to support local news outlets in target areas. Local news and journalism is the primary vehicle for community education and understanding regarding the coast. People will be more interested in green and blue spaces by knowing about current projects, and recreation and conservation economies will potentially increase as well.

Finally, this support should provide and support opportunities to strengthen grant writing education for smaller, local environmental and conservation organizations. This will directly impact the momentum of organization's coastal resilience projects and serve to build partnerships with them. This can be done by hiring people who are experts in grant writing to hold workshops for local environmental organizations. This not only promotes and bolsters existing conservation projects but also promotes equity. Multiple interviewees mentioned that rural communities are understaffed, underserved, and underfunded; and the lack of knowledge in grant writing just further exacerbates these

inequities. With this support, the TNC can help bridge knowledge gaps, funding gaps, and gaps in labor capacity. If this support is not within the TNC's scope, we recommend establishing partnerships with other external organizations such as local anchor institutions who have the capacity and expertise to share this knowledge.

Recommendation 2

Prioritize locations for implementing natural infrastructure that: are in close proximity to the coast, have strategic benefits for resilience to storms & flooding, and are accessible to communities who: have been displaced by industry; have historically been segregated; and are of low-income (under the U.S. household average income). These priority communities can be identified using tools such as the Social Vulnerability Index, a spatial equity index, and maps that highlight flood zones in congruence with pinpointing these communities' geographic location, by exploring community partnerships, and by actively engaging with communities. To make sure these strategies and tools work cohesively; there needs to be informational and strategic meetings with communities (building trust and relationships), workshops on what coastal resiliency and conservation mean, and joint development of action plans with those who experience first-hand what happens in their coastal home.

In these meetings:

- Questions that should be addressed in partnership with community members/leaders and using tools such as GIS include: what short-term goals can be accomplished in the present and what long-term goals can be pursued in order to implement and maintain natural infrastructure for years to come?
- Barriers such as funding, time, and skills limitations, should be addressed as reasons why it is essential that everyone becomes aware of coastal issues, efforts, and planning before applying for grants. Collective grant applications should be explored.
- Education should be provided so that communities can make educated decisions regarding natural infrastructure implementation on their coasts.

This infrastructure should offer the benefit of mitigating flooding and erosion, improving water quality, preserving blue and green spaces, and acting as a place for people to recreate. Our interviews revealed that these are the concerns that are front of mind for residents and officials alike. However, natural infrastructure must be planned and implemented in a way that decreases gentrification, assuring budget accommodation housing options; as BIPOC communities living by the coast already face economic hardships. Tying conservation areas to housing and zoning may be a "growth edge" for conservation organizations, however, it will be necessary to offset the natural economic tendency towards gentrification and displacement. In addition, investing in natural infrastructure will decrease and mitigate flooding in "at-risk flooding areas" which are usually located near Black and Brown communities that are at a socioeconomic disadvantage. It is also important to recognize that most newly developed or maintained natural infrastructure will have to coexist with existing gray infrastructure in a way that will not negatively impact the existing community. One way to approach this is to

implement hearings to negotiate a compromise between BIPOC community needs and the needs of the state.

Recommendation 3

TNC should review current Master Plans of municipalities or townships that are interested in promoting conservation-based, coastal resilience. Norton (2008) asserted that the authority for land and city planning is situated at the local level, and therefore, the TNC should work closely with these local actors when engaging in conservation efforts and support them when and where possible within their scope of practice. The Plan review should focus on evidence of awareness and prioritization of: (1) coastal resilience programs; (2) natural infrastructure implementation; and (3) equity associated with such programs. The review will provide context on existing goals and values of the local government. We also recommend that the TNC and their local partners advocate for the inclusion of natural infrastructure, equity, and incorporation of metrics in future plan revisions. Inclusion of these aspects within Master Plans will help keep them in the front of mind during planning sessions.

We also encourage TNC to support joint work on Master Plans across municipalities, as we saw for the neighboring communities of Saugatuck, Saugatuck Township, and Douglas. Joint master planning allows for collaboration across municipalities, establishes common goals, and fosters a larger sense of community within a region. It is important to recognize that our coastal systems operate across political boundaries and so our planning processes need to coordinate to be effective. Joint planning also opens the door for joint projects, shared knowledge, and access to greater funding opportunities for all involved.

APPENDICES

Appendix 1. Structured Observation Questions

These are the questions for guided structured observations. We took observations in at least one stationary and one in transit observation in each study location.

