Little River Band of Ottawa Indians

Natural Hazards Mitigation Plan

2023

FEMA Letter of approval

ACKNOWLEDGEMENTS

The Little River Band of Ottawa Indians Natural Hazard Mitigation Plan is prepared for the Gaaching Ziibi Daawaa Anishinaabe Native Sovereign Nation. The Plan is a culmination of the interdisciplinary and interagency planning effort the required the assistance and expertise of numerous organizations, departments, and individuals. Without the technical assistance and contributions of time and ideas of these organizations, departments, and individuals, this plan could not have been completed.

Tribal Council 2022

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I. INTRODUCTION

Hazard mitigation is defined as any action taken before, during, or after a disaster or emergency to permanently eliminate or reduce the long-term risk to human life and property from natural, technological and human-related hazards. Mitigation is an essential element of emergency management, along with preparedness, response and recovery.

The fourth element of emergency management, mitigation, can lessen the need for a community to respond to subsequent hazard events, for some incidents may remain as mere incidents and not become disasters. Mitigation allows repairs and reconstruction to be completed after an incident occurs in such a way that does not just restore the damaged property as quickly as possible to pre-disaster conditions. It also ensures that such cycles are broken, that post-disaster repairs and reconstruction take place after damages are analyzed, and that sounder, less vulnerable conditions are produced. Through a combination of regulatory, administrative, and engineering approaches, losses can be limited by reducing susceptibility to damage. When successful, hazard mitigation will lessen the impact of a disaster on people, property, the environment and economy, and continuity of services through the coordination of available resources, programs, initiatives, and authorities.

A *hazard*, in the context of this plan, is an event or physical condition that has potential to cause fatalities; injuries; damage to personal property, infrastructure, or the environment; agricultural product loss; or interruption of business or civic life. The Little River Band of Ottawa Indians Natural Hazard Mitigation Plan focuses on *natural* hazards such as heat, drought, wildfires, flooding, shoreline erosion, thunderstorm, high winds, hail, and extreme winter weather. An exception is that it will also consider these technological and human-related hazards: dam failure, public illness outbreak, and invasive species.

The main objective of the Little River Band of Ottawa Indians Natural Hazard Mitigation Plan is to permanently eliminate or reduce long-term risks to people and property from natural hazards so that Tribal assets such as infrastructure, commerce, and housing can be sustained and strengthened. This can be accomplished through collaborative efforts/activities amongst agencies within the government to protect the health, safety, and economic interests of the residents and businesses through planning, awareness, and implementation.

Through this Plan, a broad perspective was taken in examining multiple natural hazard mitigation activities and opportunities for protecting the Little River Band of Ottawa Indians Tribal (LRBOI) community from future hazard events. Each natural hazard was analyzed from a historical perspective, evaluated for potential risk, and considered for possible mitigation.

The Little River Band of Ottawa Indians is adopting a new Hazard Mitigation Plan that meets the requirements of Title 44 of the Code of Federal Regulations, Section 201.7. A FEMA-approved hazard mitigation plan is required for receiving certain types of non-emergency disaster assistance, including funding for Hazard Mitigation Assistance projects and Public Assistance permanent work (categories C-G) for Tribal governments applying directly to FEMA for assistance. The Plan includes a description of the planning process, a description of the community, hazard identification and analysis, current mitigation capabilities, a strategy and action plan, and a process for incorporating the plan into other Tribal processes and updating the Hazard Mitigation Plan. The mitigation strategies are intended to be action items completed during the 5-year timeframe the plan is active.

Recognizing the importance of reducing community vulnerability to natural hazards, Little River Band of Ottawa Indians is actively addressing the issue through the development and implementation of this plan. This process will help ensure that Tribal community remain a vibrant, safe, enjoyable place in which to live, raise a family, continue to conduct business. The Plan serves as the foundation for natural hazard mitigation activities and actions within Manistee County and surrounding areas, and will be a resource for building coordination and cooperation within the community for local control of future mitigation and community preparedness around the following:

Planning Goals

To be developed

II. PLANNING PROCESS

The Stafford Act, as amended by the Disaster Mitigation Act of 2000, shifted the Federal Emergency Management Agency's (FEMA) scope of work to promoting and supporting prevention, or what is referred to as hazard mitigation planning. FEMA requires Tribal nations to have a natural hazards mitigation plan in place and updated on a 5-year cycle as a condition for receiving grant money related to natural hazard remediation. The Little River Band of Ottawa Indians is adopting a new Hazard Mitigation Plan that meets the requirements of Title 44 of the Code of Federal Regulations, Section 201.7. The adoption of the 2022 plan will affirm the Tribe's eligibility for federal funding.

The creation of the Tribe's plan was led by the Natural Hazards Task Force comprised of the Tribal Emergency Response Team (TERT). Team members consist of Tribal Councilmembers, emergency response personnel, and government staff that ensure the readiness of the Tribe by recommending equipment purchases, training and exercises, and member education on preparedness issues. Networks Northwest assisted with the planning process and provided support to facilitate meetings and plan writing. The Task Force met regularly virtually and at the Justice Center. The following is an outline of events for the development of the 2022 Natural Hazard Mitigation Plan:

- On July 1, 2021, Brandy Martin attended a project kick off meeting with county and tribal emergency managers.
- On October 6, 2021 Networks Northwest attended a TERT meeting and provided an introduction and timeline for the project. The meeting was held virtually.
- In October 2021, the Tribe released an online community survey. More details about the survey are below.
- On, November 17, 2021 Networks Northwest presented the community profile information and provided a summary of preliminary survey results. The meeting was held in person.
- On February 18, 2022 Networks Northwest presented the final survey results and the hazard analysis including historic weather events. The meeting was held in person.
- On May 19, 2022 a joint community meeting was held between Tribal officials and representatives from Manistee County to discuss potential hazards. The meeting was held virtually.
- August , 2022…

Community Survey Results

The primary source of feedback was gathered through the Community Survey. The survey was shared electronically and available in an online format from October 2021 to February 2022. The survey asked twelve questions related to hazard mitigation and received 45 responses. The majority of responses were from government employees and Tribal members. The Emergency Coordinator for Mason County also participated in the survey.

Responses to Question 1 largely represent the primary concern of the time, the Covid-19 Pandemic. For example, when asked what natural hazard event is likely to have the largest impact on your community, 31 of the responses were related to pandemic/illness outbreak or lack of outbreak resources. Other responses included flood and wildfire (eighteen responses each), snowstorms/winter storms/blizzards, and major or sever weather storms. High winds, tornado, dam failure and power outages were mentioned less frequently.

Questions 4 and 5 asked about community concerns for infrastructure and what forms of investment might be required to mitigate natural hazards. Of those who responded that infrastructure is a concern, many commented on sewer system inadequacies. This goes hand-in-hand with potential power outages that power sewer lift stations. Many participants were concerned about power outages and the need for back-up power. Therefore, the Tribe's renewable energy plan was also frequently mentioned as well as internet availability, and reliable cellular service. For example, the survey received the following response, "[I] don't know about everyone else but [I] do have infrastructure concerns, stormwater management, technology, internet… we are looking at going into renewable energy so it's a start."

In Question 6, 25 of the 41 participants who provided a response said no or were unsure if there have been any negative impacts on the public health and/or natural environment of their community that are attributed climate change. Of those who responded in the affirmative, increased wildfire frequency and severity, increased precipitation, high water levels, milder winters, hot summers, and the strain on emergency services were all mentioned as impacts from climate change. Several responses identify a chain reaction between unusual or uncommon weather patterns and effects on plant and animal species.

Questions 7 and 8 asked if participants were familiar with requests for assistance for mitigation projects in the past. 91% were unknown as to whether or not requests have been made. Similarly, Question 9 asked if the community has considered mitigation strategies for potential hazards. 75% responded, "unknown." In the follow up question, Question 10, several responses identified the renewable energy studies, additional support for emergency services, and consideration

for alternative locations for storing electronic information. A survey-taker also responded that Mason County is currently in the process of updating their hazard mitigation plan and it's strategies.

Question 11 asked if there was any additional information to be considered for the Tribe's Natural Hazard Mitigation Plan. One participant asked to include all Reservation lands for inclusion in the plan. Several responses asked for the plan to reflect cultural appreciation of lands/property as well as Tribal values and importance of game and non-game species to the community. Others mentioned the need to include winter storms including snow and ice storms and the danger they pose to employees traveling on the road. And another asked to have a plan that is realistic, do-able and easy to follow by the people that will implement the plan.

The final question, Question 12, asked survey-takers to respond with their contact information if they wish to be involved with the plan process. Several responses included a name, email address, and phone number to contact those who are interested. Many indicated no, they are not interested.

Draft Plan Review and Comment

Upon approval by the Natural Hazards Task Force, the plan was released for review and comment. A notice of availability was published in the " " and government staff and the entire membership were encouraged to view the plan and submit suggestions and ideas for updates, changes to be considered during updates.

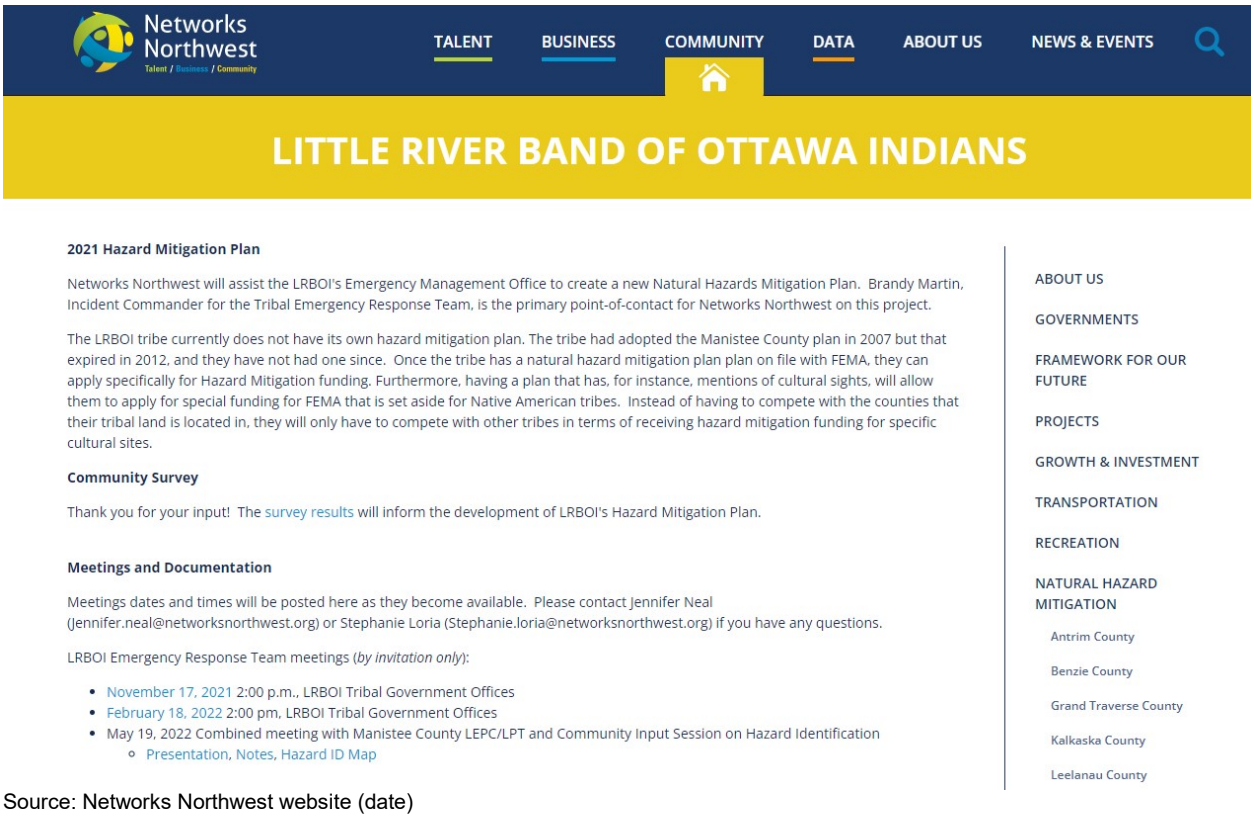
Additionally, county and regional agencies that share jurisdictional boundaries with the Little River Band of Ottawa Indians were provided the opportunity to formally comment on the draft plan and other related materials. A copy of the plan in its draft form was published openly on the LRBOI's website and Networks Northwest's website. Those agency staff members are:

- Jolanda Murphy, Public Safety Department 2 Manager and Emergency Manager, Grand Traverse Band of Ottawa and Chippewa Indians
- Rebecca Hubers, Emergency Management Coordinator, Benzie County
- Mike Machen, Deputy Director/Emergency Management Coordinator, Manistee County
- Elizabeth A. Reimink, Emergency Management Coordinator, Mason County
- Richard D. Warner, II, Director of Emergency Management, Muskegon County
- Troy Maloney, Emergency Manager, Oceana County
- Lou Hunt, Emergency Management Director, Ottawa County
- Kent County, ###
- Abby Watkins, Emergency Services, Newaygo County
- Patrick Maddox, Director of Emergency Management, Lake County
- Gregg Bird, Emergency Management Coordinator, Grand Traverse County
- Travis Baker, Deputy 911 Director/Emergency Management Coordinator, Wexford County
- Robert Carson, Regional Director of Community Development, Networks Northwest

While no formal written comments were received, county staff (particularly the county Emergency Manager) received feedback via other informal means. This feedback took the form of phone calls, emails and conversations that occurred at various non-mitigation related meetings.

The public was notified through a published notice in the ### on ###, 2022 of the Tribe's draft Hazard Mitigation Plan and the opportunity to provide feedback at the public hearing held on (date). The draft plan was made available on the Tribe's website as well as Networks Northwest's website. Below are images of the websites for the available draft plan and a copy of the published notice to the public.

Website Image
Source: Little River Band of Ottawa Indians' website (date)



Source: Networks Northwest website (date)

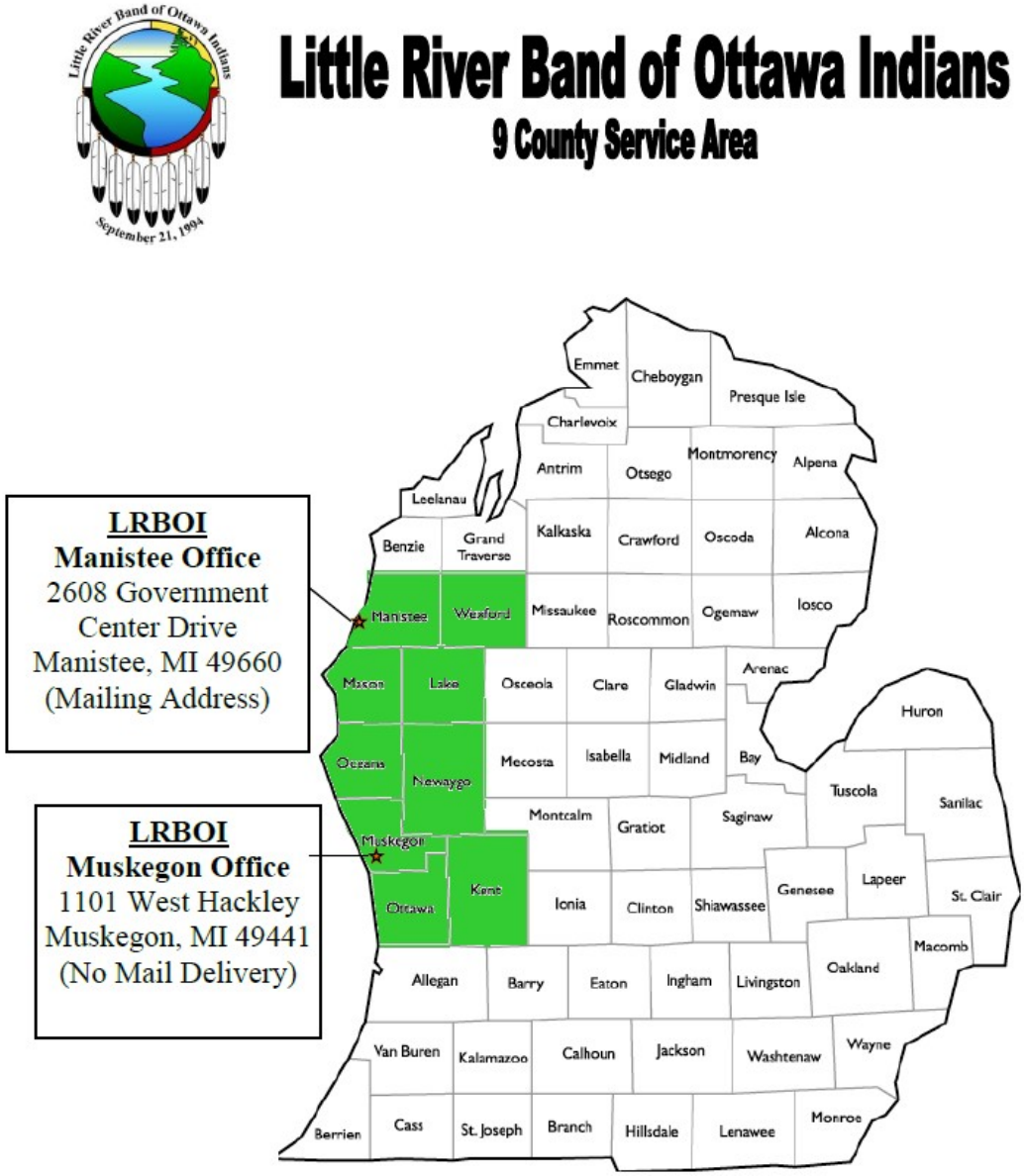
II. COMMUNITY PROFILE

The Little River Band of Ottawa Indians (LRBOI or the "Tribe") is a Federally-recognized Native Sovereign Nation descended from members of certain Grand River Ottawa Bands who lived in villages located on the Manistee River, Pere Marquette River, and at several villages on the Grand River system in Michigan. As a result of historic circumstances, only that portion of the Grand River Ottawa people now known as Little River Band of Ottawa, had its status as a federally recognized Indian tribe reaffirmed and restored by the United States in 1994. On September 21, 1994, the president of the United States signed into law Senate Bill 1357, *To Reaffirm and Clarify the Federal Relationships of the Little Traverse Bay Bands of Odawa Indians and the Little River Band of Ottawa Indians as Distinct Federally Recognized Indian Tribes*. The Tribe adopted its constitution on May 27, 1998.

Location

The Little River Band of Ottawa Indians Tribal lands are located in northwest and west-central lower Michigan, across nine counties: Manistee and Wexford Counties are the most northern and going south there are Mason, Lake, Oceana, Newaygo, Muskegon, Kent, and Ottawa Counties (Figure 1). In 1999, the Little River Band of Ottawa Indians owned approximately 2,000 acres of land within the original 1836 and 1855 Reservation boundaries (Table 1) that consisted of approximately 70,000 acres in what is now known as southern Manistee County, and more than 84,000 acres in what is now known as Mason County. The LRBOI continues to purchase land within these areas for historical, spiritual, environmental, economic, and development purposes. 32 Tribal facilities including the Government Complex, Justice Center, member residential areas, and the Little River Casino Resort are concentrated in Manistee County within a one-mile radius.

Figure 1: Little River Band of Ottawa Indians Service Area



Source: Little River Band of Ottawa Indians Program for Services

Table 1: LRBOI Land, Trust and Non-Trust

Location	Acreage	
	Trust	Non-Trust
Land Within 1836 Reservation Boundary	1,002.9	1,254.2
Land Within 1855 Reservation Boundary	639.5	0
Sub-total	1,642.4	1,254.2
Land outside reservation in Manistee County	65.1	204.3
Sub-total	65.1	204.3
TOTAL	**1,707.5**	**1,458.5**

Source: Little River Band of Ottawa Indians Land Records

Recent History of Land Use

The following historical information was based on information provided in the 2005 and 1999 Tribal Land Use Plan of Little River Band of Ottawa and from the June 2004 Vol. I, Issue 5, Little River Currents Newspaper, pgs 8-10.

The existing land uses on the 1836 and 1855 Reservations directly relate to the historical land uses and occurrences. The fragmentation of land and displacement of members occurred in the 1800's and altered the tribal member's way of living. This historical summary provides an explanation of why the land uses and ownership fragmentation occurred. The information in this section was derived from Jay Sam, the draft 1999 Tribal Land Use Plan, and articles in the *Little River Currents*.

Before the arrival of the European explorers, the Anishnaabek (now known as the Ottawa) were located throughout the Great Lakes region, including Canada. The Little River Band of Ottawa Indians (LRBOI) is the political successor to nine of the nineteen historic bands of the Grand River Ottawa people. The Grand River Ottawa people traded, trapped, cultivated, gathered, and hunted throughout the region. They were riverine people, who used rivers for these activities as well as for traveling.

The permanent villages of the Grand River Bands, from which the Little River Ottawa people descended, were located on the Thornapple River, Grand River, White River, Pere Marquette River, and the Big and Little Manistee Rivers. The southern Grand River Bands had a close relationship with the Manistee and the Pere Marquette bands and shared winter hunting and trapping territories with the northern Grand River Bands.