Questions: In Transit & Stationery
1. Describe any significant landmarks or scenery.
2. Describe any sounds we hear. What are the main sounds we hear out in nature in this specific location?
3. What does outside smell like?
4. What communities are we seeing? Is it a diverse community or predominantly white? How populated does it look? Is downtown busy or empty?
5. People: what are they doing, wearing, look like? Are people out in groups? Recreating in groups or alone? Where are they? What does accessibility look like? Hostile architecture?
6. What does the transportation and associated infrastructure look like?
7. What housing is available? What is the pricing of housing?
8. What services and businesses does the community include?
9. How far or close is the community to the shore/ access to the water? Are there any observable barriers to access of shorelines? Is any degradation/ pollution observed within and out of water regions? Are natural areas thriving or not? Is there noticeable wildlife? Do we observe people accessing the coast for recreational purposes, resources, etc?
10. What buildings do you see? How would you describe them?
11. Is there any natural infrastructure implemented?
12. Are there any green spaces such as parks around? How are these situated in the community relative to different neighborhoods, amenities, etc.

13. What is the community known for? Any patterns you see in the community that seem important for tourism or economic development?
14. Is there industry in the area? Where is it? What is it?
15. What is the condition of the hard infrastructure in the area?
16. Are there noticeable patterns in land use? How condensed is the area? Is there much urban sprawl?
17. Are there visible signs of risk of/ harm from flooding, storms, etc?
18. Does good access to the coast come at the expense of hard infrastructure?
19. Do the benefits of industry come at the cost of harms to nature or people?
20. What is the police presence like in this area? Are there other forms of security present?
21. Questions?
22. Other notes

Appendix 2. Organizations and Anchor Institutions

These are lists of current or potential partnership organizations identified in each target location. Potential Anchor Institutions are bolded.

Milwaukee, WI	● **Milwaukee Metropolitan Sewer Department** ● Milwaukee Riverkeeper ● **University of Wisconsin- Milwaukee** ● Milwaukee School of Engineering ● Marquette University ● Urban Ecology Center ● Milwaukee Water Commons ● Fund for Lake Michigan ● Walnut Way ● Reflo ● Green Schools Consortium ● Waterway Restoration Partnership ● Milwaukee River Greenway Coalition ● Nearby Nature ● **Wisconsin Department of Natural Resources**
Toledo, OH	● Toledo Metropolitan Areas Council of Government

	● **Toledo Port Authority** ● **Metroparks Toledo** ● **Ohio Department of Natural Resources** ● Great Lakes Protection Fund ● **H2Ohio**
Gary, IN	● **Indiana Dunes National Park** ● Save the Dunes ● **Northwest Indiana Regional Planning Commission** ● **US Steel** ● Brown Faces Green Spaces ● Gary Department of Parks and Recreation
Bayfield, WI	● Superior Rivers Watershed Association ● Lake Superior Collaborative ● **University of Wisconsin - Madison** ● **University of Wisconsin- Superior** ● Bad River Watershed Association ● Red Cliff Band of Lake Superior Chippewa Indians ● Bad River Band of Lake Superior Chippewa Indians ● Wisconsin Wetlands Association ● **Wisconsin Department of Natural Resources** ● Northland College
Saugatuck, MI	● Saugatuck Dunes Coastal Alliance ● **Oxbow School of Art - Art Institute of Chicago** ● **Saugatuck Dunes State Park** ● Michigan Natural Resources Trust Fund ● **Western Michigan University** ● Kalamazoo College ● Lake Michigan Shore Association ● Outdoor Discovery Center ● West Michigan Environmental Action Council

LITERATURE CITED

Aaronson, D., Hartley, D., Bhaskar, M. (2020). The effect of the 1930s HOLC “redlining” maps. Working Paper, No. 2017-12, Federal Reserve Bank of Chicago, Chicago, IL.

Abdel-Fattah, Sommer, and Gail Krantzberg. (2014). A Review: Building the Resilience of Great Lakes Beneficial Uses to Climate Change. *Sustainability of Water Quality and Ecology*, vol. 3-4, 2014, pp. 3–13., https://doi.org/10.1016/j.swaqe.2014.11.006.

Argumedo, A. and Yun Loong Wong, B. (2010). The *ayllu* system of the Potato Park (Peru). *United Nations University Institute of Advanced Studies,* 84-90.