During the 1820s and 1830s, a larger number of settlers originating from Europe began moving to the Michigan Territory. Eventually there were enough settlers that Michigan qualified for statehood. Territory leaders pressured the Ottawa people to convey or sell their land to allow for lumbering activities, settlement, and statehood. Although there were intense political pressures and difficult obstacles (reduced food supply and disease), the Ottawa people were protective of their native land and natural resources.

In 1821, federal officials invited the Potawatomi and Ottawa people to negotiate a Treaty to cede lands south of the Grand River. The majority of Ottawa refused to participate. An Ottawa leader, Kewaycooshkum, who did not have the authority to sell Ottawa land, attended the meeting. At this meeting, he signed the 1821 Treaty of Chicago, which sold all of the Ottawa land south of the Grand River. Although the Ottawa people did not accept this agreement and did not recognize it, federal and state officials surveyed and sold the lands to the new settlers.

As the settlement population increase in 1830s, pressure was placed on the federal government to remove the Ottawa people from Michigan to a new reservation west of the Mississippi. The Ottawa people feared this displacement and refused to leave or sell their native Michigan land. Ottawa leaders were escorted from their home in Michigan to Washington D.C. to pressure them to sell the remaining Ottawa lands. Reluctantly, the Ottawa leaders agreed to sell most of their land to the United States in exchange for a 70,000-acre tract on the Manistee River. This area is now known as the Manistee Reservation (Figure 2). The Ottawa leaders also reserved the right for "hunting and other usual privileges of occupancy," such as fishing, trapping, and gathering, in Article 13 of the 1836 Treaty. Unfortunately, after the Ottawa leaders returned to Michigan, they learned that members of the United States Senate had amended the 1836 Treaty to limit the length the Ottawa people could live on the Reservation to five years.

The federal government hoped to move the Grand River Ottawa people from Pere Marquette, Muskegon, and other southern river communities to the Manistee Reservation, away from the new settlers. They proposed blacksmith shops and other improvements to assist this movement.

Most of the members of the Grand River Band did not abandon their current homes along the Grand and Thornapple Rivers to move to a temporary home. Other than the Manistee Band, whose permanent villages were located on the Manistee Reservation, the southern Grand River Ottawa were only seasonal residents of the Reservation and used the area for trapping and hunting.

Under the 1855 Treaty of Detroit, many of the Grand River Band members were moved from their permanent villages to an 84,000-acre Reservation in Muskegon, Oceana, and Mason Counties (Figure 3). The nine Grand River Bands, from which the Little River Ottawa are descended from, established a major settlement known as "Indian Town" on the Pere Marquette River, in Custer and Eden Townships in Mason County. The other ten Grand River Bands settled on the Pentwater River near modem-day Hart, in Oceana County.

Figure 2: 1836 Reservation Base Map, Present Day Manistee County

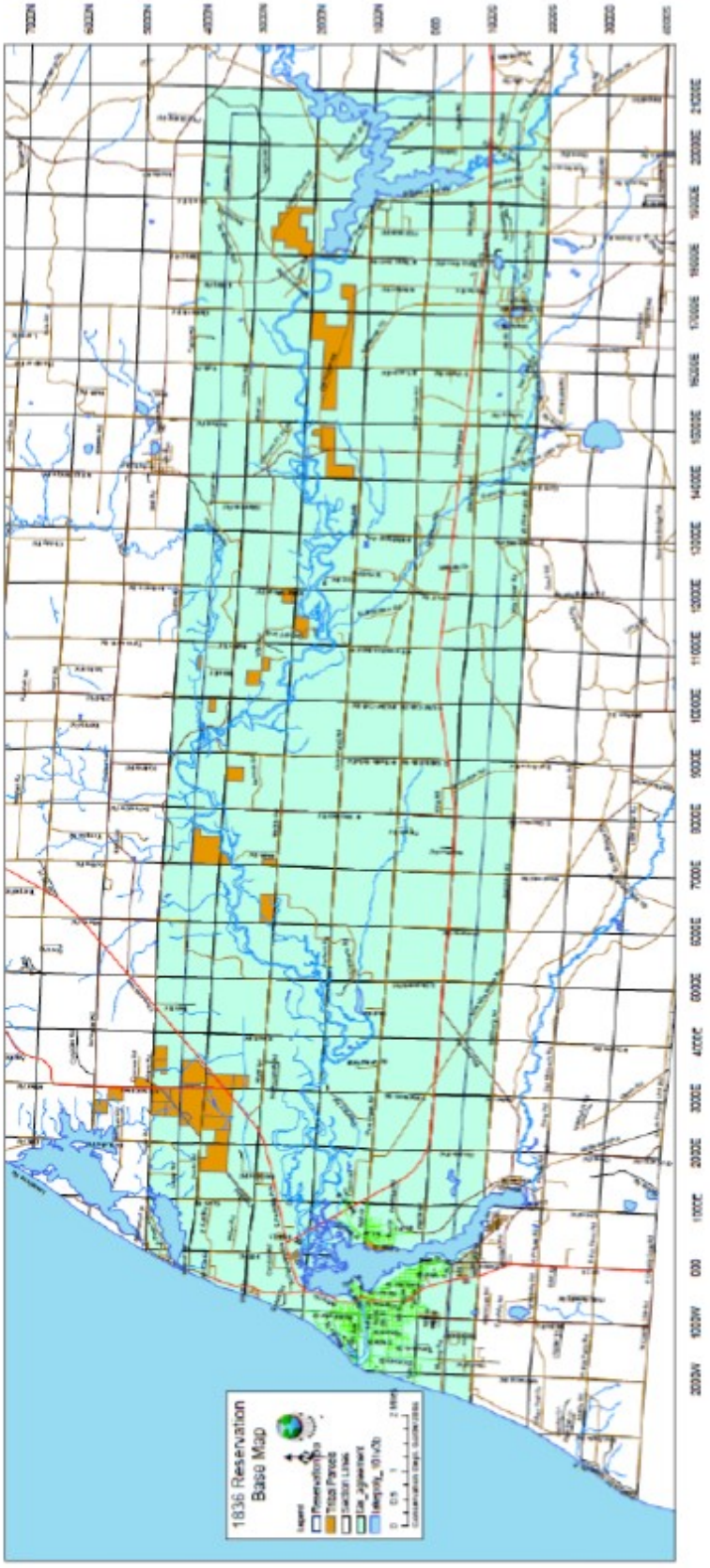
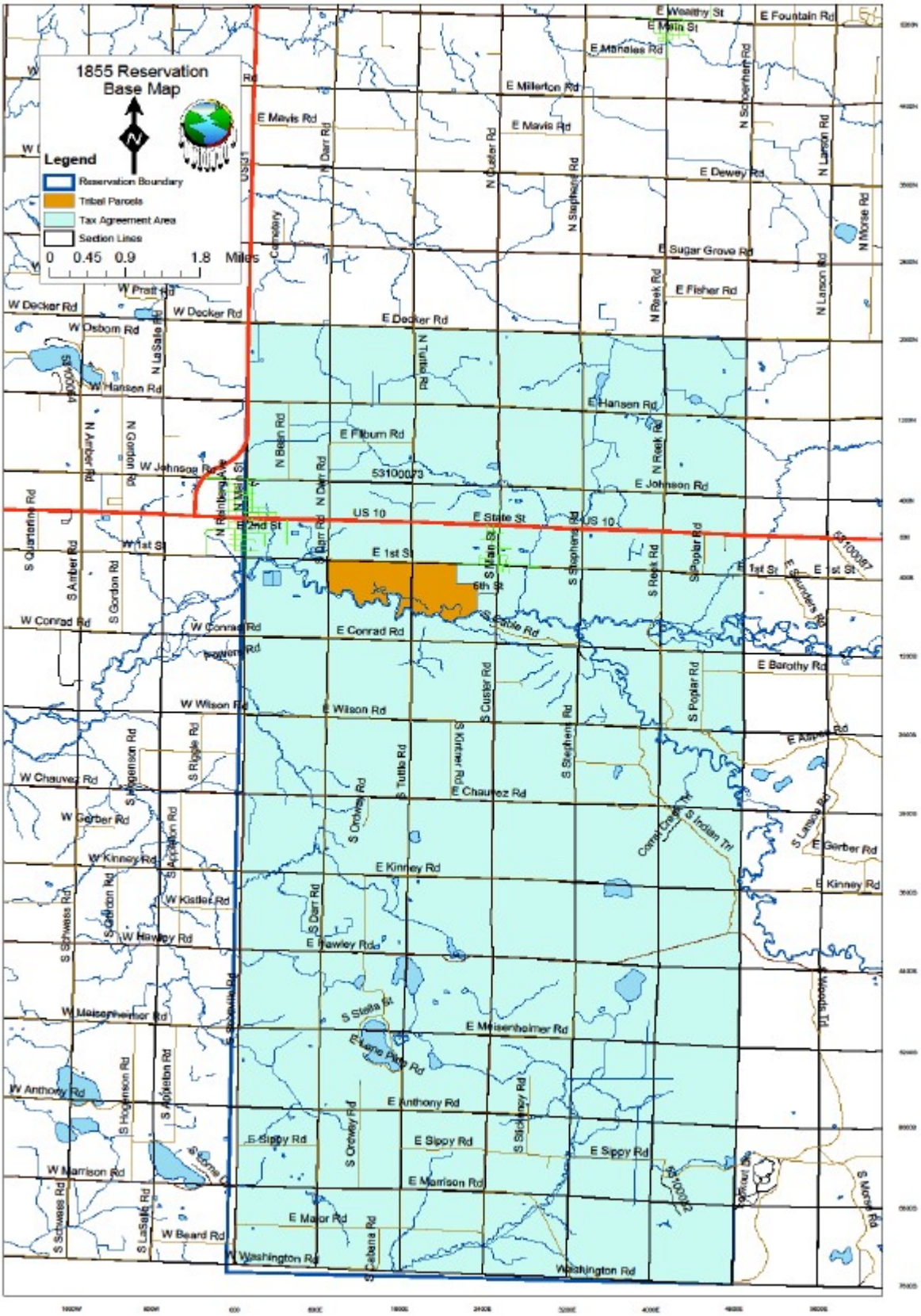


Figure 3: 1855 Reservation Base Map,



Unfortunately, the Grand River Ottawa lost record title to the majority of their Reservation lands to fraud and theft. Special Homestead Laws were enacted by Congress to allow members of the Grand River Ottawa to acquire fee-restricted homestead lands. Many of the Little River Ottawa Bands from Indian Town established new settlements in Mason County at Fountain, Freesoil, and Ludington. A number of members also moved to the 1836 Reservation and established settlements along the Manistee River near Brethen and Wellston.

After a 120-year struggle, the Little River Band of Ottawa Indians was reaffirmed when President Clinton signed into law, the Little Traverse Bay Band of Odawa and the Little River Band of Ottawa Indians Act, Pub. L. 103-324, 25 U.S.C. 1300k, on September 21,1994. The Congressional findings set forth in Section 2 of the act confirm the fact the Little River Band and Little Traverse Bay Band are the political successors to signatory bands to the 1836 Treaty of Washington and the 1855 Treaty of Detroit. The Act also confirms the fact that the Little River Band "continued [its] political and social existence with [a] viable tribal government." Thus, it is clear that Congress' purpose in enacting Pub.L. 103-324 was to "restore," not "recognize" the Little River Band of Ottawa Indians.

Geography and Natural Features

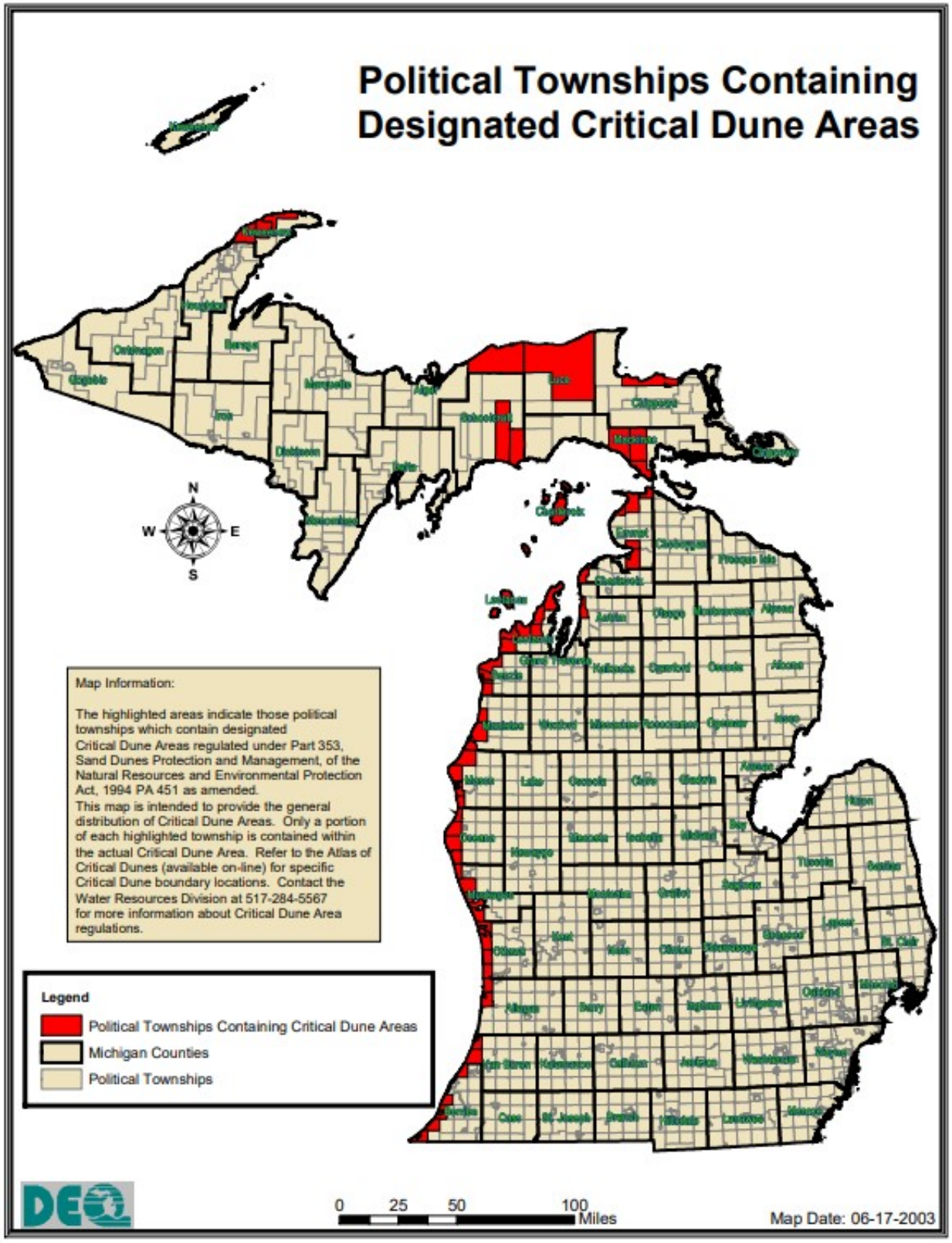
Northwest and west-central Michigan is blessed with abundant and high quality natural resources: the Lake Michigan coastline, extensive river systems, vast forested areas, high value wetlands, productive soils, and fresh-water lakes. Much of LRBOI's government, economic ,and housing are centralized in Manistee County and therefore will be the focus of the land analysis.

Manistee County has 25 miles of Lake Michigan shoreline including several critical dune protection areas (Figure 4). It is estimated that there are 276 miles of rivers and streams in Manistee County, with an estimated 45 miles of state or federal wild/scenic/natural rivers. There are 9,600 acres of surface water in Manistee County, consisting in part of nine inland lakes each with a surface area greater than fifty acres. The importance of fresh water and water bodies for providing sustenance is immeasurable. One such resource is wild rice, or manoomin. "The word manoomin translates in Anishinaabemowin or Ojibwemowin, to 'the good berry,' a literal reflection of the cultural importance it has to Anishinaabek communities." Manoomin rice beds used to sit at the mouths of Michigan's rivers where it grows best in near-perfect shallow, slow moving waters. Some beds were thousands of acres in size. Today, only one large bed remains in Michigan. *Complete table of culturally significant animal and plant species.*

Approximately 73% of the some 356,000 acres of land area in the county is forested, accounting for some 253,200 acres. Most of this (91,337 acres or 143 square miles) is federally owned land in the Manistee National Forest. A total of approximately 90 percent of the land area of the county is open space. There are 41,371 acres of farmland (274 total farms) in Manistee County according to the 2017 Census of Agriculture. Of the products sold, crop, especially grains, oilseeds, dry beans, and dry peas are the #1 selling product.

There are approximately 73,000 acres of wetlands in the county, some 21% of the total land area. These wetlands are primarily located along the Manistee River and within the Pere Marquette State Forest and the Manistee National Forest. Wetlands contribute significantly to water quality by acting as filters of storm water in addition to sustaining forest growth and providing habitat for wildlife. These areas generally are not suitable for development, but provide open space and recreational value as well as vital habitat for culturally significant animal and plant species.

Figure 4: Michigan Critical Dune Areas, 2003



Source: Michigan.gov/egle

Climate

Northwest Michigan experiences a four season climate with mild summers and cold, snowy winters. The LRBOI's coastal areas are set apart from inland areas. Lake Michigan keeps coastal areas warmer in the winter and cooler in the summer, with less rainfall than locations further inland. Since 1991, Manistee County has experienced the most precipitation in October with 3.91 inches on average and an average annual total precipitation of 35.54 inches. June and July share the hottest month with a mean average temperature of 92 °F, however, June has the highest temperature on record of 103 °F. February is the coldest month with a mean average temperature of -11 °F. The lowest temperature on record is -29 °F in February 2015.

On any given day, coastal areas including Manistee County, are highly susceptible to quick, sudden changes in the weather. Depending on the time of the year, the Great Lakes have a significant impact on temperatures, precipitation, and the strength of storms. In the spring when the lake water is colder than the air over them, they extract heat from the atmosphere. During the fall, the Great Lakes give off heat and moisture. In both cases, storms arrive on land stronger and more persistent than they might otherwise be. Thunderstorms, extreme winter weather events, and excessive rainfall are common natural hazards with the potential to cause loss of life and significant property damage. This plan identifies potential hazards and mitigation strategies to reduce the impact of those disasters.

Membership

Tribal membership is located throughout the nine-county region as shown in Table 2. Muskegon County has the highest number of Tribal members followed by Manistee County; however membership in Muskegon County also saw the largest numeric decrease from 2010-2021. Kent County which is the most populated county in the nine-county area and the location of the largest urban area, the City of Grand Rapids, has the third highest number of members. Mason County has the fourth highest membership population followed by Ottawa County, the southernmost county, west of Kent, has the fifth highest population. Oceana County has the sixth highest membership population and is one of only two counties with an increase in membership from 2010 to 2021. Oceana saw a 14% increase; Lake County, the eighth highest in membership, saw a 13% increase in membership. Newaygo and Wexford, inland counties, have the seventh and ninth highest membership population, respectively. Wexford County also has the largest percentage decrease in overall membership size from 2010 to 2021.

Table 2: Membership Population Change by County, 2010, 2021

County	2010	2021	Numeric Change	% Change
Muskegon	668	612	-56	-9%
Manistee	390	387	-3	-1%
Kent	283	250	-33	-13%
Mason	138	136	-2	-1%
Ottawa	114	104	-10	-10%
Oceana	71	83	12	14%
Newaygo	51	45	-6	-13%
Lake	33	38	5	13%
Wexford	31	24	-7	-29%
TOTAL	**1,779**	**1,679**	**-99**	**-6%**

Source: Little River Band of Ottawa Indians Membership Records

The membership's age is recorded in Table 3. The LRBOI's total 2010 and 2021 population is broken into age cohorts (analyzing which proportions of the population are in which stages of life). The membership age is broken down into cohorts of members aged 0-17, 18 to 54, and Elders, those aged 55 and over. The table identifies the number of members within each cohort for each county. Understanding the age distribution and median age can help identify social, economic, and public service needs in the community.

In the first two cohorts, ages 0-17 and 18-54, membership decreased in almost all counties. However, Lake County saw an increase in youth and went from no members aged 0-17 in 2010 to 5 members aged 0-17 in 2021. Ottawa County remained the same at 74 members aged 18-54 in 2010 and 2021. Oceana County saw an increase in members aged 18-54 and went from 48 members in 2010 to 53 members in 2021. Each county showed an increase in the Elder membership population from 2010 to 2021. The 2021 Elder membership is highest in Newaygo County where Elders make up 67% of the total population. There were no members aged 0-17 in Newaygo County in 2021. All nine counties indicate at least a quarter of the membership is made of Elders. Overall, 38% of the Tribe is aged 55 and over.