Ban, N. C., Wilson, E., & Neasloss, D. (2019). Historical and Contemporary Indigenous Marine Conservation Strategies in the North Pacific. *Conservation Biology*, *34*(1), 5–14. https://doi.org/10.1111/cobi.13432

Beyer, K. M. M., Kaltenbach, A., Szabo, A., Bogar, S., Nieto, F. J., Malecki, K. M. (2014). Exposure to neighborhood green space and mental health: evidence from the Survey of the Health of Wisconsin. *International Journal of Environmental Research and Public Health,* 3453-3472. doi:10.3390/ijerph110303453

Brodkin, D., Dellinger, J., Keifer, M., Orris, P., Shapiro, H., and Takaro, T. (2014). Recommended Human Health Indicators for Assessment of Progress on the Great Lakes Water Quality Agreement. *International Joint Commission of Canada and the United States.* *https://www.ijc.org/sites/default/files/Recommended%20Human%20Health%20Indicators%20for%20Assessment%20of%20Progress%20on%20the%20Great%20Lakes.pdf*

Butler, C., Watkinson, B., & Witzke, J. (2021). The immovable object: Mitigation as indigenous conservation. *Collaborative Anthropologies*, *13*(2), 1–28. https://doi.org/10.1353/cla.2021.0001

Carroll, C. (2014). Native enclosures: Tribal national parks and the progressive politics of environmental stewardship in Indian Country. *Geoforum,* vol. 53, 31-40.

Chisholm Hatfield, S., Marino, E., Whyte, K.P., Dello, K.D., and Mote, P.W. (2018). Indian time: time, seasonality, and culture in Traditional Ecological Knowledge of climate change. *Ecological Processes*, vol. 7, issue 25, 1-11, https://doi.org/10.1186/s13717-018-0136-6

Commission of the European Communities. (2000). Communication from the Commission to the Council and the European Parliament on Integrated Coastal Zone Management: A Strategy for Europe. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52000DC0547

Dawson, N. M., Coolsaet, B., Sterling, E. J., Loveridge, R., Gross-Camp, N. D., Wongbusarakum, S., Sangha, K. K., Scherl, L. M., Phan, H. P., Zafra-Calvo, N., Lavey, W. G., Byakagaba, P., Idrobo, C. J., Chenet, A., Bennett, N. J., Mansourian, S., and Rosado-May, F. J. (2021). The role of indigenous peoples and local communities in effective and equitable conservation. *Ecology and Society*, *26*(3). https://doi.org/10.5751/es-12625-260319

Dobie, S., Doran, P. J., Norton, R. K., Hughes, S., & Goode, M. J. (2022). Defining coastal resilience in the Great Lakes: A systematic review and critical comparison. In *Journal of Great Lakes Research*. International Association of Great Lakes Research. https://doi.org/10.1016/j.jglr.2022.08.001d.

Dowie, M. (2009). *Conservation Refugees: The Hundred-Year Conflict between Global Conservation and Native Peoples.* MIT Press. https://doi.org/10.7551/mitpress/7532.001.0001
Egan, D. (2017). *The Death and Life of the Great Lakes*. WW Norton & Company.

Fabre, P., Bambridge, T., Claudet, J., Sterling, E., & Mawyer, A. (2021). Contemporary rāhui: Placing indigenous, conservation, and Sustainability Sciences in community-led conservation. *Pacific Conservation Biology*, *27*(4), 451–463. https://doi.org/10.1071/pc20087

Fisher, T. G. and Hansen, E.C. (2014). *Coastline and Dune Evolution along the Great Lakes.* The Geological Society of America.

Friedman, R. S., Law, E. A., Bennett, N. J., Ives, C. D., Thorn, J. P. R., & Wilson, K. A. (2018). How just and just how? A systematic review of social equity in conservation research. *Environmental Research Letters*, *13*(5), 053001. https://doi.org/10.1088/1748-9326/AABCDE

Garcia, H., Murphy, L., Wendland, B., and Wu, T. (2021). Assessing Equity and Environmental Justice in the Great Lakes Restoration Initiative. *University of Michigan School for Environment and Sustainability.*

Green Infrastructure Plan - Gary. (n.d.). Retrieved April 17, 2023, from http://garyin.us/redevelopment/wp-content/uploads/sites/2/2019/10/Gary-Comp-Plan_Final_Appendix-A_GI-Plan_LR.pdf

Gilio-Whitaker, D. (2019) *As long as grass grows: the indigenous fight for environmental justice, from colonization to Standing Rock.* Beacon Press.