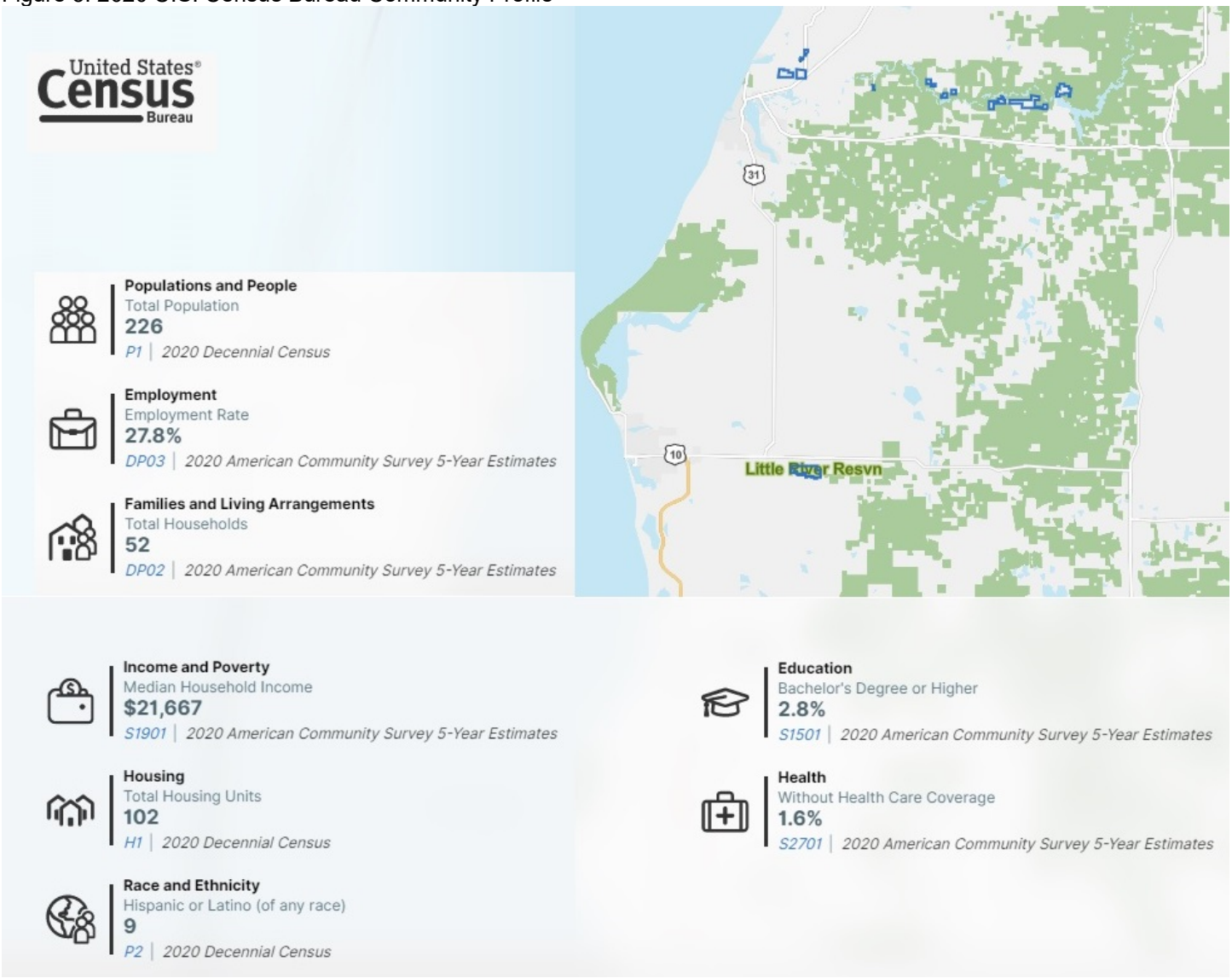
Table 3: Membership Age by Cohort, County, 2010, 2021

	0-17		18-54		55+		Total		Elder Membership %
	2010	2021	2010	2021	2010	2021	2010	2021	2021
Muskegon	84	39	435	347	149	226	668	612	37%
Manistee	44	40	250	182	96	165	390	387	43%
Kent	37	16	189	157	57	77	283	250	31%
Mason	31	25	74	56	33	55	138	136	40%
Newaygo	2	0	31	15	18	30	51	45	67%
Ottawa	21	1	74	74	19	29	114	104	28%
Oceana	10	6	48	53	13	24	71	83	29%
Lake	0	5	22	17	11	16	33	38	42%
Wexford	2	1	23	11	6	12	31	24	50%
TOTAL	**231**	**133**	**1,146**	**912**	**402**	**634**	**1,779**	**1,679**	**38%**

Source: Little River Band of Ottawa Indians Membership Records

Other LRBOI demographic information can be collected from the U.S. Census Bureau. In 2020, population, employment, household, income, education, and health-related information was collected via the Decennial Census and the American Community Survey 5-Year Estimates for LRBOI Reservation and Off-Reservation Trust Land in Michigan.

Figure 5: 2020 U.S. Census Bureau Community Profile



Source: U.S. Census Bureau

Housing

In 2020, there were 102 estimated total housing units on LRBOI Reservation and Off-Reservation Trust Land in Michigan. Of these, 92 were occupied, 10 were vacant. 52 households were reported and the average household size was 2.37 persons. 71% of households reported living in a 1-unit structure while 29% reported living in a 2-or-more-unit structure. 92% of units were renter-occupied while 8% were owner-occupied. The Census defines a household as all the people who occupy a single housing unit, regardless of their relationship to one another.

For purposes of this planning process, a list of membership and residential addresses was provided. The list includes only those names and addresses who chose to make their information available. Table 4 represents a breakdown of the number of residential units by county.

Table 4: Membership Housing Units by County, 2019

County	2021 Member Housing Units	Percent of 2019 Total
Kent County		%
Lake County		%
Manistee County		%
Mason County		%
Muskegon County		%
Newaygo County		%
Oceana County		%
Ottawa County		%
Wexford County		%
TOTAL		**%**

Source: Little River Band of Ottawa Indians Membership Records

Residential development for members continues to be a main priority for the Tribe. New housing opportunities are being built at Aki Maadiziwin off of Dontz Road in Manistee County and the Odeno subdivision in Fruitport Charter Township in Muskegon County. The Tribal Housing development at Dontz Road is an ### acre site with ### single-family units. Building permit data is presented in Table 5 indicates the number of permits that have been completed within the last ten years. Overall, ### single-family homes are planned for this site. The site is intended for both family and Elder housing. The Odeno development is overseen by the Tribe's economic development corporation, Little River Holdings, LLC. It is taking place in two phases: Phase I has 96 single-family units, and Phase II has 68 single-family units. The 2021 Strategic Plan's 2025 and Beyond objectives includes, "Work with Executive Branch and Housing Department to schedule and complete two (2) homes per year for Tribal Membership to occupy.

Table 5: Housing Units by Permit, 2010-2019

Year	# of Permits
2010	6
2011	12
2012	4
2013	7
2014	0
2015	0
2016	2
2017	8
2018	2
2019	0
TOTAL	**41**

Source: Little River Band of Ottawa Indians Planning Department

The social-economic profile includes employment and income characteristics reported to the U.S. Census Bureau as shown in the following tables. Table 6 represents the occupations reported by the 32 members who were employed at the time of the survey. The largest number of workers are employed in “Arts, entertainment, and recreation, and accommodation and food services” sector with 13 or 41% followed by the “Transportation and warehousing, and utilities” sector with 11 or 34%.

Table 6: Occupation by Industry, 2020

Industry	Estimate	Percent
Transportation and warehousing, and utilities	11	34%
Educational services, and health care and social assistance	1	3%
Arts, entertainment, and recreation, and accommodation and food services	13	41%
Other services, except public administration	1	3%
Public administration	6	19%
TOTAL	**32**	

Source: U.S. Census 2020 ACS 5-Year Estimate

52 households reported income and benefit information as shown in Table 7. The largest number of households reported an income of less than $10,000 with 17 or 33% followed by those who reported an income level of $25,000 to $34,999 with 14 or 27%. It is estimated that 20% of *families* and 38% of *people* have income levels below the poverty line.

Table 7: Household Income, 2020

	Estimate	Percent
Less than $10,000	17	33%
$10,000 to $14,999	5	10%
$15,000 to $24,999	5	10%
$25,000 to $34,999	14	27%
$35,000 to $49,999	1	2%
$50,000 to $74,999	5	10%
$75,000 to $99,999	3	6%
$100,000 to $149,999	2	4%
$150,000 to $199,999	0	0%
$200,000 or more	0	0%
TOTAL	52	
Median household income	$ 21,667	

Source: U.S. Census 2020 ACS 5-Year Estimate

Transportation

The LRBOI service area is crossed by several national and state highways. U.S. 31 and state highways M-55, M-10, M-46, and M-37. U.S. 31 is a north-south route that follows the Lake Michigan coastline. U.S. 31 is a primary route for connecting the LRBOI community in Manistee to the community in Muskegon. It starts in the north near Mackinaw City and connects to Interstate 196 in Grand Rapids. M-55 is an east-west corridor which runs from Manistee in the west to Cadillac in the east. M-10 is an east-west corridor which runs from Ludington in the west and traverses the state to end in Bay City in the east. M-46, another east-west corridor, begins in the west at Muskegon and travels east across the state to Port Sanilac. M-37 is a north-south corridor which connects U.S. 31 at Traverse City to U.S. 131 at Grand Rapids in the south. Kent County is connected by many national and state highway routes including Interstate 96 and 196, U.S. 131, and M-6 and M-45. The remainder of the LRBOI service area is accessed via numerous county and forest roads. The area also contains many miles of seasonal roads with a number in Manistee County being built and maintained by the U.S. Forest Service. The local County Road Commissions are the primary owner of the local street network and maintains roads within township jurisdictions.

Rail access is available in the southern counties, Kent and Ottawa, where Amtrak operates Michigan train services from Grand Rapids and Holland to Chicago, Illinois. Major area airports include Manistee County Blacker Airport in Manistee, Muskegon County Airport in Muskegon, Gerald R. Ford International Airport in Grand Rapids, and West Michigan Regional Airport in Holland. Just to the north, in Traverse City is the Cherry Capital Airport. Ferry travel to Milwaukee, Wisconsin is also available from Muskegon via the Lake Express High-Speed Ferry.

Utilities and Energy

The LRBOI operate water and wastewater utility services in portions of Manistee County. The Utility Department, led by the Utility Director, was created to manage the water and wastewater systems. LRBOI utilities are considered critical infrastructure as indicated in Table 8 below. Recently, the Tribal Council expressed an interest in leveraging the successful self-managing wastewater system and explore a similar expansion into renewable energy.

In 2019, the LRBOI joined the Midwest Tribal Energy Resources Association (MTERA) as a first step to prepare the Tribe to plan and develop Tribally-owned renewable projects. Through its MTERA membership, the project lead started tracking the Tribe’s energy utility bills, launched investment grade energy audits on the Tribe’s facilities, and has learned about other successful Tribal energy projects by networking with other Tribal energy champions serving on the MTERA Board. The 2020 Energy and Mineral Development Program builds on LRBOI’s newly developed energy planning capacity. It is the first major step in developing a renewable energy microgrid that accomplishes the Tribal Council’s desire to increase sovereignty, enhance the Tribe’s resilience, increase economic development, and reduce the Tribe’s carbon footprint. The overarching objective of the project is to identify the optimal renewable microgrid with diesel generation as a backup source that could power LRBOI’s facilities on trust land during outages Consumers Energy Company transmission and distribution system. The study is currently underway.

Future Land Use

The following is an except taken from the Vision Statement of the 2005 Land Use Plan

Lands in the 1836 and 1855 Reservations were used by our grandfather's grandfathers and will be used by our grandchildren' s grandchildren. We have embraced our historical land use and environmental patterns and have applied them to the medicine wheel for land use planning. In twenty years, the Anishinabek people are viewed as successful land use custodians:

We are the Ogimaniniwok and Ogimaniniikwek (leaders) in environmental stewardship, infrastructure management, service provisions, and cultural preservation. Our distinct philosophy in embracing the Medicine Wheel has been applied to these four land use components equally balanced.

On the east side of the land use Medicine Wheel is the Waabinong (Environmental aspect), which is the protection of the Aki (Earth), the purity of air and water, and natural resource management. On the south side is Zhaawanong (Infrastructure), which are policies regarding how much is provided, where it is provided, what types are provided, and to whom it is provided. Epangishmok (Services) is on the west side and represent the programs that are offered directly or indirectly to our citizens. Completing the circle is the Kiiwedinong (Tribal Survival) on the north side, the items that give us our identity and existence: language, art, traditions, and culture. Every piece of land has each of these elements.

Like the Medicine Wheel, all of the land uses are interconnected and complement each other. Development has been guided by the Medicine Wheel and was not solely driven by economics. Because development was planned using this approach, development costs were lower, more services were provided in an economical manner, and the natural resources were protected. Specifically, we have insured that:

- Lands with fragile or sensitive natural characteristics, such as wetlands and wildlife habitat along the Manistee River and Pere Marquette River have been protected. Development was successfully integrated with watershed and ecosystem management initiatives, animal and vegetation vitality, and Tribal member life-sustaining activities like fishing, gathering, and hunting.
- Like our ancestors, population areas were built in areas using nature as guidance. Buildings were placed where they would not be in conflict with the natural or cultural patterns. Buildings were designed to be integrated with nature, not separate. Careful infrastructure (water, sewer, and roads) planning helped guide and control where development occurred.
- These development patterns have created communities where services such as schools, hospitals, and cultural gathering areas are located near where people live. Land use planning has provided a nurturing family environment and made this a place where our membership enjoys living.
- People of all ages live here and are able to share in the culture, art, and traditions. The Anishinaabemowin, language of the Anishinabek, is spoken frequently here. Because this is a desired place, a majority of our membership lives here and keeps cultural education and preservation a priority. An important component of our cultural preservation is the use of natural resources for Tribal member life-sustaining activities. Stewardship of the natural resources has insured abundance for generations to come.

The 1836 and 1855 Reservations welcome the Seventh Generation with feelings of sustainability, community, and vitality to them and to Grandmother Earth. Our design and land use premises of our plan are based on their symbiotic relationships like the separate but touching parts of the Medicine Wheel. ".. . The four are interdependent, if one is ignored the others will suffer" (Jay Sam, Tribal member).

III. Hazard Identification and Assessments

Vulnerability Assessment

Natural hazard impact on the community can be understood by evaluating vulnerabilities for commonly agreed upon assets. A community's assets are defined broadly to include anything that is important to the character and function of a community and can be described very generally in the following categories:

- People
- Economy
- Built environment
- Natural environment

Vulnerable populations include the economically disadvantaged, elderly, homeless, and persons with a disability. Those that live unsheltered or in homeless encampments, assisted living facilities, mobile home parks, or isolated subdivisions are more susceptible to hazardous events. Vulnerable populations are represented on the Vulnerable Populations and Hazard Areas Map in Appendix A. Those locations included on the map were specifically mentioned during public input sessions. There may be additional locations of vulnerable populations that are not listed.

As shown in Table 8, the primary economic generators for the LRBOI are Tribal government and the Little River Casino Resort. The Government Center and Casino are located within one lime of each other in addition to Tribal housing and other government facilities in Manistee County. This concentration of population and resources within the built environment make this area critically important both economically and as a resource for community members. It is vulnerable to all countywide hazards which is further detailed in the hazard analysis. Infrastructure points (stream crossings, bridge conditions, and dams) and their ratings are mapped on the Infrastructure Map in Appendix A.

The natural environment is one of the primary features of LRBOI culture and traditions. Its significance shows up in different aspects of daily life and Tribal celebrations and festivals. The forest lands, water features, and shorelines and all of the wildlife within them are integral to the identity of the community. While natural resources are abundant they are vulnerable to all types of hazards. Northwest Lower Michigan is also home to many sensitive wildlife populations that require specific climates and habitats to survive. Damaged, destroyed, or changing environments may decrease the chances for certain species' survival.

LRBOI critical infrastructure is represented in Table 8. Task Force members identified the critical facilities and infrastructure and the points were mapped on the Critical Infrastructure Points Map in Appendix A.

Table 8: Critical Facilities and Infrastructure

No. of Facilities (TOTAL)	FACILITY TYPE
1	**Government** • Government Center
1	**Public Safety** • Justice Center
8	**Utility Service** • Water Tower • Lagoon • Lift Stations
2	**Commercial** • Little River Casino Resort • Little River Trading Post
1	**Residential** • Elder Apartment Complex
1	**Community Center**

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Source: LRBOI Emergency Management

Historical Analysis

The Historical Analysis of weather-related hazards in Manistee County and the surrounding service area uses information on impacts and losses from previous hazard events to predict potential impacts and losses during a similar event. Because of the frequency of these events, communities are more likely to have experience with and data on impacts and losses. There have been eight distinct disaster declarations that have involved in the LRBOI service area (Table 9). These events are further included in the hazard analysis for individual event types.

Table 9: Presidential and Governor Declared Disasters

Date of Incident	Type of Incident	Affected Area	(P)residential Declaration* / Federal ID Number** (T) Tribal Declaration of State of Emergency (G)overnor's Declaration***
3/10/2020 3/27/2020	Pandemic	All 83 counties / LRBOI Service area	(P) Major Disaster, (T) Emergency, (G) Emergency
3/14/2019	Flooding	Newaygo County	(G) Emergency
2/7/2019	Severe Winter Weather	City of Grand Rapids	(G) Emergency
1/29/2019	Extreme Cold	All 83 counties	(G) Emergency
2/19/2018	Flooding	City of Grand Rapids and City of Lansing; Allegan, Arenac, Barry, Berrien, Cass, Clare, Eaton, Ingham, Ionia, Kalamazoo, Kent, Newaygo, Mecosta, Ogemaw, Oscoda, Ottawa, and St. Joseph Co.	(G) Disaster
4/12/2014	Flooding	Isabella, Mecosta, Missaukee, Muskegon, Newaygo, Osceola, Roscommon, and Wexford Co.	(G) Disaster
5/7/13 - 6/18/13	Flooding	Allegan, Baraga, Barry, Benzie, Genesee, Gogebic, Gratiot, Houghton, Ionia, Iron, Kent, Keweenaw, Marquette, Mecosta, Midland, Muskegon, Newaygo, Ontonagon, Osceola, Ottawa and Saginaw Co.; City of Grand Rapids (Kent Co.); City of Ionia (Ionia Co.)	(G) Disaster
4/16/13-5/14/13	Flooding	16 counties: Allegan, Baraga, Barry, Gogebic, Houghton, Ionia, Kent, Keweenaw, Marquette, Midland, Muskegon, Newaygo, Ontonagon, Osceola, Ottawa, and Saginaw Co.	(P) Major Disaster (4121)
7/14/2008	Thunderstorms, flooding	12 counties: Allegan, Barry, Eaton, Ingham, Lake, Manistee, Mason, Missaukee, Osceola, Ottawa, Saginaw, and Wexford Co.	(P) Major Disaster (1777)
6/19/2008	Thunderstorms	Lake, Manistee, Osceola, Ottawa, and Wexford Co.	(G) Emergency
6/13/2008	Thunderstorms	City of Saginaw and City of Lansing (Ingham Co.); Allegan, Eaton, and Mason Co.	(G) Emergency
9/7/2005	Hurricane evacuation	All 83 counties	(P) Emergency (3225)
9/4/2005	Hurricane evacuation	All 83 counties	(G Disaster
5/20/04-6/8/04	Thunderstorms, flooding	23 counties: Barry, Berrien, Cass, Eaton, Genesee, Gladwin, Ingham, Ionia, Jackson, Kent, Livingston, Macomb, Mecosta, Muskegon, Oakland, Ottawa, Saginaw, Sanilac, Shiawassee, St. Clair, St. Joseph, Washtenaw, and Wayne Co.	(P) Major Disaster (1527)
6/3/2004	Thunderstorms, flooding	Arenac, Barry, Berrien, Cass, Genesee, Gladwin, Ingham, Ionia, Jackson, Kent, Livingston, Macomb, Mecosta, Newaygo, Oakland, Ottawa, Saginaw, St. Clair, St. Joseph, Sanilac, Shiawassee, Van Buren and Wayne Co.	(G) Disaster
12/11-31/00	Blizzard, snowstorm	39 counties: Allegan, Barry, Bay, Berrien, Branch, Calhoun, Cass, Clare, Clinton, Eaton, Genesee, Gladwin, Gratiot, Hillsdale, Huron, Ingham, Ionia, Isabella, Jackson, Kalamazoo, Kent, Lapeer, Livingston, Macomb, Mecosta, Midland, Montcalm, Muskegon, Oakland, Osceola, Ottawa, Saginaw, St. Clair, St. Joseph, Sanilac, Shiawassee, Tuscola, Van Buren, and Washtenaw Co.	(P) Emergency (3160)
1/2-15/99	Blizzard, snowstorm	31 counties: Alcona, Allegan, Arenac, Barry, Berrien, Cass, Crawford, Ionia, Iosco, Jackson, Kalamazoo, Kent, Lenawee, Macomb, Marquette, Mecosta, Monroe, Montmorency, Muskegon, Newaygo, Oakland, Oceana, Ogemaw, Osceola, Oscoda, Otsego, Ottawa, St. Joseph, Van Buren, Washtenaw, and Wayne Co.	(P) Emergency (3137)
6/3-5/1998	Thunderstorms, severe winds	Bay, Clinton, Gratiot, Ionia, Kent, Mason, Mecosta, Montcalm, Muskegon, Newaygo, Oceana, Ottawa, Saginaw, and Shiawassee Co.; Village of Armada (Macomb Co.)	(G) Disaster
5/31/1998	Thunderstorms, severe winds	13 counties: Bay, Clinton, Gratiot, Ionia, Kent, Mason, Montcalm, Muskegon, Newaygo, Oceana, Ottawa, Saginaw, and Shiawassee Co.	(P) Major Disaster (1226)