Grineski, S., Collins, T. W., Chakraborty, J., and Montgomery, M. (2014). Hazardous air pollutants and flooding: a comparative interurban study of environmental justice. *Geojournal,* vol. 80, 145-158.

Great Lakes Commission and Great Lakes Rivermouth Collaboratory. (2013). Great

Lakes Rivermouths: A Primer for Managers. Edited by Victoria Pebbles, James Larson, and Paul Seelbach.

Green, Gary Paul. (2020). Deindustrialization of rural America: Economic restructuring and the rural ghetto. *Local Development & Society.*

Hanna, P. and Vanclay, F. (2013). "Human rights, Indigenous peoples, and the concept of Free, Prior, and Informed Consent." *Impact Assessment and Project Appraisal,* 13(2), 146-157.

Heckert, M. and Rosan, C. (2015). Developing a green infrastructure equity index to promote equity planning. *Urban Forestry and Urban Greening.* 19, 263-270. http://dx.doi.org/10.1016/j.ufug.2015.12.011

Hockley, N., Mandimbiniaina, R., and Rakotonarivo, O. S. (2018). Fair and equitable conservation: do we really want it, and if so, how do we achieve it? *Madagascar Conservation & Development*, *13*(1), 3–5.

Home | *city of Gary*. (n.d.). https://gary.gov/

Houston, D., Werrity, A., Ball, T., and Black, A. (2020). Environmental vulnerability and resilience: Social differentiation in short- and long-term flood impacts. *Transactions of the Institute of British Geographers,* 46(1), 102-119. https://doi.org/10.1111/tran.12408

Howell, E.T., Chomicki, K.M., Kaltenecker, G. (2012). Tributary discharge, lake circulation and lake biology as drivers of water quality in the Canadian nearshore of Lake Ontario. *Great Lakes Research*. 38, 47–61.

Hughes, S., Dobie, S., Schwarz, K., LeMee, L.G., Lane, M., and Gonzalez, A. (2022). Centering Racial Justice in Urban Flood Resilience Policy and Planning: Tools for Practitioners. *Environmental Justice*, 15(2), 83-89.

Ibáñez, D., Lyster, C., Waldheim, C., and White, M. (2017). Introduction. In *Third Coast Atlas: Prelude to a Plan*.

Ismael, A. (2003). Nature tourism, conservation, and development in KwaZulu Natal, South Africa. https://doi.org/10.1596/0-8213-5350-0

Infrastructure Investment and Jobs Act, Pub, L. No. 117-58 U.S.C. (2021). https://www.congress.gov/bill/117th-congress/house-bill/3684/text

Johnson, E.M. (2014). How John Muir's Brand of Conservation Led to the Decline of Yosemite." ICCA Consortium, *Scientific American,* https://www.iccaconsortium.org/index.php/2014/08/13/how-john-muirs-brand-of-conservation-led-to-the-decline-of-yosemite/

Jude, D.J., Pappas, J. (1992). "Fish utilization of Great Lakes coastal wetlands. *J. Great*

Lakes Research. 18, 651–672.

Kamoto, J.; Clarkson, G.; Dorward, P.; Shepherd, D. “Doing more harm than good? Community based natural resource management and the neglect of local institutions in policy development.” *Land Use Policy,* vol. 35, 2013, pp. 293-301.

Katt, S. and Waldhuetter, D. *Water Centric city Framework - Milwaukee*. city of Milwaukee, https://city.milwaukee.gov/ImageLibrary/WCC/WaterCentriccityFramework.pdf.

Kimmerer, R. W. (2015). *Braiding Sweetgrass*. Milkweed Editions.

Larson, J. H., Trebitz, A.S., Steinman, A.D., Wiley, M.J., Mazur, M.C., Pebbles, V., Braun, H.A., and Seelbach, P.W. (2013). Great Lakes rivermouth ecosystems: scientific synthesis and management implications. *Journal of Great Lakes Research* (39)3, 513-524.