6/27/1997	Rainstorms, flooding	Allegan and Ottawa Co.	(G) Disaster
10/28/1986 **9/15/1986** **9/12/1986**	Flooding, heavy rain	Allegan, Arenac, Bay, Clare, Clinton, Genesee, Gladwin, Gratiot, Huron, Ionia, Isabella, Kent, Lake, Lapeer, Macomb, Manistee, Mason, Mecosta, Midland, Montcalm, Muskegon, Newaygo, Oceana, Osceola, Ottawa, Saginaw, Shiawassee, Tuscola, and Van Buren Co.	(G) Disaster
9/10-19/86	Flooding	30 counties: Allegan, Arenac, Bay, Clare, Clinton, Genesee, Gladwin, Gratiot, Huron, Ionia, Isabella, Kent, Lake, Lapeer, Macomb, Manistee, Mason, Mecosta, Midland, Montcalm, Muskegon, Newaygo, Oceana, Osceola, Ottawa, Saginaw, Sanilac, Shiawassee, Tuscola, and Van Buren Co.	(P) Major Disaster (774)
2/21/1986	Great Lakes flooding, wave action	Allegan, Arenac, Bay, Berrien, Grand Traverse, Iosco, Macomb, Marquette, Menominee, Monroe, Muskegon, Ottawa, Saginaw, St. Clair, Tuscola, Van Buren, and Wayne Co.	(G) Disaster
7/21/1980	Thunderstorms, severe winds	Allegan, Berrien, Calhoun, Cass, Jackson, St. Joseph, Van Buren, Washtenaw, and Wayne Co.; City of Grand Haven and Village of Spring Lake (Ottawa Co.)	(G) Disaster
7/15-20/80	Severe winds	10 counties: Allegan, Berrien, Calhoun, Cass, Jackson, Ottawa, St. Joseph, Van Buren, Washtenaw, and Wayne Co.	(P) Major Disaster (631)
1/26-27/78	Blizzard, snowstorm	Statewide	(P) Emergency (3057)
1/26/1978	Blizzard, snowstorm	Statewide	(G) Disaster
3/2/1977	Drought	44 counties: Alcona, Alger, Alpena, Antrim, Arenac, Baraga, Benzie, Charlevoix, Cheboygan, Chippewa, Clare, Crawford, Delta, Dickinson, Emmet, Gladwin, Gogebic, Grand Traverse, Houghton, Iosco, Iron, Isabella, Kalkaska, Lake, Leelanau, Luce, Mackinac, Manistee, Marquette, Mason, Mecosta, Menominee, Missaukee, Montmorency, Oceana, Ogemaw, Ontonagon, Osceola, Oscoda, Otsego, Presque Isle, Roscommon, Schoolcraft, and Wexford Co.	(P) Emergency (3035)
1/26-31/77	Blizzard, snowstorm	15 counties: Allegan, Barry, Berrien, Cass, Chippewa, Hillsdale, Kalamazoo, Kent, Monroe, Muskegon, Newaygo, Oceana, Ottawa, St. Joseph, and Van Buren Co.	(P) Emergency (3030)
1/28/1977	Blizzard	Allegan, Barry, Berrien, Cass, Chippewa, Eaton, Hillsdale, Ionia, Muskegon, Newaygo, Oceana, Ottawa, Sanilac, Shiawassee, and Van Buren Co.	(G) Disaster
3/20/76, 3/2-7/76	Ice storm, tornadoes	29 counties: Allegan, Bay, Clare, Clinton, Genesee, Gladwin, Gratiot, Ionia, Isabella, Jackson, Kent, Lapeer, Macomb, Mecosta, Midland, Montcalm, Muskegon, Newaygo, Oakland, Oceana, Osceola, Ottawa, Roscommon, Saginaw, St. Clair, Sanilac, Shiawassee, Tuscola, and Wayne Co.	(P) Major Disaster (495)
8/20/75-9/6/75	Rainstorms, severe winds, flooding	16 counties: Allegan, Clare, Genesee, Gratiot, Ingham, Isabella, Mecosta, Midland, Montcalm, Muskegon, Newaygo, Oceana, Osceola, Ottawa, Saginaw, and Shiawassee Co.	(P) Major Disaster (486)
4/18-30/75	Flooding, rain, tornadoes	21 counties: Allegan, Barry, Berrien, Calhoun, Clinton, Crawford, Eaton, Genesee, Ingham, Ionia, Kalamazoo, Kent, Lapeer, Livingston, Macomb, Oakland, Ottawa, Saginaw, St. Clair, Shiawassee, and Van Buren Co.	(P) Major Disaster (465)
4/11/1965	Tornadoes, severe storms	16 counties: Allegan, Barry, Bay, Branch, Clinton, Eaton, Gratiot, Hillsdale, Kalamazoo, Kent, Lenawee, Monroe, Montcalm, Ottawa, Shiawassee, and Washtenaw Co.	(P) Major Disaster (190)
4/5/1956	Tornado	4 counties: Benzie, Leelanau, Manistee, and Ottawa Co.	(P) Major Disaster (53)

Notes

***Does not include separate Secretary of Agriculture or Small Business Administration (SBA) disaster declarations, which are issued under other authorities. Declarations after 1974 were issued under PL 93-288 (Disaster Relief Act), as amended by the Robert T. Stafford Disaster Relief and Emergency Assistance Act (1988) and the Disaster Mitigation Act (2000).**

****Indicates federal declaration number assigned by FEMA or its predecessor agencies**

*****Declarations since 1977 were issued under 1976 PA 390, as amended (Michigan Emergency Management Act).**

Source: FEMA

Hazard Descriptions

The LRBOI lands and service area is vulnerable to a wide range of natural hazards. Hazard events have the potential to impact members, economic drivers in the community, critical infrastructure and the built environment, and the natural environment. The Little River Band of Ottawa Indian's Emergency Management is challenged with managing these threats to protect life and property. This plan includes a profile for each natural hazard event the LRBOI is likely to face. Due to a concentration of facilities and members, the primary focus of the hazard analysis is events in Manistee County. Each profile includes the location, extent, previous occurrences, probability of future events, and vulnerability assessment.

- Location is the geographic areas within the planning area that are affected by the hazard, such as a floodplain. The entire planning area may be uniformly affected by some hazards, such as drought or winter storm. Location may be described in narrative and or through map illustrations.
- Extent is the strength or magnitude of the hazard. Extent can be described in a combination of ways depending on the hazard.
- Previous occurrences describe the history of previous hazard events within the county. This information helps estimate the likelihood of future events and predict potential impacts. The extent of historic events may be included when the data is available. Data is collected from the National Oceanic and Atmospheric Administration's National Centers for Environmental Information data center (NOAA).
- Probability of future events is the likelihood of the hazard occurring in the future and can be described in a variety of ways. Probability may be defined using historical frequencies or statistical probabilities.
- Vulnerability assessment accounts for the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas and provides an estimate of the potential dollar losses to vulnerable assets identified.

Data for natural hazard events in Manistee County was compiled from several different sources. Weather event data was collected primarily from the National Centers for Environmental Information through the National Oceanic and Atmospheric Administration's (NOAA). All sources include:

- FEMA records of historic Presidential and/or Governor declared emergencies (Table 9)
- Tribal emergency declarations (Table 9)
- National Weather Service Climate and Past Weather
- Weather/Climate Events, Information, Assessments
- Climatology and Extreme Events
- NOAA Storm Event Database (Table 10); started at 1950 to present, however, information for various events is limited The database utilizes local storm reports, damage reports, events checked for Manistee County included: Flood (Flash Flood, Flood),Shoreline (Lakeshore) Flood, Hail (Hail), Extreme Winter Weather (Blizzard, Freezing Fog, Frost/Freeze, Heavy Snow, Ice Storm, Lake-effect Snow, Sleet, Winter Storm, Winter Weather), Extreme Temperatures (Cold/Wind Chill/Heat/Extreme Heat), Tornado (Tornado, Funnel Cloud), Dense Fog, Thunderstorm and High Wind (Heavy Rain, High Wind, Lightning, Strong Wind, Thunderstorm Wind), Wildfire (Wildfire)
- The *Michigan Hazard Analysis* report by the Michigan Department of State Police in 2019 and the Michigan Department of Natural Resources was used to collect data on wildfires
- The National Inventory of Dams was used to collect information on countywide dams

The Storm Events Database is updated on a rolling basis, and thus the database is always being added to. The most up to date information was added to Table 10, but as events occur the database will change. Thus, 2022 is likely only partially represented. As of 8/1/2022, 221 events were reported between 01/01/1950 and 08/1/2022 (26,511 days). There were a total of 183 days with an event, 3 days with event and death or injury, 34 days with event and property damage, and 2 days with event and crop damage. Those events as well as the emergency declaration events are included in the hazard analysis. The hazard analysis groups the events into the following categories:

Table 10: NOAA Storm Events Database, Manistee County Event by Type, 1950-2022

Type of Event	# of Events	Event Location
Extreme Winter Weather (Inc. Ice, Snow, Blizzard)	100	Countywide
Thunderstorms and Severe Winds	65	Countywide
Hail	32	Countywide
Riverine and Urban Flooding	10	Arcadia Township, Onekama Township, Manistee Township, Filer Township, City of Manistee,
Lightning	2	Countywide
Shoreline Hazard(Coastal Flooding / Coastal Recession)	4	Arcadia Township, Onekama Township, Manistee Township, Filer Township, City of Manistee
Tornado	2	Countywide
Extreme Temperatures (Heat / Cold)	2 / 2	Countywide
Wildfire		MDNR Lands
Rip Current	1	Arcadia Township, Onekama Township, Manistee Township, Filer Township, City of Manistee
Dense Fog	1	Countywide
Public Health Emergency	1	Countywide
Invasive Species		Countywide

Source: NOAA: National Centers for Environmental Information and MDNR

Economic Impact Analysis

Table 11 presents the *reported* deaths, injuries, property damages, and crop damages of storm events in Manistee County from 1950-2022. There were four deaths and zero injuries. Two deaths occurred from a thunderstorm on July 20, 1987, one death occurred from a rip current on July 11, 2007, and one death occurred from lightning on September 6, 2016. The economic impact of Manistee County natural hazards is $6,779,000 in property damages and $10,035,000 in crop damages since 1950 Events such as hail likely cause numerous residents small amounts in property damage, but go unreported. The total reported Damaging Events' Costs recorded since 1950 with the National Oceanic and Atmospheric Administration for Manistee County are as follows:

Table 11: Damage Cost by Event Type, 1950-2022

Manistee County	Death / Injury	Property Damage Cost	Crop Damage Cost
Extreme Winter Weather	0 / 0	$350,000	$10,000,000
Thunderstorm and High Wind	2 / 0	$645,500	$0
Hail	0 / 0	$0	$35,000
Riverine and Urban Flooding	0 / 0	$5,020,000	$0
Lightning	1 / 0	$0	$0
Shoreline Hazards	0 / 0	$499,000	$0
Tornado	0 / 0	$265,000	$0
Extreme Temperatures	0 / 0	$0	$0
Wildfire	0 / 0	$	$
Rip Currents	1 / 0	$0	$0
Dense Fog	0 / 0	$0	$0
Public Health Emergency	0 / 0	NA	NA
Invasive Species	0 / 0	NA	NA
TOTAL	**4 / 0**	**$6,779,000**	**$10,035,000**

Source: NOAA: National Centers for Environmental Information and MDNR

Table 12 provides an overview of each potential hazard's estimated impact on the State Equalized Values (SEV) for real and personal property (residential and commercial).

Table 12: Geographic Economic Impact by Event

Hazard Event	Geography	Population Totals	State Equalized Value
Extreme Winter Weather, Thunderstorm, Hail, Lightning, Tornado, Extreme Temperatures, Dense Fog	Manistee County		$
Inland Flooding	Manistee Township, City of Manistee, and other inland lake jurisdictions		$
Wildfire	Areas within Jack Pine forest		$
Shoreline Hazards, Rip Currents	Arcadia Township, Onekama Township, Manistee Township, Filer Township, City of Manistee		$

Source: 2019 ACS Estimate, Manistee County Equalization

Extreme Winter Weather

National Weather Service defined as: *phenomenon (such as snow, sleet, ice, wind chill) that impacts public safety, transportation, and/or commerce.* The Extreme Winter Weather category includes the following subcategories: winter weather, winter storm, ice storm, heavy snow, blizzard, frost/freeze, and lake effect snow. Blizzards are the most perilous snowstorms and are characterized by low temperatures, strong winds, and enormous amounts of fine, powdery snow. Snowstorms have the potential to reduce visibility, cause property damage, and loss of life.

According to the 2019 Michigan Hazard Analysis, Michigan has 360 snowstorms with 0.1 average annual deaths, 0.1 average annual injuries, and $1.9 million in average annual property and crop damage. Michigan experiences large differences in snowfall over short distances due to the Great Lakes. The average annual snowfall accumulation ranges from 30 to 200 inches with the highest accumulations in the northern and western parts of the Upper Peninsula. In Lower Michigan, the highest snowfall accumulations occur near Lake Michigan and in the higher elevations of northern Lower Michigan. For example, the average snowfall ranges from 141 inches in the Gaylord area to 101 inches in Traverse City in the northwest region of the Lower Peninsula.

Ice and Sleet Storms are storms that generate sufficient quantities of ice or sleet that result in hazardous conditions and/or property damage. Ice storms occur when cold rain freezes on contact with the surface and coats the ground, trees, buildings, and overhead wires with ice. Often times, ice storms are accompanied by snowfall, which sometimes causes extensive damage, treacherous conditions, and power loss. On the other hand, sleet storms are small ice pellets that bounce when hitting the ground or other objects. It does not stick to trees or wires, but can cause hazardous driving conditions. When electric lines are down, households are inconvenienced, and communities experience economic loss and the disruption of essential services.

According to the 2019 Michigan Hazard Mitigation Plan, Michigan has 16 average annual ice and sleet storm events with 0.2 average annual deaths, 0.5 average annual injuries, and $11.4 million in average annual property and crop damage.

Location
Extreme winter weather events are regional events that are not confined to geographic boundaries and can affect several areas at one time with varying severity depending on factors such as elevation and wind patterns. All of Manistee County and other LRBOI lands are at risk to the occurrence and impacts from extreme winter weather. The coastal counties are more susceptible to lake-effect snow due to proximity to Lake Michigan.

One of the highest-impact snowstorms in recent memory pounded Northern Michigan on the night of March 2, 2012. Low pressure tracked from Missouri, to southern Lower Michigan, and on to eastern Canada, while rapidly strengthening. Precipitation surged northward into the region on the evening of the 2nd. This was primarily snow, except in parts of east central Lower Michigan (especially near Lake Huron), where temperatures were mild enough for rain. Snow wound down on the morning of the 3rd, and though somewhat blustery winds occurred behind the system on the 3rd, blowing snow was limited because the snowfall was so wet. Snow totals ranged from 6 to 14 inches across most of Northern Michigan. Higher amounts fell near and west of Grand Traverse Bay, with a maximum amount of 20 inches near Lake Ann. With relatively warm temperatures, the snow was very wet; Traverse City saw around a foot of snow during the night, with a low temperature of 33 degrees. The snow stuck to everything, with the weight of the snow downing many, many trees and power lines. Power outages were widespread, with an outright majority of Northern Michigan residents losing power at some time during or after the storm. In Benzie County, 95 percent of residents lost power. Outages lasted up to a week in some spots. Great Lakes Energy described it as the worst snowstorm (in regards to power outages) in 30 years. A number of counties and communities opened shelters to aid those without power or heat. Also included in the tree damage was substantial damage to fruit trees in the Grand Traverse Bay region, particularly cherry trees. This event accounts for $350,000 in reported damages.

The frost/freeze event on listed in Table 13 took place on April 27, 2012 across Northwest Lower Michigan. A killing freeze caused extreme damage to agriculture, particularly in the fruit belt of Northwest Lower Michigan. Traverse City saw low temperatures of 25 degrees on the 27th, 31 degrees on the 28th, and 26 degrees on the 29th. These values were not exceptionally colder than normal lows, which are in the middle 30s. Ultimately, the main culprit was a stretch of unprecedented warmth in mid-March, which included five consecutive 80-degree days (17th-21st). This caused fruit trees to bud out far, far ahead of schedule, and left them vulnerable to even relatively normal weather as the spring progressed. The tart cherry crop was a total loss, while other orchard fruits such as sweet cherries, apples, pears, and peaches saw losses in excess of 90% of the expected crop.

Extent
Snowstorms can be measured based on snowfall accumulations or damages. The average annual snowfall in Manistee County is 80.9 inches. On March 2, 2012 Manistee County had $350,000 in property damages caused by heavy snow. Extreme winter weather events in total caused $350,000 in property damages and $10,000,000 in crop damages between 1950-2022.

Previous Occurrences
Since 1950, there have been 100 extreme winter weather events, including heavy snowstorms, ice storms, frost/freeze, blizzards, winter weather, and winter storms reported in Manistee County (Table 13). There have been six winter weather-related Presidential or Governor declared emergencies or disasters across the entire LRBOI area. Two of those events occurred in Manistee and are accounted for (1999 and 2000). Four additional events occurred outside of Manistee County or were not included on the Storm Database (1976, 1977, 1978, and 2019). These earlier historic events were mostly blizzard events that hit large areas of the state. In recent years, the more common events are winter storms with moderate snowfall of 5-10 inches. Heavy snow, blizzards, and lake-effect snows have been less common. Nonetheless, extreme winter weather events are the most frequent recorded event with the potential to impact the entire county and cause widespread damage. With combined property and crop damages, winter weather events are also the most costly events to occur in Manistee County.

Table 13: Extreme Winter Weather Previous Occurrences, 1950-2022

Event Type	Number of Events	Property Damage	Crop Damage	Event Year(s)
Winter Weather	1	$ -	$ -	2006
Winter Storm	49	$ -	$ -	1997-2022
Ice Storm	5	$ -	$ -	2001, 2002, 2005, 2008
Heavy Snow	30	$ 350,000	$ -	1997-2012
Blizzard	5	$ -	$ -	1997, 1998, 1999, 2002, 2019
Frost/Freeze	1	$ -	$ 10,000,000	2012
Lake-Effect Snow	9	$ -	$ -	2006-2019
TOTAL	**100**	**$ 350,000**	**$ 10,000,000**	

Source: NOAA: National Centers for Environmental Information

Probability of Future Events and Vulnerability Assessment
Since 1950, Manistee County has had 100 extreme winter weather events. This averages to about two events every year. The probability of an event occurring in future years is 100 percent. Heavy snow events have the potential of shutting down towns and businesses for a significant period of time. Blowing and drifting snow with blizzard conditions cause driving hazards. Ice damage may occur when high winds push lake water and ice past the shoreline, causing damage to public infrastructure and residential property. The LRBOI grows much of its own food and a frost/freeze event of the magnitude in 2012 would decimate an essential food source.

LRBOI members are the primary vulnerability during winter weather-related events. The reasons for member vulnerability include: the high percentage of Elder members, the high percentage of members within poverty level, members who live in remote areas, limited access to technology including cellular phone service and broadband internet, and minimal access to backup power sources. The Community Survey specifically mentioned internet and cell access was an issue and there were concerns about access to power in the event of a natural hazard. One response said, “Cell towers in our region are spotty and are regularly taken out by violent storms.” Ice storms have the capability to take out power, and cold temperatures can be fatal for members without a backup power source. Providing help and assistance to members in remote locations can treacherous when combined with icy or snowy roads.

Thunderstorms and Severe Winds

Severe thunderstorms are weather systems accompanied by strong winds (at least 56mph), lightning, heavy rain (that could cause flash flooding), hail (at least 3/4:" diameter), or tornadoes. Severe thunderstorms can occur at any time in Michigan, although they are most frequent during the warm spring and summer months from May through September.

Severe wind events are included in this category. Long-lived wind events associated with fast-moving severe thunderstorms are known as a derecho. A derecho often occurs during the spring or summer; however, it can occur any time of the year. According to The National Severe Storms Laboratory, winds in excess of 58 miles per hour are considered to be a derecho. Severe windstorms can cause damage to homes and businesses, power lines, trees and agricultural crops, and may require temporary sheltering of individuals without power for extended periods of time.

Location
Thunderstorms and severe wind are regional events that are not confined to geographic boundaries and can affect several areas at one time with varying severity depending on factors such as elevation and wind patterns. All of Manistee County and the LRBOI area is at risk to the occurrence and impacts from thunderstorms and severe winds.

The most life threatening event occurred on July 20, 1987. A severe weather outbreak came across Michigan causing property damage across the state. In Manistee County, swimmers were drowned when winds came up suddenly. Two deaths were reported from this storm.

In June 2008, thunderstorms, flooding and tornadoes crossed Manistee County. A large area of thunderstorms developed over Lake Michigan late in the evening on the 12th, as very moist air surged into the region. These storms were severe as they moved onshore, producing damaging winds, large hail, and a brief tornado. However, the biggest impact was from excessive rainfall, which produced unusually severe flooding in West Central Lower Michigan. The Governor of Michigan declared a state of emergency for Manistee and Wexford Counties, along with other counties downstate. This episode featured widespread straight-line wind damage in parts of northwest lower Michigan, and the largest hail on record in northern Michigan in Ogemaw County. This event resulted in $ 195,000 in property damages.

Extent
Thunderstorms can be measured based on wind speed or damages. The average wind speed for events in Manistee County is 53 knots. Manistee County had $645,500 in property damages and no reported crop damages caused by thunderstorms and severe winds.

Previous Occurrences
Since 1950, there have been 65 thunderstorm events accompanied by strong winds and severe wind events reported in Manistee County (Table 14). There have been eleven thunderstorm or wind-related Presidential or Governor declared emergencies or disasters across the entire LRBOI area.

Table 14: Thunderstorm and Wind Events Previous Occurrences, 1950-2022

Event Type	Number of Events	Property Damage	Crop Damage	Event Year(s)
Thunderstorm Wind	56	$ 510,500	$ -	1950-2021
High Wind	7	$ 90,000	$ -	1998, 2001, 2003, 2005, 2010, 2015, 2021
Strong Wind	2	$ 45,000	$ -	2007, 2007
TOTAL	**65**	**$ 645,500**	**$ 0**	

Source: NOAA: National Centers for Environmental Information

Probability of Future Events and Vulnerability Assessment
Since 1950, Manistee County has had 65 thunderstorm events accompanied by strong winds. This averages to .9 events every year. The probability of an event occurring in future years is 90 percent. Damage from straight line winds usually affects multiple counties through the loss of electricity from trees/tree limbs downing power lines; causing widespread property damage; and potentially exposing members to severe injury or fatality due to flying debris. The magnitude and severity depend on the population, seasonal activity, and the spread of development. During the warm or summer months, friends and family visit or celebrations and festivals are held that draw a large number of visitors to the area. Those without permanent shelter or are caught outside in a quickly moving storm are vulnerable to hazardous conditions.

During community meetings, Tribal government employees indicated thunderstorms, lightning and potential power outages were the number 1 concern for the members. Thunderstorms can appear quickly and cause significant damage. Members are geographically spread out and notifying them of inclement weather is difficult. The Tribe currently uses Fast Command, TV and radio announcements, and weather notifications to alert members. Fast Command is limited due to the sign up process: members must request to be added to the alert system. The Tribe seeks better ways to forewarn people about severe storms. Additionally, power outages caused by downed trees or lightning strikes have caused service issues for the utility systems. Lightning has struck the utility system's electrical components, and they have had to repair the component and put surge protectors in place. The Tribe has installed generators in order to minimize disruptions in the power to the utility system.

Hail

Hailstorms occur when a severe thunderstorm produces hail that falls to the ground. Hail is formed when the updrafts of the storm carries water droplets above the freezing level, where they form into rounded or irregular lumps of ice that range from the size of a pea to the size of a grapefruit. When the weight of the hail is no longer supported by the air, it falls to the ground and has the potential to batter crops, dent automobiles, and injure people and wildlife. Sometimes, large hail appears before a tornado since it is formed in the area of a thunderstorm that tornadoes are most likely to form.

According to the 2019 Michigan Hazard Mitigation Plan, Michigan has on average 191 hail storms, an expected annual statewide loss of about $16.6 million, no deaths, and approximately 1 injury per year. Despite damaging hail occurring in every part of Michigan, the areas of the state most prone to severe thunderstorms (e.g. the Southern half of the Lower Peninsula) are also most prone to large and damaging hail. The majority of the hailstorms occur during the growing season from May through August when crops have the greatest potential to be damaged by hail.

According to the 2012 Michigan Hazard Analysis, the National Weather Service began recording hail activity in Michigan in 1967. The National Weather Service issues forecasts for severe thunderstorms with sufficient warning time to allow residents to take appropriate action to reduce the effects of hail damage to vehicles and some property. However, little can be done to prevent damage to crops. For example, during September 26-27, 1998, a line of severe thunderstorms moved across northern Lower Michigan producing hail up to 2” in diameter, destroying an estimated 30,000-35,000 bushels of apples at area farms, and damaging several homes and vehicles.

Location
Hailstorms are regional events that frequently accompany thunderstorms, and are not confined to geographic boundaries. The severity of hailstorms may range across the affected areas. All of Manistee County and LRBOI areas are at risk to the occurrence and impacts from hailstorms. According to the National Weather Service, Manistee County is in an area of the United States that has on average two days of hailstorm events per year.

During one particularly strong event occurred on September 26, 1998 near Bear Lake. Hail severely damaged two apple orchards. Around 15,000 bushels of apples were destroyed with an estimated monetary loss of $35,000. The reported hail size was 2”, roughly the size of a hen egg.

Extent
Hailstorms are categorized using the TORRO Hailstorm Intensity Scale, which ranges from H0 (Hard Hail) to H10 (Super Hailstorms) (Table 15). According to the NOAA National Centers for Environmental Information, the approximate size of hail is described as follows:

Table 15: NOAA Hail Size Description

Appearance	Approximate Size in Inches
Pea	0.25-0.5 inch
Penny	0.75 inch
Nickel	0.88 inch
Quarter	1.00 inch
Walnut/Ping Pong	1.50 inch
Golf Ball	1.75 inch
Hen Egg	2.00 inch
Tennis Ball	2.50 inch
Baseball	2.75 inch
Tea Cup	3.00 inch
Grapefruit	4.00 inch
Softball	4.50 inch

The greatest extent hail reported in Manistee County was 2 inches on September 26, 1998, which correlates to H6 (destructive) on the TORRO Hailstorm Intensity Scale. According to the scale, hailstones of this size are equivalent to a hen egg and can damage ground aircraft and brick walls.

Previous Occurrences
Between 1950 and 2022, Manistee County had 32 hailstorms reported to NOAA (Table 16). There are no damages, injuries, or deaths attributed to hail.

Table 16: Hail Events, 1950-2022

Place	Date	Magnitude
MANISTEE	7/12/1973	1.75
MANISTEE	6/8/1985	0.75
ONEKAMA	8/23/1998	1.75
BEAR LAKE	9/26/1998	2
WELLSTON	9/26/1998	1.25
BEAR LAKE	10/13/1999	0.75
WELLSTON	10/13/1999	0.75
MANISTEE	8/9/2000	0.88
WELLSTON	4/15/2003	1
BEAR LAKE	7/20/2003	0.88
MANISTEE	7/24/2005	0.88
COPEMISH	9/7/2005	0.75
MANISTEE	10/3/2006	0.75
SPRINGDALE	6/14/2008	1
KALEVA	6/14/2008	0.75
WELLSTON	6/14/2008	0.75
NORWALK	**5/11/2011**	**0.75**
WELLSTON	5/11/2011	1.25
MANISTEE	5/11/2011	1.5
MANISTEE	5/15/2012	0.88
MANISTEE	5/15/2012	1
WELLSTON	5/27/2012	0.75
STRONACH	8/3/2017	0.75
ARCADIA	5/31/2019	0.75
COPEMISH	5/31/2019	0.88
ARCADIA	4/7/2020	1
BEAR LAKE	4/7/2020	0.75
BEAR LAKE	4/7/2020	1
PARKDALE	9/7/2021	1
HIGH BRIDGE	9/7/2021	1.5
WELLSTON	9/7/2021	1.75
MANISTEE	9/7/2021	0.88

Source: NOAA: National Centers for Environmental Information

Probability of Future Events and Vulnerability Assessment
With 32 events reported in the past 72 years, Manistee County has a 44% chance of a major hailstorm every year. All existing and future buildings, exposed infrastructure, and populations are at risk from hailstorms since hail causes damage to roofs, brick walls, glass, landscaping, crops, and cars. Manufactured homes are located throughout the county and are more susceptible to hail damage. Hail can also damage roads, sidewalks, bridges, and above ground utilities. Hail has the potential to cause injury and death, and populations are advised to take shelter when an event occurs.

Riverine and Urban Flooding

Riverine flooding occurs when rivers, streams, and lakes overflow into adjacent floodplains due to prolonged, intense rainfall, rapid snowmelt or ice jams. Flooding can damage or destroy property, disable utilities, destroy crops and agricultural lands, make roads and bridges impassable, and cause public health and safety concerns. Floods occur in the early spring, but also occur in the winter due to ice jams, and during the summer or fall from severe thunderstorms. Flooding caused by severe thunderstorms has a greater impact on watercourses with smaller drainage areas.

Urban flooding occurs when water flows into low-lying areas because it does not have a place to go. This flooding occurs from a combination of excessive rainfall, snowmelt, saturated ground, and inadequate drainage, and is becoming more common in Michigan. Since development is occurring in floodplains, the natural landscape is unable to properly disperse the water. Urban flooding also has the potential to overflow onto docks or other structures with electricity running to them, which increases the risk for an electric shock drowning. Additionally, storm and sanitary sewers are unable to handle the water flows associated with storm events, which can result in sewer overflows and affect the water quality of nearby lakes and rivers, as well as structures with basements or shallow groundwater tables.

According to the 2019 Michigan Hazard Analysis, the most damaging hazard in Michigan, based upon estimated physical damages and known response/recovery costs, appears to be floods. The MSP reports that flooding events have a statewide expected annual loss estimated at more than $100 million ($25.69 million had previously been estimated in the 2014 Michigan Hazard Mitigation Plan, but Federal Disaster 4195 confirmed a higher magnitude more in line with earlier MDEQ estimates, as that Metro Detroit flood event was quite similar to Federal Disaster 1346 during the previous decade).

The MSP's 2019 Michigan Hazard Analysis indicates that the Northern Lower Peninsula averages 0.3 annual flooding events, with average annual property and crop damages of $2,591,244 due to flooding. Manistee County experienced ten flood events since 1950, with $5,020,000 in property damages. The largest was a failure by a temporary dam structure in 2012 which impacted 53 homes.

Location
The City of Manistee is the urbanized center of the county and the most likely location to experience both riverine and urban flooding. Five of the seven separate flooding events occurred in the City of Manistee. Not only does the city have a significant amount of impervious surface coverage, but also the county's major river system, the Manistee River, travels west through the city to reach the Lake Michigan. The Manistee River starts in Antrim County to the northeast, travels through Otsego County, Crawford County, Kalkaska County, Missaukee County, Wexford County, and enters Manistee County. The Manistee River then runs through in Dickson, Norman, Stronach, and Manistee Townships and the City of Manistee. These places are likely to experience riverine flooding from the Manistee River tributaries. The Manistee River has several dams located in Manistee County. Most notably, there is the Tippy Dam and the Hodenpyl Dam located on the Wexford/Manistee County border. Each are high hazard potential dams.

Onekama, Pleasanton, and Bear Lake Townships may experience flooding from inland lakes and surrounding tributaries. Other flooding may involve low-lying areas that collect runoff waters; flaws or shortcomings in existing sewer infrastructure; undersized or poorly designed storm water control practices; collective effects of land use and development trends; illegal diversion of water, or actions that interfere with system function.

Extent
In Manistee County, flood extent can be measured by the amount of property damage and accumulation of rainfall. The most damaging event on record occurred on July 20, 2019, when a large area of regenerating thunderstorms produced excessive rainfall and some severe weather in northern lower Michigan. Thunderstorms moved repeatedly over Manistee County in the morning and afternoon of the 20th. Excessive rainfall produced substantial flooding across central and southern Manistee County. By late on the 20th, rainfall totals reached 8.90 in Parkdale (near Manistee), and 5.95 in Wellston. Water entered numerous homes and stores in the greater Manistee area, and in Dublin, resulting in property damage. The campground at Orchard Beach State Park was at one point under four feet of water. Many roads were flooded and closed to travel for several hours. 12th Street in the city of Manistee was washed out. Places near the Manistee River were most susceptible to flooding. This event is reported to have caused $3.5 million dollars in property damages.

In a separate event, on June 13, 2008, the Governor declared a state of emergency for Lake, Manistee, Osceola, Ottawa, and Wexford Counties. A large area of thunderstorms developed over Lake Michigan late in the evening on the 12th, as very moist air surged into the region. These storms were severe as they moved onshore, producing damaging winds,

large hail, and a brief tornado. However, the biggest impact was from excessive rainfall, which produced unusually severe flooding in West Central Lower Michigan. Spotters in Manistee and Wellston measured around 6 inches of rain in a few hours very late on the 12th into the pre-dawn hours of the 13th. Radar estimated up to 10 inches of rainfall along the southern border of Manistee County. Substantial flash flooding resulted, with considerable soil erosion, thanks in part to the sandy soils of the area. At one point the majority of roads in the south half of Manistee County were under water. High water entered some homes. In the city of Manistee, asphalt, stop signs, and light posts were flushed into Lake Michigan by the raging waters. The county road commission estimated $500,000 in damages to the county road system. In total, this event caused $970,000 in damages.

From 1950-2022, flash flood and flood events have caused a total of $5,020,000 in property damages (Table 17). No crop damages were reported and there have been no deaths or injuries from flooding. To date, flooding events account for 74% of all property damages recorded.

Previous Occurrences
The threat of damage to communities along the Manistee River, especially the City of Manistee is significant. With many of the flooding events the extent of the damage was multiplied by soil erosion, sewer backups, and road washouts. The event narrative for the flash flood event on July 24, 2005 further describes the damages a heavy rainfall can cause. A slow moving thunderstorm dumped over three inches of rain (and hail) on the southwest corner of Manistee County. A spotter in the City of Manistee reported 4.35 inches of rain in two and a half hours. Widespread urban flooding resulted in the city and its environs, with the worst damage along the River Street corridor. Erosion was severe in spots, due to the sandy soils prevalent in the area. Some gravel roads and driveways were washed out; city streets had one to two feet of flowing water in them. Numerous vehicles stalled out in the high water. Basement flooding was also widespread. A hotel had flood waters enter its ground floor, prompting the evacuation of twenty five guests. Sewage system backups contributed to flood damage in the city. This event caused $500,000 in damages.

Table 17: Manistee County Fluvial and Pluvial Flood Events

LOCATION	DATE	EVENT TYPE	DEATHS / INJURIES	PROERTY DAMAGE	CROP DAMAGE	FLOOD CAUSE
Manistee / Cadillac	5/12/2000	Flash Flood	0 / 0	$ -	$ -	Heavy Rain
Manistee River Communities	4/12/2001	Flash Flood	0 / 0	$ -	$ -	Snowmelt / Rain
Manistee River Communities	5/19/2001	Flash Flood	0 / 0	$ -	$ -	Heavy Rain
Manistee River Communities	7/24/2005	Flash Flood	0 / 0	$ 500,000	$ -	Heavy Rain
Manistee River Communities	6/12/2008	Flash Flood	0 / 0	$ 970,000	$ -	Excessive Rain
City of Manistee	5/11/2011	Flash Flood	0 / 0	$ 40,000	$ -	Heavy Rain
Manistee River Communities	5/11/2011	Flash Flood	0 / 0	$ 10,000	$ -	Heavy Rain
Manistee River Communities	7/20/2019	Flash Flood	0 / 0	$ 3,500,000	$ -	Excessive Rain
Manistee River Communities	6/13/2008	Flood	0 / 0	$ -	$ -	Excessive Rain
Manistee River Communities	7/20/2019	Flood	0 / 0	$ -	$ -	Excessive Rain
TOTAL				**$ 5,020,000**	**$ -**	

Source: NOAA: National Centers for Environmental Information

Probability of Future Events and Vulnerability Assessment
Floods can damage or destroy public and private property, disable utilities, make roads and bridges impassable, destroy crops and agricultural lands, cause disruption to emergency services, and result in fatalities. People may be stranded in their homes for several days without power or heat, or they may be unable to reach their homes at all. Long-term collateral dangers include the outbreak of disease, widespread animal death, broken sewer lines causing water supply pollution, downed power lines, broken gas lines, fires, and the release of hazardous materials.

The seasonal nature of flooding will continue to occur. Years with exceptional snowfall levels will likely result in flooding events from snowmelt. Lake Michigan water temperatures will create more active storm systems and heavier rainfalls. Lake Michigan water levels will also increase flooding events inland as the water table rises. Furthermore, increased development, reduction in green space, and subsequent soil erosion cause sedimentation to accumulate in river and lake beds reduce the amount of water flow. Rivers and lakes with sedimentation buildup will experience water backups and flooding events unless mitigated.

Since 1950, Manistee County has had 11 flooding events. There is a 15% chance of an annual flood. The magnitude and severity depend on the area of impact's population, seasonal activity, and the spread of development. During the warm or summer months, the population expands to include both the permanent population and visitors to the area. The seasonal population is attracted to both rural, sparsely populated rural areas and urban activity centers. In addition to the City of Manistee, the City of Muskegon, and The City of Grand Rapids, there are numerous locations ideal for visiting. These cities and several others have downtowns and Central Business Districts located along major river systems. The Cities' dense, urban development, including historical resources, impoverished and elderly independent and assisted living facilities are vulnerable to flooding from rivers that pass through. The Tribe holds festivals and events such as the ### which takes place ###.

Specific flood hazard areas were identified during public meetings and are identified on the Hazard Areas Map provided in Appendix A. Flood hazard information may be obtained from the Flood Rate Insurance Maps (FIRM) available for jurisdictions. In order to delineate potential flood plain areas (seasonal floodplains) for each jurisdiction, Networks Northwest overlaid wetland, soils, and elevation data to determine the most likely flood prone areas. Once overlaid; isolated polygons (areas) were deleted in order to show a more accurate representation of potential flood prone areas along lakes, rivers, and streams. Sources: Temporary/Seasonally Flooded Areas data are from the National Wetland Inventory of the US Fish and Wildlife Service; and Digital Elevation Model data are from Manistee County.

NFIP Participation Status
The Little River Band of Ottawa Indians is not a participating community in the National Flood Insurance Program.

The following communities in Manistee County and Wexford County are participants in the program:

Lightning

Lightning is a random and unpredictable discharge of electricity in the atmosphere between the clouds, air, or ground to equalize the charged regions in the atmosphere. It is still being debated how the electrical charges build up in the clouds. Lightning generally occurs during thunderstorms; however, it can occur without a thunderstorm, such as during intense forest fires and heavy snowstorms. Lightning that occurs without nearby rain is most likely to cause forest fires.

Location
Lightning is not confined to geographic boundaries and is a regional event. Since lightning occurs randomly, it is impossible to predict where lightning will occur and how severe it will be. All of Manistee County and the LRBOI service area is at risk to the occurrence and impacts from lightning.

Extent
Lightning can be measured by damages-caused including deaths, injuries, property damages, and/or crop damages. Since 1950, two lightning events have been reported to NOAA in Manistee County. Those events have caused $0 in property or crop damages, no injuries, and one fatality. The fatality occurred on September 6, 2016 where a Texas was was struck and killed by lightning while on the North Country Trail in Dickson Township. The lightning strike was accompanied by a line of strong to severe thunderstorms that crossed northern lower Michigan during the afternoon.

Previous Occurrences
There have been two lightning strikes reported to NOAA since 1950. There was one fatality. There have been no other reports of damages or injuries from lightning. Table 18 is a record of lightning events in Manistee County.

Table 18: Lightning Events

LOCATION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE
COUNTYWIDE	9/1/2000	0	0	$0
HIGH BRIDGE	9/6/2016	1	0	$0
TOTAL		**1**	**0**	**$0**

Source: NOAA: National Centers for Environmental Information

Probability of Future Events and Vulnerability Assessment
Since there have been two lightning events reported in the last 72 years, the data shows that there is a 3% chance a lightning strike would occur every year. However, not all lightning events may have been reported since events with injuries, deaths, and extensive damages tend to be the only ones reported. Therefore, the number of lightning events and damages may be higher.

All existing and future buildings, exposed infrastructure, and populations are at risk from lightning events since it may cause structural and wildland fires, loss of electrical and telecommunications equipment, and damage to buildings or vehicles from falling trees struck by lightning. In the case of the fatality caused by lightning in 2016, people that work outside or participate in outdoor recreation activities are at a higher risk to be struck by lightning. The Tribal government staff expressed concern for members who may be caught unaware by a severe storm system. Additionally, power outages caused by downed trees or lightning strikes have caused service issues for the utility systems. Lightning has struck the utility system's electrical components, and they have had to repair the component and put surge protectors in place. The Tribe has installed generators in order to minimize disruptions in the power to the utility system.

Tornado

A tornado is a violently rotating column of air that extends from a thunderstorm to the ground, and can occur anytime during the day and throughout the year. It can only be seen if water droplets, dust, and debris form a funnel. The funnel cloud can have winds that reach up to 300 miles per hour with an interior air pressure that is 10-20% below the surrounding atmosphere's pressure. The length of a tornado path has been reported up to 200 miles. Tornado path widths are generally less than one-quarter mile wide. These storms are the most violent of the atmospheric storms since they have the potential to destroy buildings, uproot trees, hurl objects, and cause loss of life.

According to the National Oceanic and Atmospheric Administration/National Weather Service's Storm Prediction Center, tornadoes cause approximately 60 deaths and hundreds of millions of dollars in property damage each year. According to the 2019 Michigan Hazards Plan, Michigan is located on the northern fringe of the nation's tornado belt and has a statewide expected annual loss of about $19.6 million due to tornadoes. Michigan also has an average of 18 tornadoes, approximately 4 deaths, and approximately 50 injuries per year. Between 1999 and 2019, Michigan has had 314 reported tornado events with 52.9% as EF0 (weak) or EF1 (moderate), 38.9% reported as F0 or F1 (weak), 6.7% as EF2 (significant) or EF3 (severe), and 1.6% as F2 (strong). In Northern Michigan, tornados are most likely in the summer months, although some have occurred in the spring and fall.