Lepofsky, D., & Caldwell, M. (2013). Indigenous Marine Resource Management on the Northwest Coast of North America. *Ecological Processes*, *2*(1). https://doi.org/10.1186/2192-1709-2-12

Lindsay, J., Rogers, B.C., Church, E., Gunn, A., Hammer, K., Dean, A.J., Fielding, K. (2019). The Role of Community Champions in Long-Term Sustainable Urban Water Planning. *Water*, 11(3). https://doi.org/10.3390/w11030476

Living atlas of the world. ArcGIS. (n.d.). Retrieved April 17, 2023, from https://livingatlas.arcgis.com/en/home/

Liu, Z., Fagherazzi, S. and Cui, B. (2021). Success of coastal wetlands restoration is driven by sediment availability. *Commununications Earth and Environment,* 2(44). https://doi.org/10.1038/s43247-021-00117-7

Mace, G., Masundire, H., Baillie, J. (2005). Biodiversity. In: Hassan, R, Scholes, R., Ash, N., eds. Ecosystems and human well-being: current state and trends—findings of the condition and trends working group of the Millennium Ecosystem Assessment. Washington, DC: Island Press: 77–122.

Mangor, K., Drønen, N. K., Kaergaard, K.H. and Kristensen, N.E. (2017). Shoreline management guidelines. DHI https://www.dhigroup.com/marine-water/ebook-shoreline-management-guidelines

Massé, Francis. (2020). “Conservation Law Enforcement: Policing Protected Areas, Annals of the American Association of Geographers,” 110:3, 758-773, DOI: 10.1080/24694452.2019.1630249

McGregor, D. (2004). Coming full circle: Indigenous knowledge, environment, and our future. *The American Indian Quarterly*, *28*(3), 385–410. https://doi.org/10.1353/aiq.2004.0101

McKinney, R. A., Rapose, K. B., Cournoyer, R. M. (2011). Wetlands as habitat in urbanizing landscapes: Patterns of bird abundance and occupancy. *Landscape and Urban Planning,* 100, 144-152.

Milwaukee Public Museum. “Great Lakes History: A General View.” *Milwaukee Public Museum*, https://www.mpm.edu/educators/wirp/history.

Minns CK, Cairns VW, Randall RG, Moore JE. (1994). An index of biotic integrity (IBI) for fish assemblages in the littoral zone of Great Lakes areas of concern. *Canadian Journal of Fisheries and Aquatic Sciences*. 51, 1804-1822. https://doi.org/10.1139/f94-183

Mitsch, W. J., Bernal, B., and Hernandez, M. E. (2015). Ecosystem Services of Wetlands. *International Journal of Biodiversity Science, Ecosystem Services & Management,* 11(1), 1-4.

Morrice, J.M., Kelly, J.R., Trebitz, A.S., Cotter, A., Knuth, M. (2004). Temporal dynamics of nutrients and hydrology in a Lake Superior coastal wetland. *Journal of Great Lakes Research*, 30 (Suppl. 1), 82–96.

NOAA Fisheries. “Social Indicators for Coastal Communities.” *NOAA*, 19 Aug. 2021, accessed 7 June 2022, https://www.fisheries.noaa.gov/national/socioeconomics/social-indicators-coastal-communities

Norton, R. K. (2008). Using content analysis to evaluate local master plans and zoning codes. *Land Use Policy*, *25*(3), 432–454. https://doi.org/10.1016/J.LANDUSEPOL.2007.10.006

NPS.gov Homepage (U.S. National Park Service). (n.d.). https://nps.gov/
Oregon State University. (2022). Coastal ecosystem being destabilized by climate change. ScienceDaily. www.sciencedaily.com/releases/2022/01/220110184900.htm.

Orum, Anthony. “Economy.” *Encyclopedia of Milwaukee*, University of Wisconsin-Milwaukee, 4 Dec. 2019, https://emke.uwm.edu/entry/economy/.

Peacock, W.G. (2010). Advancing the Resilience of Coastal Localities: Developing, Implementing and Sustaining the Use of Coastal Resilience Indicators: A Final Report. *NOAA.*

“Pioneering the Upper Midwest: Books from Michigan, Minnesota, and Wisconsin, ca. 1820 to 1910: The French Lead the Way: c. 1500-1763.” *Library of Congress.* https://www.loc.gov/collections/pioneering-the-upper-midwest/articles-and-essays/history-of-the-upper-midwest-overview/french-lead-the-way/

Porter, David. (2022). The Detroit River Story Lab: Community narratives and ecosystems in Great Lakes research. *Journal of Great Lakes Research*, 48, 1485-1488.

"President Biden's Bipartisan Infrastructure Law." *The White House*, The United States Government, 2 Dec. 2021, https://www.whitehouse.gov/bipartisan-infrastructure-law/.

Purdy, J. (2015). "Environmentalism's Racist History." *The New Yorker.* https://www.newyorker.com/news/news-desk/environmentalisms-racist-history

Roy, Dimple. (2018). The Multiple Benefits of Natural Infrastructure. *International Institute for Sustainable Development*. https://www.iisd.org/articles/multiple-benefits-natural-infrastructure

Rosaen, A. L. (2014). Innovating for the Blue Economy: Water Research at the URC. Anderson Economic Group, East Lansing, MI, USA.

Science and Resilience Institute. (2020). Measuring Success: Monitoring Natural and Nature Based Shoreline Features in New York State. *New York Department of State and NOAA.*

Song, F., Lupi, F., Kaplowitz, M. (2010). Valuing Great Lakes Beaches. *Agricultural & Applied Economics Association.*

Starr, Stephen. (2019). Rust Belt states reinvent their abandoned industrial landscapes: US midwest is fighting back after years of economic decline and population flight. *Irish Times*, 17. ProQuest, https://proxy.lib.umich.edu/login?url=https://www.proquest.com/newspapers/rustbelt-states-reinvent-their-abandoned/docview/2163281109/se-2?accountid=1466 7.

Steinman, A., Chu, X., Ogdahl, M. (2009). Spatial and temporal variability of internal and external phosphorus loads in Mona Lake, Michigan. *Aquatic Ecology*. 43, 1–18.

Sutton-Grier, A.E., Wowk, K., Bamford, H. (2015). Future of our coasts: The potential for natural and hybrid infrastructure to enhance the resilience of our coastal communities, economies, and ecosystems. *Environmental Science and Policy* 51, 137-148.

Tate, E., Md, ·, Rahman, A., Christopher, ·, Emrich, T., Sampson, C., Emrich, C. T., & Sampson, C. C. (2021). Flood exposure and social vulnerability in the United States. *Natural Hazards*, *106*, 435–457. https://doi.org/10.1007/s11069-020-04470-2

Taylor, A., Cocklin, C., and Brown, R. (2012). Fostering environmental champions: A process to build their capacity to drive change. *Journal of Environmental Management,* 98, 84-97. https://doi.org/10.1016/j.jenvman.2011.12.001

The Nature Conservancy. "Who We Are." *The Nature Conservancy*,

https://www.nature.org/en-us/about-us/who-we-are/. Accessed 30 January 2023.

The Nature Conservancy in Washington. (n.d.). *Washington Equity Statement*. The Nature Conservancy. Retrieved February 7, 2023, from https://www.washingtonnature.org/washington-equity-statement

Tockner, K. and Stanford, J.A. (2002). Riverine flood plains: present state and future trends. *Environmental Conservation,* 29(3), 325.

Tolnay, S.E. (2003). The African American "Great Migration" and Beyond. *Annual Review of Sociology*. 29, 209-23.

United States Department of Transportation. (2020). The Great Lakes-St. Lawrence Seaway System. *Great Lakes St. Lawrence Seaway Development Corporation*, www.seaway.dot.gov/about/great-lakes-st-lawrence-seaway-system.

United States Forest Service. (2017). "Appendix F: Ecosystem Services Provided by Floodplains." *South Fork McKenzie River Enhancement Project*, USDA, www.fs.usda.gov/nfs/11558/www/nepa/98306_FSPLT3_4130975.pdf. Accessed 5 Mar. 2022.

Uzarski, D. G., Burton, T. M., Cooper, M. J., Ingram, J. W., and Timmermans, S. T.A. (2005). Fish Habitat Use Within and Across Wetland Classes in Coastal Wetlands of the Five Great Lakes: Development of a Fish-based Index of Biotic Integrity. *Great Lakes Research,* 31, 171-187.

Van Berkel, D., Kalafatis, S., Gibbons, B., Naud, M., and Carmen Lemos, M. (2022). Planning for climate migration in Great Lakes legacy cities. *Earth's Future*, 10(10), https://doi.org/10.1029/2022EF002942

West, P., Igoe, J., and Brockington, D. (2006). "Parks and Peoples: The Social Impact of Protected Areas." *Annual Review Anthropology,* 35, 251-277.

Wolch, J. R., Byrne, J., Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough. *Landscape and Urban Planning,* vol. 125, 234-244.

Zhu, Z., Ren, J., & Liu, X. (2019). *Green infrastructure provision for environmental justice: Application of the equity index in Guangzhou, China*. https://doi.org/10.1016/j.ufug.2019.126443