Location

Tornadoes are a regional event that are not confined to geographic boundaries and can affect several areas at one time. Also, the magnitude of tornadoes may range across the affected areas. All of Manistee County and the LRBOI service area is at risk to the occurrence and impacts from tornadoes. It should be noted that it is impossible to predict where and with what magnitude a tornado will touchdown.

The two tornadoes described in Table 19 impacted different townships and cities in Manistee County. The first reported tornado first touched down north of Portage Lake in Onekama Township and headed northeast through Pleasanton Township into Benzie County. The second reported tornado occurred in Stronach Township, south of M-55 at Skocelas Road. The event on June 28, 2008 was accompanied by a large area thunderstorm with damaging winds, large hail, and excessive rainfall. Each of these events are reported in their respective sections. This event is also associated with the Governor declared state of emergency for Manistee and Wexford Counties.

Table 19: Tornado Events

LOCATION	DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE
COUNTYWIDE	4/3/1956	F4	0	0	$250,000
HIGH BRIDGE	6/12/2008	EF0	0	0	$15,000
TOTAL			**0**	**0**	**$265,000**

Extent

The Fujita Scale (Table 20) categorizes tornado severity based on observed damage. The six-step scale ranges from F0 (light damage) to F5 (incredible damage). As of February 2007, the National Weather Service uses the Enhanced Fujita Scale (EF Scale). This new scale ranges from EF0 to EF5. Based on the Fujita Scale, Manistee County's most damaging tornado occurred on April 3, 1956 with winds ranging from 210-261 mph. It caused no injuries or deaths, but $ 250,000 in property damages.

Table 20: Fujita and Enhanced Fujita Scale Comparison

Fujita Scale		EF Scale	
Fujita Scale	**3-Second Gust Speed (mph)**	**EF Scale**	**3-Second Gust Speed (mph)**
F0	45-78	EF0	65-85
F1	79-117	EF1	86-109
F2	118-161	EF2	110-137
F3	162-209	EF3	138-167
F4	210-261	EF4	168-199
F5	262-317	EF5	200-234

Source: FEMA

Previous Occurrences
Between 1950 and 2021, Manistee County has had two (2) reported tornadoes touchdown, causing over $ 265,000 in property damage (Table 19). As a result of these tornadoes, there were no deaths, no injuries, and no reported crop damage. One of the tornadoes caused $ 250,000 in damage, the most destructive of the two. The second tornado caused $ 15,000 in property damages. The events in 2008 was an EF0 tornado with estimated wind speeds 75 to 85 mph. The tornado tracked through forested land near Skocelas Road, just south of M-55. Numerous trees and large limbs were downed.

Probability of Future Events and Vulnerability Assessment
Since there have been two tornadoes events reported in the last 72 years, the data shows that there is a 3% chance a tornado would occur every year. While the chance for a tornado is low, if an event occurs, there is potential for a higher magnitude tornado to touch down. All reported historic events have caused significant property damage. Due to increased residential growth in the county, the chances of a tornado touching down and causing residential damage is very high, especially in the City of Manistee and surrounding townships where population densities are highest.

Sirens and shelters…###

Extreme Temperatures

Prolonged periods of very high or very low temperatures are often accompanied by other extreme meteorological conditions, such as high humidity, drought, heavy snowfall, or high winds. Extreme heat or extreme cold primarily affect the most vulnerable segments of the population, such as the elderly, children, impoverished individuals, and people in poor health.

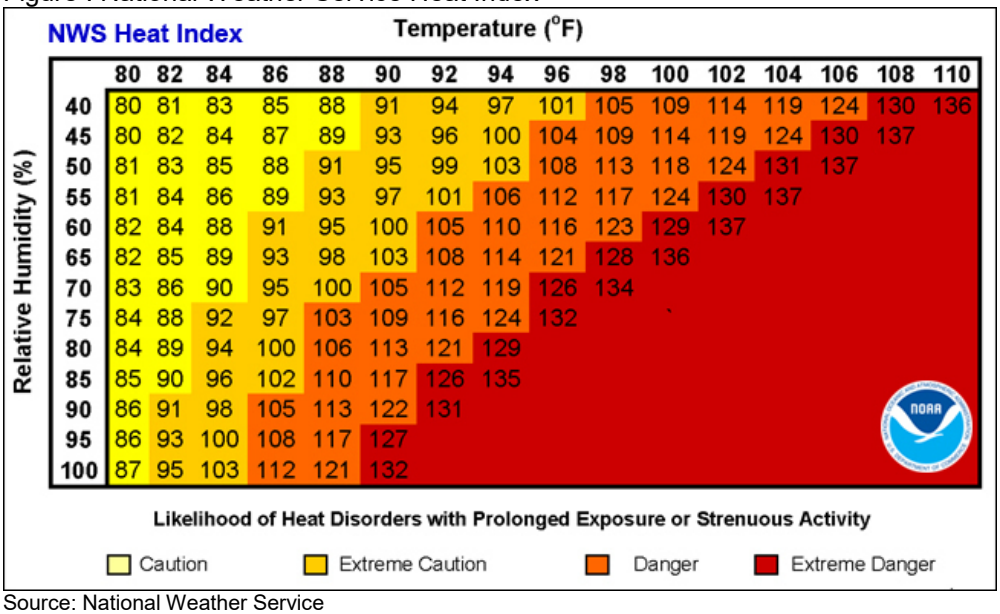
Nationwide, there have been approximately 175 deaths per year that are attributable to extreme heat according to the 2019 Michigan Hazard Analysis. The threats from extreme heat are heatstroke, sunstroke, muscle cramps, heat exhaustion, and fatigue. It is hazardous to livestock and agricultural crops, causes water shortages, exacerbates fire hazards, exacerbates respiratory problems, prompts excessive electrical energy demands, and causes infrastructure failures. Urban areas experience the most serious extreme heat with the combined high temperatures and high humidity that produce a heat-island effect.

According to the 2019 Michigan Hazard Mitigation Plan, Michigan has 11 average annual extreme heat events with 0.4 average annual deaths and 41 average annual injuries.

In the United States, approximately 700 people die each year as a result of severe cold temperature-related causes according to the 2019 Michigan Hazard Analysis, with a significant number of deaths occurring due to illnesses or disease that are negatively impacted by severe cold weather, such as stroke, heart disease, and pneumonia. Exposure to extreme cold temperatures can be life threatening and can cause hypothermia and frostbite. According to the 2019 Michigan Hazard Mitigation Plan, Michigan has 35 average annual extreme cold events with 1 death, 9.4 average annual injuries, and $6.4 million in average annual property and crop damage. Extreme cold affects transportation modes and power utilities, resulting in dead vehicle batteries and loss of power/heat.

Measuring Extreme Temperatures (Extreme Heat and Extreme Cold)
Extreme heat is measured with the National Weather Service's Heat Index Chart (Figure). The chart uses relative humidity and air temperature to determine the likelihood of heat disorders with prolonged exposure or strenuous activity. Individuals are unable to shed excess heat from their bodies when they experience prolonged exposure to hot temperatures, which results in heat disorders.

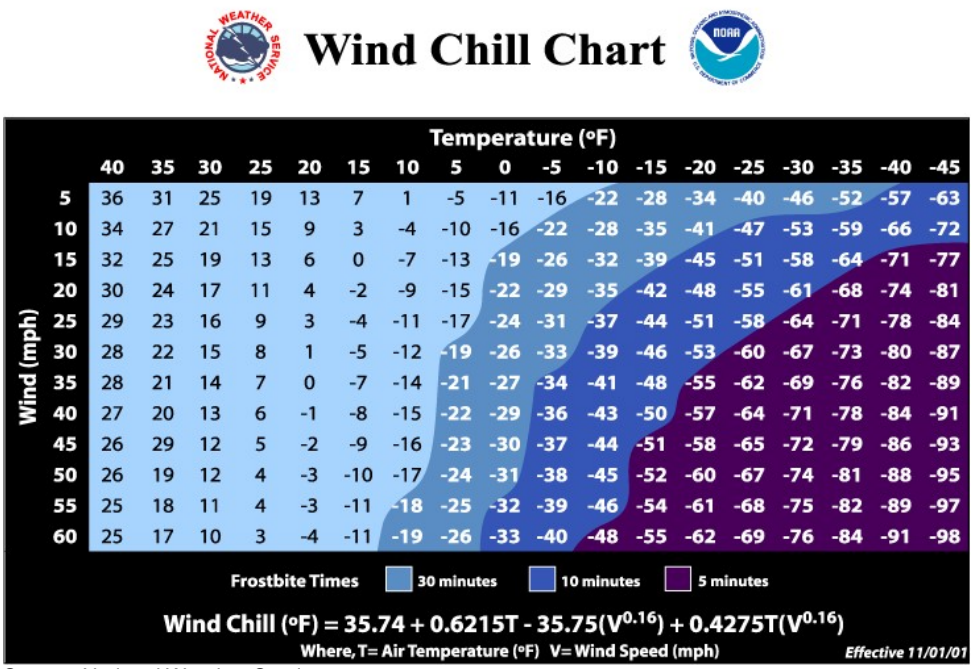
Figure : National Weather Service Heat Index



Source: National Weather Service

Extreme cold is measured with the wind chill index, which is a measure of the rate of heat loss from exposed skin caused by the combined effects of wind and cold. As the wind increases, heat is carried away from the body and reduces the external and internal body temperatures. Figure shows the NOAA Wind Chill Chart as it corresponds to various temperatures and wind speeds.

Figure : National Weather Service Wind Chill Chart

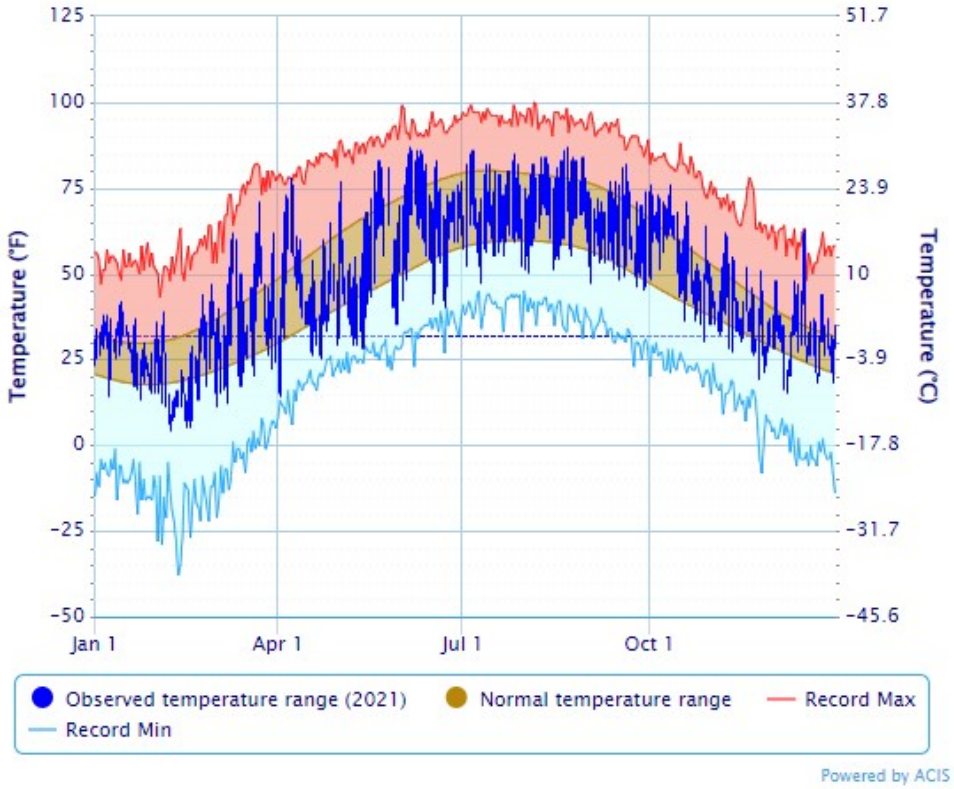


Wind (mph)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	29	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Source: National Weather Service

Figure are the observed temperatures at Manistee 3SE for 2021. The dark blue line shows temperatures recorded between January 1 2021 and December 21, 2021. The red line above shows record high temperatures for that day, and the light blue line below indicates record low temperatures for that day.

Figure : Daily Temperature Data:



Source: NOAA Climate Data Online

Location and Extent
Extreme temperatures are a regional event that are not confined to geographic boundaries and range in severity across the affected areas. All of Manistee County and the LRBOI service area is at risk to the occurrence and impacts from extreme temperatures.

The first instance of reported excessive heat occurred on August 1, 2001. Excessive Heat was also a problem the first two weeks in August across all of northern Michigan. Temperatures reach the mid to upper 90s, on average, a few days each year; however, for a 5 day (8/5 - 8/9) stretch overnight low temperatures failed to fall below the lower 70s in most areas. This very humid air mass was unusual for northern Michigan, an area which typically sees cool nighttime temperatures and for this reason has very few homes with air conditioners. No heat related deaths or injuries were reported; however, most outdoor events were modified due to the forecasts of hot and humid conditions. County fairs sent animals home, yet still there were livestock losses at fairs in Otsego and Alcona counties. Attendance at county fairs was well below normal and this was attributed to the heat. This period of excessive heat also brought on a drought event at the same time.

The second instance of reported excessive heat occurred on June 30, 2018. The month of June closed with one of the hottest days in recent memory. Highs were well into the 90s, including 99 at Alpena, and 98 at Traverse City and Gaylord. The National Weather Service office near Gaylord also hit 98; that was (by several degrees) the warmest reading recorded at that location since observations began there in the late 1990s. Heat indices exceeded 105 degrees across most of northern lower Michigan, and some locations exceed 110. The warmest reported heat index on the day was 114 near Indian River. There were estimated to be between 25 and 30 individuals who visited local hospitals due to heat-related illnesses.

Since 1950, there have been three extreme cold events reported in Manistee County. The first occurred on February 4, 2007. Exceptionally cold air surged into Northern Michigan. High temperatures on the 4th (Super Bowl Sunday) were around zero, with low temperatures that night from five to ten below zero. Gusty northwest winds produced hazardous wind chills of 20 to 30 below zero, along with blowing and drifting snow. Many area schools closed on the 5th, due to the extreme cold and poor road conditions.

The second instance of extreme cold occurred on January 6, 2014. This event was one of the most brutal cold air outbreaks in recent memory - the coldest since at least January 1994 - plunged into the Great Lakes region. Near- to below-zero temperatures were accompanied by blustery northwest winds. Away from the warming influence of Lake Michigan, wind chills sunk to 30 below zero or colder. The coldest wind chills observed were -44 near Cedarville, -39 near Engadine, -36 at Sault Ste Marie, and -33 at West Branch and Houghton Lake. All of these were reached in the morning hours of the 7th. As a result, school closings were widespread across northern Michigan on the 7th.

The third and last instance of extreme cold is the Governor Declared Emergency that occurred on January 29, 2019. Wind chills of 15 to 30 below zero were common in northern lower Michigan. Wind chills were much colder in eastern upper Michigan, including -51 at Kinross, and -42 at Sault Ste Marie and Mackinac Island.

Previous Occurrences
Manistee County has had two extreme heat events in 2001 and 2018 (Table 21). The events did not have any deaths, injuries, or property/crop damages. The events consisted of hot and humid conditions that caused outdoor events to be modified and attendance at outdoor events to be lower than normal.

Table 21: Heat Related Events

	DATE	EVENT TYPE	INJURIES, DEATHS, DAMAGES	EVENT DESCRIPTION
MANISTEE (ZONE)	8/1/2001	Heat	0	Excessive Heat was also a problem the first two weeks in August across all of northern Michigan. Temperatures reach the mid to upper 90s, on average, a few days each year; however, for a 5 day (8/5 - 8/9) stretch overnight low temperatures failed to fall below the lower 70s in most areas.
MANISTEE (ZONE)	6/30/2018	Excessive Heat	0	Highs were well into the 90s, including 98 at Traverse City and Gaylord. The National Weather Service office near Gaylord also hit 98; that was (by several degrees) the warmest reading recorded at that location since observations began there in the late 1990s.

Source: NOAA: National Centers for Environmental Information

Since 1950, there have been three extreme cold events reported in Manistee County (Table 22). The events did not have any deaths, injuries, or property/crop damages. The low temperatures caused schools to close. However, since cold temperatures typically occur during winter months, many events may have gone unrecorded.

Governor Declared Emergency for extreme cold in the State was enacted in 2019 and included all 83 counties in the state.

Table 22: Cold Related Events

	DATE	EVENT TYPE	INJURIES, DEATHS, DAMAGES	EVENT DESCRIPTION
MANISTEE (ZONE)	2/4/2007	Extreme Cold/wind chill	0	High temperatures on the 4th (Super Bowl Sunday) were around zero, with low temperatures that night from five to ten below zero. Gusty northwest winds produced hazardous wind chills of 20 to 30 below zero, along with blowing and drifting snow. Many area schools closed on the 5th, due to the extreme cold and poor road conditions.
MANISTEE (ZONE)	1/6/2014	Extreme Cold/wind chill	0	One of the most brutal cold air outbreaks in recent memory - the coldest since at least January 1994 - plunged into the Great Lakes region. Near- to below-zero temperatures were accompanied by blustery northwest winds. Away from the warming influence of Lake Michigan, wind chills sunk to 30 below zero or colder. The coldest wind chills observed were -44 near Cedarville, -39 near Engadine, -36 at Sault Ste Marie, and -33 at West Branch and Houghton Lake. All of these were reached in the morning hours of the 7th. As a result, school closings were widespread across northern Michigan on the 7th.
STATEWIDE	1/29/2019	Extreme Cold/wind chill		Governor Declared Emergency – Wind chills of 15 to 30 below zero were common in northern lower Michigan. Wind chills were much colder in eastern upper Michigan, including -51 at Kinross, and -42 at Sault Ste Marie and Mackinac Island.

Source: NOAA: National Centers for Environmental Information

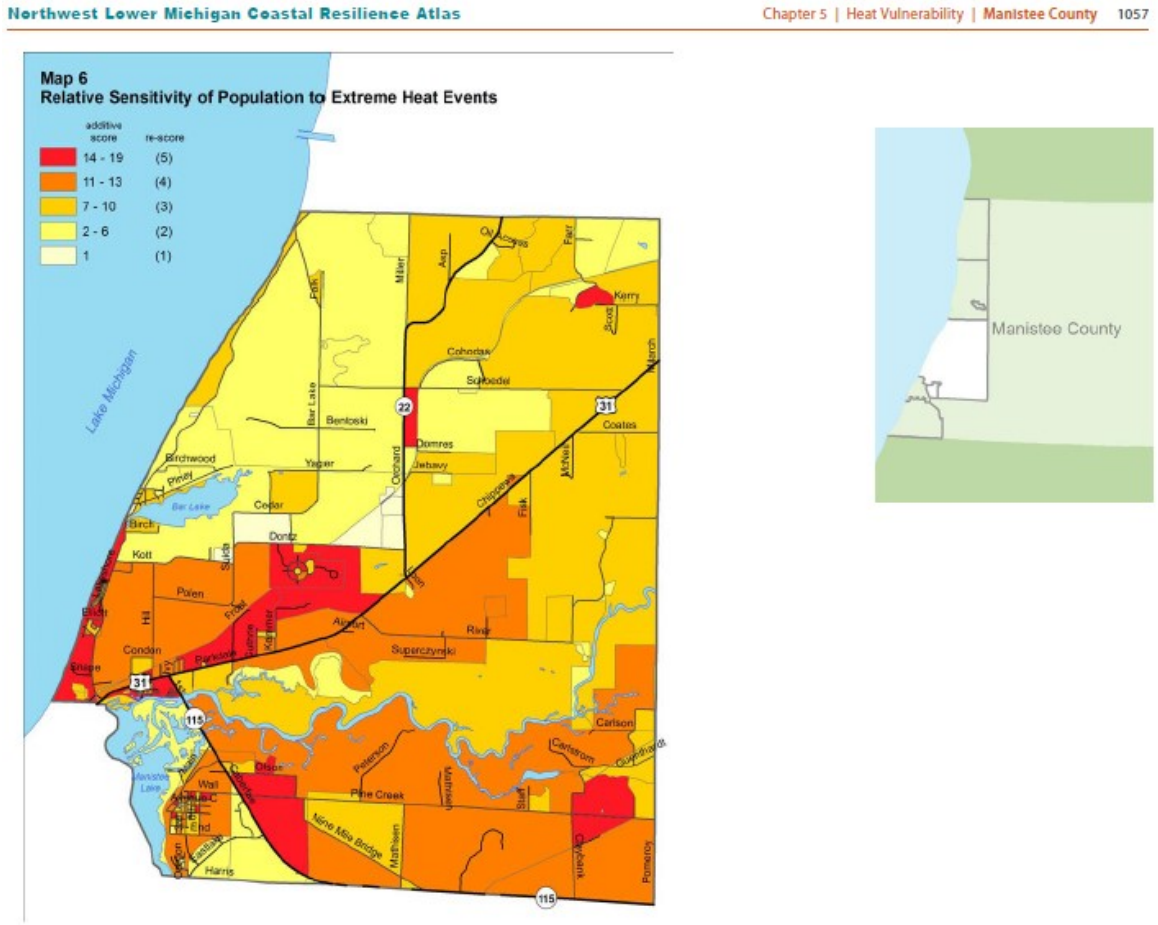
Probability of Future Events and Vulnerability Assessment
Since 1950, there have been two extreme heat events in Manistee County. This data shows approximately one extreme heat event would occur every 36 years. Since 1950, there have been three extreme cold events in Manistee County. This data shows approximately one event would occur every 24 years. Since extreme cold events tend to occur during the winter months and are coupled with blustery winds and snowstorms, these events may have been reported as other hazards or not at all, which means there may have been more extreme cold events in the county.

Extreme heat and cold events are more likely to impact unsheltered populations. The urban homeless population is especially vulnerable. The *Northwest Lower Michigan Coastal Resilience Atlas* written by the Land Information Access Association completed a Heat Vulnerability Assessment[1] of coastal communities. A community's vulnerability is their exposure to the hazard (determined by tree canopy and impervious surface coverage) + their sensitivity. Sensitivity is determined by the folowing factors:

- Persons > 65 years
- Persons living alone
- Minority (non-white) persons
- Persons living below the poverty threshold
- People > age 25 with less than a high school education
- Disability status (i.e., ambulatory difficulty, mental disability)

The LRBOI Elder population ranges anywhere from 28% to as high as 67% in county membership counts. Newaygo County has the highest percentage of Elder members and Muskegon County has the highest number of Elders. Manistee County has the second highest number of Elder members. Census data also indicates high levels of poverty for many Tribal members. These factors should be considered for the vulnerability of the LRBOI members. Figure , indicates the Relative Sensitivity of Population to Extreme Heat Events in Manistee Township.

Figure 10: LRBOI Lands/Manistee Township Relative Sensitivity of Population to Extreme Heat Events



Source: LIAA *Northwest Lower Michigan Coastal Resilience Atlas*

[1] Land Information Access Association. (2019). *Northwest Lower Michigan Coastal Resilience Atlas.* http://www.resilientmichigan.org/nw_atlas.asp

Drought

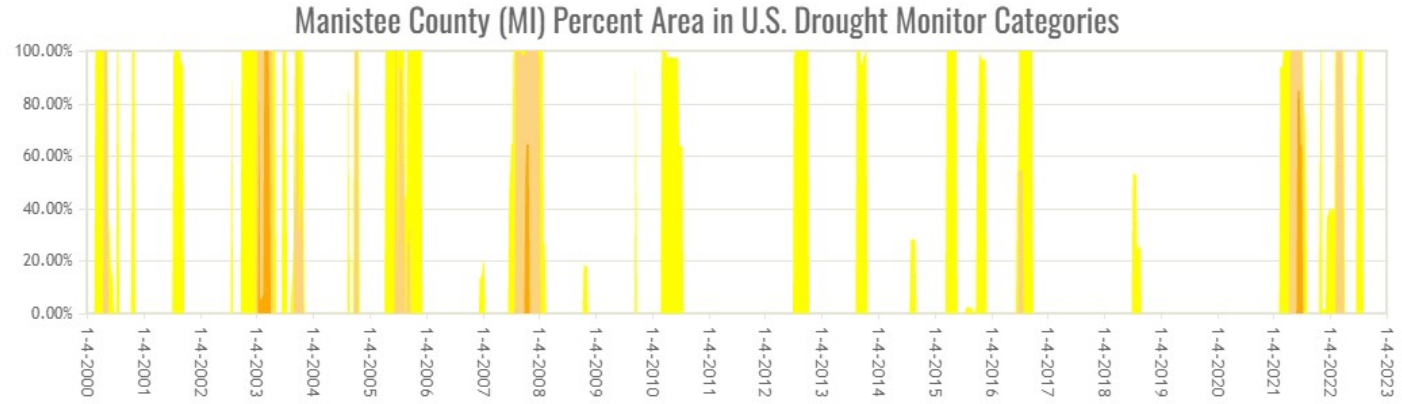
Drought is a normal part of the climate cycle. It is a slow-moving hazard, which causes people to underestimate the damage it can do, but losses from drought are as substantial as those from hurricanes, tornadoes and other faster-moving disasters. Drought causes losses to agriculture; affects domestic water supply, energy production, public health, and wildlife; and contributes to wildfire, to name a few of its effects.

Location
Drought is a regional event that is not confined to geographic boundaries and range in severity across the affected areas. All of Manistee County and the LRBOI lands are at risk to the occurrence and impacts from drought.

Extent
The Palmer Drought Severity Index (PDSI) uses readily available temperature and precipitation data to estimate relative dryness. It is a standardized index that generally spans -10 (dry) to +10 (wet). Maps of operational agencies like NOAA typically show a range of -4 to +4, but more extreme values are possible. The PDSI has been reasonably successful at quantifying long-term drought.

The U.S. Drought Monitor (Figure 11) combines several input sources including the PDSI and the Standardized Precipitation Index to prepare a weekly map showing parts of the U.S. that are in drought. The map uses five classifications: abnormally dry (D0), showing areas that may be going into or are coming out of drought, and four levels of drought: moderate (D1), severe (D2), extreme (D3) and exceptional (D4) (Figure 12).

Figure 11: Manistee County Historical Drought Levels



Source: US Drought Monitor

Figure 12: U.S. Drought Categories and Historically Observed Impacts

Michigan

Category	Historically observed impacts
D0	Grass fires increase
	Lawns are brown; landscape and gardens are watered more frequently
D1	Most crops and vegetation are stressed; farmed Christmas trees are stressed
	Well levels decline
D2	Corn and soybean yields are low
	Mature trees are stressed
	Streamflow is extremely low, potentially too low to irrigate

Source: US Drought Monitor

Previous Occurrences
Since 1950, there has been one instance of drought in Manistee County. The event was a Presidential Declared Emergency for drought problems in the State was enacted in 1977 and included Manistee, Lake, Mason, Oceana, and Wexford Counties.

Probability of Future Events and Vulnerability Assessment
There is a 1.4% annual chance for a drought event in Manistee County. In Northern Michigan's forested regions, drought can adversely impact timber production and some tourism and recreational enterprises. This can also cause a drop in income, which impacts other economic sectors. The biggest problem drought presents, however, is the increased threat of wildfire. Southern portions of Manistee County are heavily forested and are therefore highly vulnerable to drought-related wildfire threats. Additionally, the threat to water sources should also be considered. Many county residents rely on ground water wells for drinking water. Even drought events in category D1 experience water well level decline. Drought events combined with excessive heat can have severe impacts on elderly and low income people.

Dense Fog

Fog forms near the ground when water vapor condenses into tiny liquid water droplets that remain suspended in the air. Many different processes can lead to the formation of fog, but the main factor is water-saturated air. Two ways that air can become saturated are by cooling it to its dew point temperature or by evaporating moisture into it to increase its water vapor content. Although most fog, by itself, is not generally a hazard because it does not actually apply damaging forces, the interaction between humans and fog can be a dangerous situation, sometimes resulting in disastrous consequences. It must be noted, however, that freezing fog (a hazard for which the National Weather Service issues special statements) can cause direct harm by causing slickness on roadways, walkways, bridges, and highway ramps, and therefore leading to serious transportation accidents (examples are provided later in this chapter). One of the main risks involves morning school buses and the safety of students and their parents while waiting near roadways under conditions of very low visibility.

Most attention rightfully gets focused upon severe and high-impact meteorological events, such as thunderstorms and tornadoes. Fog is not so easy to classify as a severe and high-impact hazard, although it has caused costs and casualties in the transportation sector, especially—sometimes with deadly consequences. Fog has played a contributing role in several multi-vehicle interstate highway pileups during recent years. While statistics suggest that highway accidents and fatalities, in general, have fallen, that trend is not evident with respect to accidents and fatalities caused by fog. The vast majority of automotive accidents are caused by unsafe driving habits and risk-taking behaviors, such as following too closely behind another vehicle, driving too fast for weather and visibility conditions, and being unduly distracted by the use of phones and other electronic luxuries while on the road. Airplanes have their own inherent vulnerabilities when foggy conditions develop and make a safe landing more difficult.

Fog can be very dangerous when it reduces visibility. Although some forms of transport can penetrate fog using radar, road vehicles have to travel slowly and use their lights to become visible to each other. Localized fog is dangerous if drivers are surprised by it. At airports, some efforts have been made to develop methods (such as using heating or spraying salt particles) to aid fog dispersal, especially at temperatures near or below freezing.

One severe fog event is estimated to occur in Michigan approximately every two years. Property damage can be significant for vehicles, although real property and structures are usually unaffected. Fog has not yet been identified as one of the most significant hazards in any of Michigan's local hazard mitigation plans.

Location
Dense fog is a regional event that is not confined to geographic boundaries and range in severity across the affected areas. All of Manistee County and the LRBOI lands are at risk to the occurrence and impacts from dense fog.

Extent
Dense fog can be measured by damages-caused including deaths, injuries, property damages, and/or crop damages. There has been one significant fog event in Manistee County, but no direct damages, injuries, or deaths were reported.

Previous Occurrences
On May 22, 2010, a dense fog event was recorded in Manistee County. A charter fishing boat struck a pier at the entrance to Manistee Harbor, took on water, and sank. The seven people on board were pulled from the water by the Coast Guard and a local good Samaritan. The first mate of the boat, a 55 year old male, was given CPR and later pronounced dead (an indirect fatality). Two others were treated at a Manistee hospital, while the other four were treated at the scene. Visibility at the accident site was described as being very poor by local media.

Probability of Future Events and Vulnerability Assessment
One dense fog event has occurred in the past 72 years. There is a 1.4% of a dense fog event happening every year. Fog events are likely to occur more frequently, but go unreported as injuries, deaths and damages do not occur.

Wildfire

A wildfire is an unplanned, uncontrolled fire in grassland, brushland, or forested areas. Wildfires can occur in any forest or grassland type under dry conditions; however, some forest types are more susceptible to wildland fires. For example, jack and red pine forest stands have a high risk for wildfires, as they dependent on fire to provide all the right conditions for regeneration, while aspen and white pine forest stands have a moderate risk. The primary cause of wildfires is from human activities, specifically burning outdoor debris. Wildfires cause destruction to property and timber resources, and injuries or loss of life to wildlife and persons living or recreating in wildfire prone areas. Long-term effects include scorched and barren land, soil erosion, landslides/mudflows, water sedimentation, and loss of recreational opportunities.

Approximately 55% (20.4 million acres) of Michigan's total land area is forest cover. The vast forests provide Michigan with the largest state-owned forest system in the United States. In addition, Michigan has the fifth largest quantity of timberland acreage, with 19.3 million acres (including hardwoods and softwoods). That vast forest cover is a boon for both industry and recreation, and these areas have been gradually increasing in recent years. However, it also means that many areas of Michigan are vulnerable to wildfires.

Michigan's fire season starts in early spring, when leaves and grasses remain dry from fall and winter and trees are not yet green. Wildfires are often accompanied by drought where dry conditions increase the potential to burn. Often a thunderstorm will roll through and lightning will strike causing sparking of dry leaves and dead wood. High winds can then spread wildfire. Wildfires can become unpredictable in windy conditions or when the wind changes direction suddenly. Cooler nighttime temperatures often help suppress wildfires and the potential for wildfire; however Michigan has had several major fire events.

According to MDNR and U.S. Forest Service records, between 1910 and 1949, over 5.8 million acres of forest were burned, an average of 145,000 acres per year. By comparison, it was reported that between 1950 and 1996, the MDNR and U.S. Forest Service were involved in suppressing over 46,100 wildfires that burned 390,000 acres of forest, which averages only 8,300 acres burned per year. This drastic reduction in the acres of timber burned was largely the result of (1) increased use of specialized equipment to suppress the fires, and (2) intensified efforts toward fire prevention.

However, lightning strikes are not the primary cause of wildfires in Michigan. Recently, only about 4% of all wildfire in Michigan were caused by lightning strikes, and most other causes have been attributed to human activity. Outdoor debris burning is the leading cause of wildfires in Michigan. Most Michigan wildfires occur close to where people live and recreate, which puts both people and property at risk. The immediate danger from wildfires is the destruction of property, timber, wildlife, and injury or loss of life of persons who live in the affected area or who are using recreational facilities in the area.

Location
All LRBOI communities and developed areas are vulnerable to wildfires since the community centers and rural residential developments interface with the high risk forest types (e.g. Red Pine, Eastern White Pine, and Jack Pine).

Extent and Previous Occurrences
Extent can be measured by the number of acres burned and the cost of property damage. Between 1996 and 2017 there were no wildfires reported outside of MDNR lands in Manistee County. Between 1981 and 2018 there were 54 reported fires on lands under MDNR jurisdiction. This resulted in 1,070.7 acres burned and 28.2 acres burned per year. No property damages were recorded.

Probability of Future Events and Vulnerability Assessment
There is a 100% chance there will be a wildfire on MDRN lands, and a small chance there will be a wildfire on lands outside of MDNR jurisdiction. Forest types (Red Pine, Eastern White Pine, and Jack Pine) within Manistee County are susceptible to wildfires. Additional factors that increase fire risk include dead or dying Ash trees as a result of disease/invasive species, lightning strikes, and human factors such as the number of persons residing, camping, or traveling through the County. Historically, Michigan's landscape has been shaped by wildfire; however, over the last several decades, the current landscape has transformed from wildland to residential development. With the increase in residential development in and around rural areas prone to wildfires, there is an increase in the potential for loss of life and property damage. Unfortunately, rural areas do not have enough fire suppression forces available to protect every structure from wildfires. Residential development in rural Manistee County is often isolated from town centers and emergency services. Those subdivisions that are located in rural areas near Jack Pine forests are identified on the Vulnerable Populations and Hazard Areas Map in Appendix A.

Rip Current

Rip currents are powerful, channeled currents of water flowing away from shore. They typically extend from the shoreline through the surf zone, and past the line of breaking waves. Typically, they form at breaks in sandbars, and also near structures, such as jetties and piers, as well as cliffs that jut into the water. Rip currents are common and can be found on most surf beaches, including the Great Lakes and Gulf of Mexico.

Location
Rip currents are a coastal event that is not confined to geographic boundaries and may occur anywhere in Lake Michigan waters. All coastal areas are at risk to the occurrence and impacts from rip currents.

Extent
The National Weather Service provides a Surf Zone Forecast to measure the risk level associated with rip current hazards. Surf Zone Forecasts contain three levels of Rip Current Outlooks:

- Low Risk: The risk for rip currents is low, however, life threatening rip currents often occur in the vicinity of groins, jetties, reefs, and piers.
- Moderate Risk: Life threatening rip currents are possible in the surf zone.
- High Risk: Life threatening rip currents are likely in the surf zone.

Rip currents can be measured by damages-caused including deaths and injuries. There has been one significant rip current event in Manistee County, and one death was reported.

Previous Occurrences
On July 11, 2007, Gusty onshore winds contributed to rip current development on Lake Michigan beaches of Northwest Lower Michigan. A 15 year old boy from a downstate Michigan community, drowned as a result of rip currents at 5th Avenue Beach in the city of Manistee.

Probability of Future Events and Vulnerability Assessment
One rip current event has occurred in the past 72 years. There is a 1.4% of a rip current event happening every year. Rip current events are likely to occur more frequently, but go unreported as injuries and deaths do not occur. Rip currents are dangerous to all swimmers, especially those who are unprepared to be swept up in the current. Many Lake Michigan beaches do not have a lifeguard on duty who may identify potential hazardous swimming conditions. Swimmers who are caught unaware may panic when caught up in the fast-moving water, tire as they try to swim against the current, and drown.

Shoreline Hazards (Coastal Flooding and Coastal Recession)

Shoreline hazards include coastal flooding and coastal recession. Coastal recession (subsidence) is the wearing away of land, such as loss of riverbank, beach, shoreline, or dune material. It is measured as the rate of change in the position or displacement of a riverbank or shoreline over a period of time. Short-term erosion typically results from periodic natural events, such as flooding, hurricanes, storm surge, and windstorms, but may be intensified by human activities. Long-term erosion is a result of multi-year impacts such as repetitive flooding, wave action, sea level rise, sediment loss, subsidence, and climate change. Death and injury are not typically associated with erosion; however, it can destroy buildings and infrastructure. Waters of the Great Lakes may cause shoreline hazards to occur making the entire northwest Michigan coastline is susceptible to shoreline hazards. As indicated in Figure , large portions of the Lake Michigan shoreline throughout west Michigan are identified as “High Risk Erosion Areas in 2019.”

Figure : Great Lakes Shorelines with High Risk Erosion Areas, 2019

Shoreline flooding results when water levels rise and push inland or during rainfall or snowmelt accumulates and is not able to drain properly. Shoreline flooding may also be caused during storms and wind events with high-energy waves. In developing the *Northwest Lower Michigan Coastal Resilience Atlas,* scenario planning was used to determine the potential impact of three differing levels of storms combined with high waters. The three scenarios are described as follows:

The first scenario, **"Lucky" Future:** Under the Lucky Climate Future, Great Lakes water levels will continue to stay relatively low. Although there will be wave and wind action, major storm events and wave impacts will not encroach on properties landward of current beaches. A Lucky Future projection, indicating the land areas that would be affected by high-energy waves along the shorefront and/or adjacent riverine flooding under these conditions, is shown in green on the maps.

"Expected" Future: Under the Expected Climate Future, Great Lakes water levels will continue to fluctuate according to long-term decadal patterns, including recent extreme storm events incorporated into the ongoing Great Lakes Coast Flood Study being conducted by the Federal Emergency Management Agency (FEMA). Given those ongoing fluctuations, this Climate Future accounts for periods when Great Lakes still-water elevations are closer to the long-term average. In addition, this Climate Future anticipates the so-called "100-year storm event" (or 1% storm) becoming more like a 20- or 50-year storm event (i.e., an expected storm within the normal community planning time horizon) because of increased storminess. The Expected Future projection is shown in yellow on the maps.

"Perfect Storm" Future: Under the Perfect Storm Climate Future, Great Lakes water levels will continue to fluctuate according to decadal patterns, consistent with assumptions made for the Expected Future. However, for this Perfect Storm Climate Future, the estimated still-water elevation is set higher than the long-term average and closer to the long-term high (583 feet). In addition, this Climate Future anticipates the occurrence of a so-called "500-year storm event" (or 0.2% storm) occurring within the planning time horizon while lake levels are high. The Perfect Storm Future projection is shown in red on the maps.

Location

To reference the *Northwest Lower Michigan Coastal Resilience Atlas*, "Climate scientists predict that northwest Lower Michigan can expect more frequent storms of increasing severity in the decades ahead. The total amount of rainfall per year in also likely to increase. The potential for substantially larger rain events and severe storms raises concerns of harm to human health and damage to buildings and infrastructure, especially for areas along the Lake Michigan coastline." Jurisdictions located on the Lake Michigan coast are impacted by shoreline hazards: Manistee, Mason, Oceana, Muskegon, and Ottawa. The Land Information Access Association documented potential shoreline hazards for Manistee County communities in the *Northwest Lower Michigan Coastal Resilience Atlas*. Specific areas of shoreline hazards were identified during public input sessions. These are marked as a hazard area on the Hazard Area Map in Appendix A.

Manistee County

Source: LIAA, Northwest Lower Michigan Coastal Resilience Atlas

More specifically, four events have been reported. The first (Although nor recorded in the Storm Events Database) occurred on February 21, 1986 during the last major high water event prior to 2019. A Governors Disaster Declaration for shoreline problems in the State was enacted in 1985-1986 and included Manistee County.

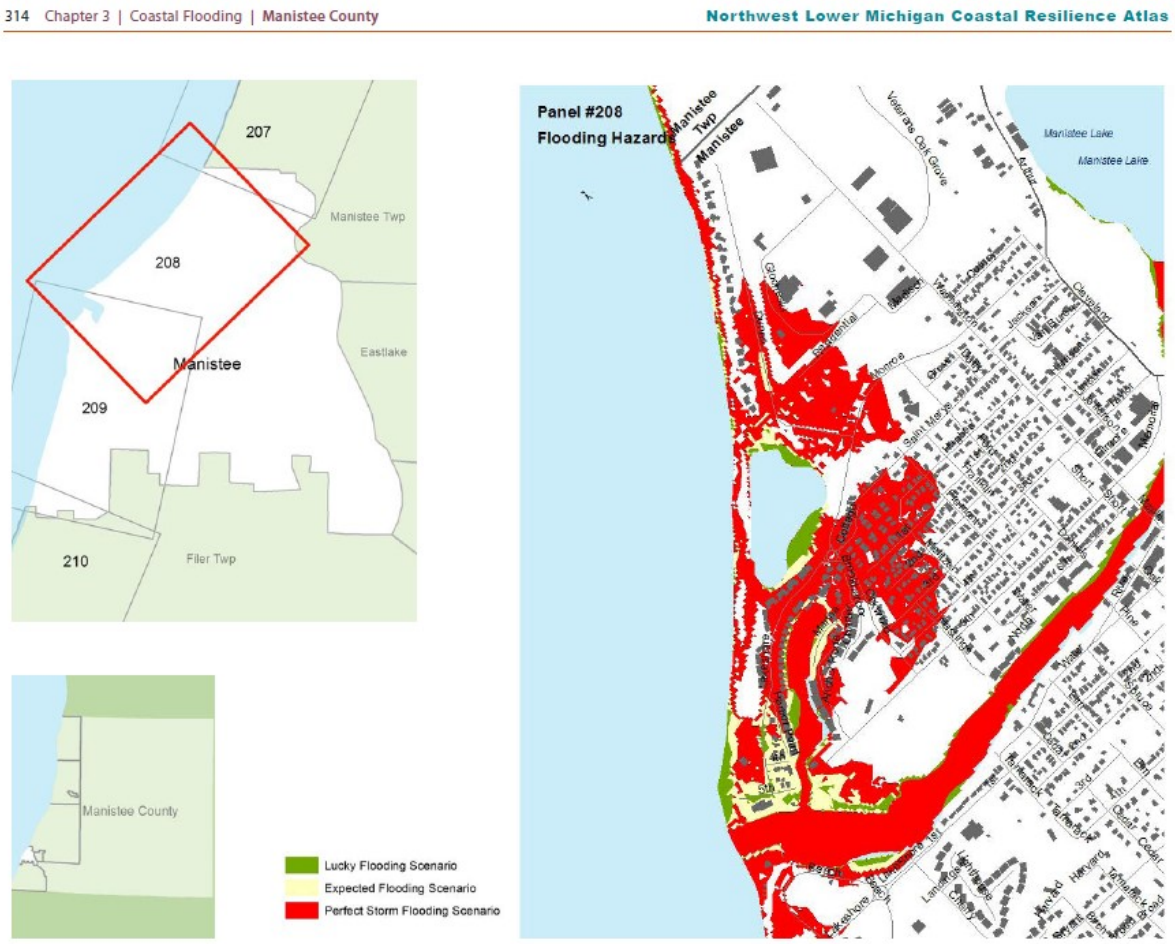
The second event occurred on October 16, 2019. Northwest to north winds produced high waves and elevated water levels along the northwest lower Michigan coastline. With Great Lakes water levels at near-record levels, significant coastal flooding and beach erosion resulted. Flooding covered a portion of Lakeshore Drive at 5th Avenue Beach in Manistee. In Parkdale, the beach eroded up to the foundation of several homes, and a number of trees were washed into the lake.

The third event occurred on October 22, 2019. Strong northerly to easterly winds resulted in another round of substantial coastal flooding and beach erosion, this time on both Lake Michigan and Lake Huron, for the 21st into the 22nd. A dock, boardwalk, and beach signage were destroyed in Parkdale.

The fourth and fifth events took place in 2020. On April 13, 2020, a strong low pressure passed just north of eastern upper Michigan on the morning of the 13th. Gusty west to northwest winds developed during the day, in the wake of the low. Gusts of 40 to 50 mph were common across northern Michigan, especially during the afternoon. The highest measured wind gust was 58 mph at the airport in Gaylord. Some localized power outages resulted. Lakeshore flooding also occurred along portions of the Lake Michigan coastline of northwest lower Michigan. The city boat launch in Frankfort experienced flooding of docks and the parking lot. And severe coastal erosion destroyed a portion of the Little Traverse Wheelway between Petoskey and Charlevoix. On November 1, 2020, a strong low pressure crossing northern Ontario would drag a cold front across northern Michigan early on the 1st. Gusty southwest winds ahead of the front became even gustier out of the northwest behind the front. Peak measured wind gusts included 58 mph at Leland and Traverse City, 57 mph at Bay Mills, and 54 mph at Pellston. North Lakeshore Drive was flooded near the US Coast Guard Station in Manistee. Streets were covered in water, and the water extended to near the base of some homes.

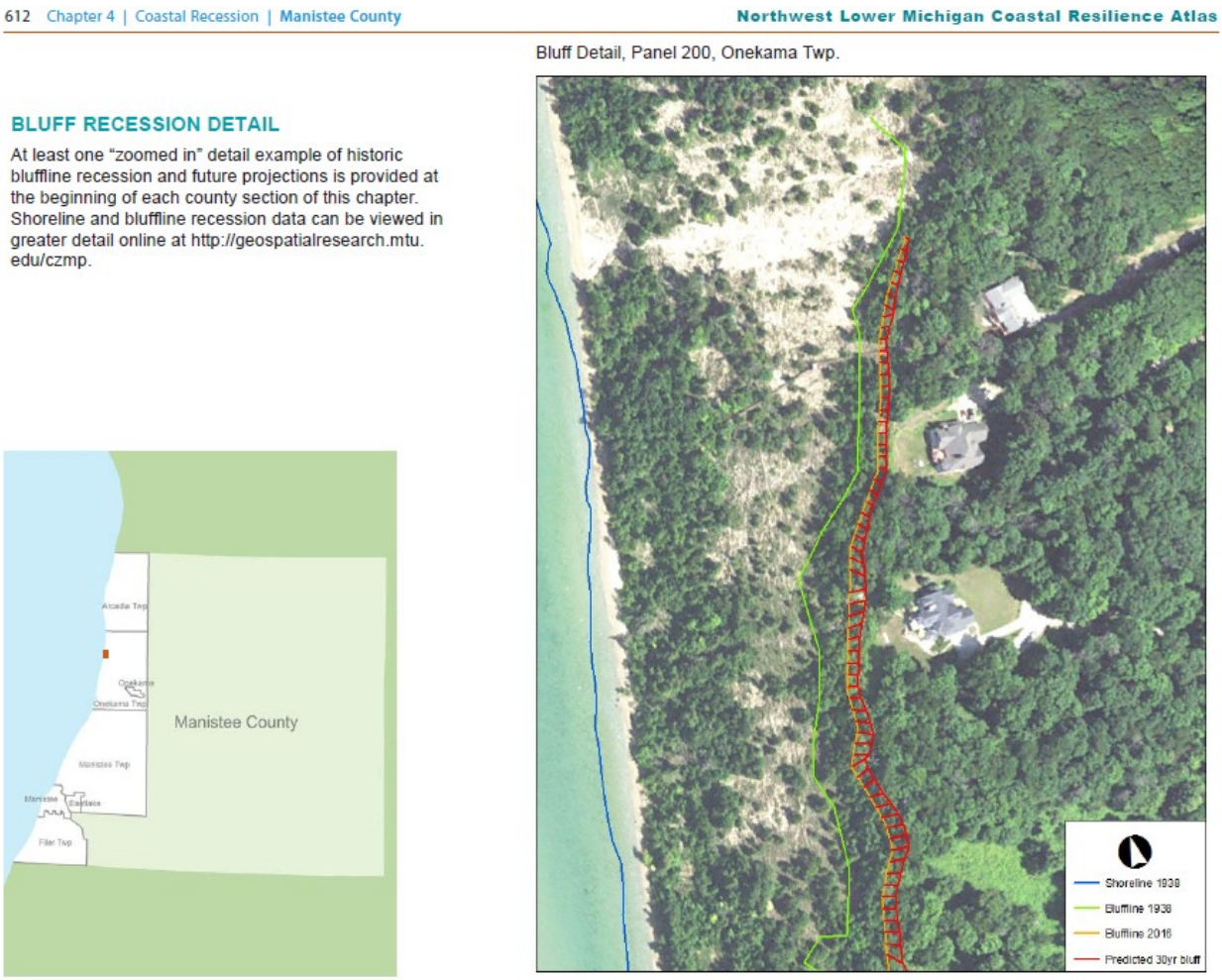
Figure 13 describes the three potential flooding scenarios in the City of Manistee. “Lucky” scenario flooding is shown in green, “Expected” flooding scenario is shown in yellow, and “Perfect Storm” future scenario is shown in red.

Figure 13: Panel #208 Flooding Hazard, City of Manistee



Coastal recession or erosion to Lake Michigan communities is a constant, but very small wearing away of the shoreline. The Great Lakes are estimated to lose one foot of shoreline per year to normal wave and wind activity. However, storms and increased wave activity have caused increased coastal recession to varying degrees in Lake Michigan coastal communities. Chapter 4 of the *Northwest Lower Michigan Coastal Resilience Atlas* describes bluffline recession since its recorded shoreline in 1938. The blue line indicates the shoreline in 1938, the green line indicates the bluffline in 1938, the yellow line is the bluffline in 2016, and the red line is the predicted 30 year bluffline. The varying lines are shown in Figure 14 depicting the recession of the bluffline in Onekama Township.

Figure 14: Panel #200 Shoreline Recession, Onekama Township



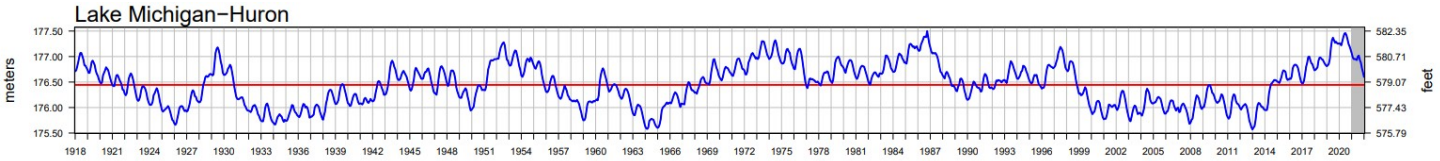
Source: LIAA, Northwest Lower Michigan Coastal Resilience Atlas

Extent

Shoreline recession can be measured by feet of bluffline retreat and property damages. Bluffline retreat distances vary across the county, and there are no reported damages from bluffline recession. Shoreline flooding can be measured by flood water levels, inches of rainfall, lake water levels (shown in Figure 15), and damages. The four Lakeshore Flooding events in 2019 and 2020 caused $499,000 in property damages in Manistee County (Table).

In recent years, the swings in water levels have been unprecedented. In January 2013, Lake Michigan-Huron set an all-time record low of 576.02 feet, and seven years later in July of 2020 Lake Michigan-Huron reached a monthly record high of 582.22, only second to the October 1986 monthly record high of 582.35.

Figure 15: Lake Michigan-Huron Historic Water Levels, 1918-2021



LAKES MICHIGAN-HURON

2021	*580.94*	*580.68*	*580.54*	*580.54*	*580.54*	*580.48*	*580.71*	*580.77*	*580.48*	*580.41*	*579.95*	*579.69*	*580.48*
Mean	**578.48**	**578.44**	**578.48**	**578.77**	**579.07**	**579.30**	**579.40**	**579.33**	**579.17**	**578.94**	**578.77**	**578.61**	**578.90**
Max	581.56	581.53	581.43	581.69	581.96	582.19	582.22	582.09	581.96	582.35	581.96	581.56	
	2020	2020	2020	2020	2020	2020	2020	2020	1986	1986	1986	1986	
Min	576.02	576.08	576.05	576.15	576.57	576.64	576.71	576.67	576.64	576.44	576.28	576.15	
	2013	1964	1964	1964	1964	1964	1964	1964	1964	1964	1964	2012	

Source: US Army Corps of Engineers

Previous Occurrences

The Great Lakes experienced record high lake levels in 1985-86, and again in 1997-98. The Great Lakes experienced record high lake levels again in 2019. Many cases of erosion are present and high lake levels causing rivers and tributaries to back up have caused infrastructure damage and failures throughout Manistee County and many other areas in Michigan. There are no recorded events related to shoreline erosion.

Table : Shoreline Flooding Events

LOCATION	DATE	EVENT TYPE	DEATHS / INJURIES	PROERTY DAMAGE	CROP DAMAGE
Manistee County	2/21/1986	Lakeshore Flood	0 / 0	Unknown	Unknown
Manistee County	10/16/2019	Lakeshore Flood	0 / 0	$ 350,000	$ -
Manistee County	10/22/2019	Lakeshore Flood	0 / 0	$ 142,000	$ -
Manistee County	4/13/2020	Lakeshore Flood	0 / 0	$ -	$ -
Manistee County	11/1/2020	Lakeshore Flood	0 / 0	$ 7,000	$ -
TOTAL				$ 499,000	$ -

Probability of Future Events and Vulnerability Assessment

There is a 5.6% chance of shoreline flooding and an equally small chance erosion will cause shoreline damages. Shoreline or soil erosion hazards involve the loss of property or necessitate the relocation of homes as sand or soil is removed by flowing water (lake, river, etc.) and carried away over time. The foundation of a structure, or underground utility pipes in the area, may become fully exposed and vulnerable to weather, extreme temperatures, water damage, or other sources of risk. Shoreline banks that support roadways may erode and cause the road surface to crack, become unstable, or more prone to deposits of sand, snow, water, and ice. This hazard is especially relevant to those municipalities that contain residential and commercial development along Lake Michigan that experience seasonal shifts in water levels and possible ice erosion hazards.

As lake water levels fluctuate and increased storminess occurs, shoreline recession and flooding will continue. In 2021 the levels of Lake Michigan-Huron began to decline, however, as historic data shows us, the water will begin to rise again. Those communities that have already faced shoreline hazards are likely to experience issues in the future. Changes in land use practices and improvements to the shoreline such as natural vegetation plantings or shoreline armoring may reinforce the shoreline for a period of time, but is likely not a permanent solution.

Public Health Emergency (Infectious Disease)

Public health emergencies occur when there is a widespread and/or severe epidemic, contamination incident, bioterrorist attacks, or other situation that negatively impacts the health and welfare of the public. These emergencies include disease epidemics, large-scale food or water contamination incidents, extended periods without adequate water and sewer services, harmful exposure to chemical, radiological or biological agents, and large-scale infestations of disease-carrying insects or rodents. A common characteristic of public health emergencies is that they impact or have the potential to impact a large number of people either statewide, regionally, or locally in scope and magnitude. These health emergencies can occur as primary events or as secondary events from another hazard or emergency (e.g. flood, tornado, or hazardous material incident).

Location
Public Health Emergency can be a worldwide, national, state or regional event that is not confined to geographic boundaries and range in severity across the affected areas. All of Manistee County is at risk to the occurrence and impacts from an infectious disease. Depending on the type of disease, different populations are more susceptible.

Extent
The extent of a public health emergency can be determined by the number of cases and deaths, and the amount of money spent to prepare for and respond to public health threats. In Manistee County, the District Health Department #10, works with local, state, and federal agencies to prepare for and respond to public health threats. State of Michigan (https://www.michigan.gov/coronavirus/stats) reports, as of August 09, 2022, there are 3,174 cumulative cases of COVID-19 and 79 deaths. Of the 73 deaths with details provided, those 80 years and older have the most deaths of any age range at 24 deaths. All of the deaths reported were persons 50 years and above. COVID-19 originally appeared in January 2020

Previous Occurrences
Throughout the years, there have been many pandemics. For example, there was an outbreak of severe acute respiratory syndrome (SARS) in 2003. This virus was a new coronavirus that resulted in over 8,000 illnesses worldwide. Of these, 774 died. Since 2012, Middle East respiratory syndrome (MERS), a coronavirus, has been reported in 27 countries where there have been approximately 2,494 people infected and 858 deaths. In 2017, the World Health Organization (WHO) put SARS and MERS on its priority pathogen list to spur further research into coronaviruses. More recently in 2020, a Presidential and Governor Emergency was declared for COVID-19 Pandemic in Michigan. Variants of the corona virus are still being found two years after the initial spread; vaccinations are available to limit the reaction from exposure and limit the spread of the disease.

Probability of Future Events and Vulnerability Assessment
Naturally occurring pandemics may result in widespread precautions around the world. The District Health Department #10 created a pandemic plan that serves as a template for responding to a large-scale outbreak of influenza and other highly infectious respiratory diseases. That plan is currently being tested, and the response is ongoing to this pandemic. The elderly, immune-compromised, and low income populations are most vulnerable to public health emergencies.

Invasive Species

The National Invasive Species Council defines an invasive species as, “A species that is not native and whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health.” The Council was formed under Presidential Executive Orders 13112 and 13751 to prevent the introduction and spread of invasive species, and to support efforts to eradicate and control invasive species that are established throughout the United States. NOAA’s National Ocean Service identifies invasive species as “capable of causing extinctions of native plants and animals, reducing biodiversity, competing with native organisms for limited resources, and altering habitats.” Invasive species harmful to Michigan and LRBOI Tribal lands may be either terrestrial invasive species (TIS) or aquatic invasive species (AIS).

Terrestrial invasive include non-native, land-based plants, insects, animals and diseases that harm Michigan’s environment, economy, and human health. Aquatic invasive (water-dwelling) species include non-native plants, animals, and other organisms that have evolved to live primarily in water (aquatic habitats) rather than on land. Aquatic habitats are habitats that are covered with water all or part of every year.

The LRBOI Wildlife Division strives to preserve, protect, and enhance native plant communities and wildlife populations important to the Tribe and its membership. To promote native plant species and protect the ecosystems they rely on, Wildlife Division staff manage Tribal properties by removing invasive plant species, such as autumn olive, Russian olive, spotted knapweed, and honeysuckle, among others. Invasive plants may outcompete native vegetation for space and nutrients so removing them reduces their risk of establishing monocultures and frees up resources for native species. Invasive plants are very persistent and often require multiple treatments to eradicate them. Therefore, this has been an ongoing multi-year project for the Wildlife Division, but the table below highlights work done over the past year. Wildlife Division staff also plant native species to help restore natural ecosystems and promote biodiversity.

Location
Combined, terrestrial and aquatic invasive species may be present in the entire nine county service area including forest, wetland, farmland, grassland, aquatic, shoreline, and urban environments. “A Field Guide to Invasive Plants of Aquatic and Wetland Habitats for Michigan” (Campbell, Higman, Slaughter, Schools) identifies the Lake Michigan coastline as particularly vulnerable. “Lake-moderated climates along the Lake Michigan shoreline, Saginaw Bay, the Thumb, Lake St. Clair, and western Lake Erie are much milder than those in the state’s interior… These areas have the potential to harbor species typically found far south of Michigan.”

Extent
According to the State of Michigan 2013 Aquatic Invasive Species State Management Plan, “Since the 1800s, at least 182 nonindigenous aquatic organisms have colonized habitats of the Great Lakes ecosystem. These species include: algae (27), vascular plants (55), invertebrates (66), fish (28), and bacteria and viruses (6) (National Oceanic and Atmospheric Administration 2011). Roughly 55% of these species are native to Eurasia; 13% are native to the Atlantic Coast.” The Great Lakes Regional Collaboration estimates that a new aquatic invasive species arrives in the Great Lakes at a rate of one every eight months. LRBOI has allocated $$$ of the 2021 budget to treating affected areas. 88.41 acres were treated from 2020-2021.

Previous Occurrences
Non-native terrestrial and aquatic species are introduced to Michigan and the Great Lakes both intentionally and unintentionally. Aquatic invasive species are the result of unwanted fish and aquatic plants released from home aquariums, travelled across the ocean in ballast water carried by freighters, or entered from the ocean through human-built channels such as the Welland Canal. There are 32 AIS specifically listed in the State Management Plan. The State TIS Management Plan lists fourteen species including insects, mollusks, plants, mammals, a shrub, and a bird. Top priority plants in the region include garlic mustard, Japanese knotweed, invasive phragmites, and Oriental bittersweet.

Property	Treatment	Species	Year	Acres
Aki Maadiziwn	Mechanical removal	Scotch pine	2020	1.01
		Autumn olive		3.04
Bull Homestead	Mechanical removal	Autumn olive	2020	5.82
			2021	5.33
Custer	Mowed		2020	9.61
				8.21
Dontz	Chemical	Autumn olive	2020	2.64
	Mechanical removal			37.26
Griffith	Mowed		2020	12.94
Justice Center	Chemical	Autumn olive	2020	1.67
Orchard warehouse	Chemical and mechanical removal	Autumn olive	2020	.34
	Mechanical removal			.54
TOTAL			2020-2021	88.41

Probability of Future Events and Vulnerability Assessment
The Great Lakes and connecting channels and rivers form the largest surface freshwater system in the world. This freshwater system, along with Michigan’s inland lakes, streams, rivers, and wetlands represent an invaluable resource and are therefore justifiably a top natural resource management priority. The State of Michigan estimates 42% of threatened or endangered species are considered at risk due to non-native species. The Michigan Department of Environment, Great Lakes, and Energy produced the “Michigan Watch List Aquatic Invasive Plants: A Guide for Identification” for those species that have been identified as posing an immediate or potential threat to Michigan’s economy, environment, or human health. Included in the watch list are ten species that have been found in limited parts of Michigan and surrounding states. The State TIS Management Plan provides a list of eleven terrestrial species on the watch list. The Wildlife Division may coordinate with the Northwest Michigan Invasive Species Network and Manistee

Conservation District and other partners “protect, enhance, and promote Northwest Michigan’s natural communities through terrestrial invasive plant management and outreach.”

IV. Goals and Objectives

V. Mitigation Strategies and Priorities

Priority and Action Strategies	Responsible Parties	Timeframe	Priority

VI. Implementation

APPENDIX A: LRBOI INFRASTRUCTURE, VULNERABILITY, AND HAZARD MAPS

APPENDIX B: COMMUNITY SURVEY RESULTS

APPENDIX C: LOCAL PLANNING TEAM MEETING DOCUMENTATION