# An Exploration of Impacts and Stakeholder Interests: Tower and Kleber Dams on the Upper Black River, Northeastern Michigan

**Prepared for:**

Michigan Department of Natural Resources

Grand Traverse Band of Ottawa and Chippewa Indians


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# Abstract

**Background:** Tower and Kleber dams operate on the Upper Black River in Northeastern Michigan and their license is set to expire on April 30, 2024. A decision to relicense or remove the dams will need to be made by the Federal Energy Regulatory Commission and the dam owner, Nelson Turcotte of Tower Kleber Limited Partnership, within the next several years. Our clients, the Michigan Department of Natural Resources and the Grand Traverse Band of Ottawa and Chippewa Indians, asked us to conduct an analysis of the impacts of the dams and explore the range of issues that need to be considered in decision-making.

**Project Purpose and Methods:** For this analysis, we sought to understand: (1) the current ecological, economic, and social impacts of Tower and Kleber dams; (2) potential impacts of dam removal; (3) key stakeholders, concerns, and considerations to be included in the decision-making process; and (4) information and processes that should be incorporated moving forward. We reviewed published literature and interviewed members of identified stakeholder groups. We also held a large public meeting where we presented our preliminary findings and gathered input from attendees. Our meeting and this final report aim to provide our clients and other stakeholders with a baseline understanding of issues surrounding the dams as they begin the decision-making process regarding the dams' future.

**Findings:** We determined that the dams are in satisfactory condition and produce expected amounts of electricity. They affect water conditions and habitat for many aquatic species, including lake sturgeon whose current spawning and nursery habitats limit natural reproduction. However, the dams do not have a significant impact on Black Lake water levels. We identified many public concerns that should be addressed moving forward, including pond-front property, fishing opportunities, recreation, and tribal rights. To address misconceptions and confusion about dam impacts, we recommend gathering additional site-specific data and ensuring all information is made publicly available. To help alleviate conflict surrounding the issue, we recommend that our clients and the dam owner clarify the decision-making process, acknowledge concerns and emotions, work directly with landowners, directly involve tribal nations, and develop stakeholder visions for future dam scenarios.

# Acknowledgements

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The Black Lake Association and residents of Black Lake

The Black Lake Preservation Society

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Hometown Inn of Indian River, Michigan

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# Acronyms and Abbreviations

**ACOE:** US Army Corps of Engineers

**ASDSO:** Association of State Dam Safety Officials

**BLA:** Black Lake Association

**BLPS:** Black Lake Preservation Society

**BRLP:** Black River Limited Partnership

**cfs:** cubic feet per second

**DSSMR:** Dam Safety Surveillance and Monitoring Report

**EIA:** United States Energy Information Administration

**FEMA:** Federal Emergency Management Agency

**FERC:** Federal Energy Regulatory Commission

**FWS:** US Fish and Wildlife Service

**GFLT:** Great Lakes Fishery Trust

**GTB:** The Grand Traverse Band of Ottawa and Chippewa Indians

**HEC:** Hydrologic Engineering Center

**HEC-EFM:** Hydrologic Engineering Center Ecosystems Functions Model

**kW:** kilowatt

**kWh:** kilowatt-hour

**LTBB:** The Little Traverse Bay Band of Odawa Indians

**MDNR:** Michigan Department of Natural Resources

**MSU:** Michigan State University

**MW:** megawatt

**MWh:** megawatt-hour

**NILCFAC:** Northern Inland Lakes Citizen Fishery Advisory Committee

**NMMA:** National Marine Manufacturers Association

**NOAA:** National Oceanic and Atmospheric Administration

**SFT:** Sturgeon for Tomorrow

**SNRE:** University of Michigan School of Natural Resources and Environment

**TKHLP:** Tower-Kleber Hydro Limited Partnership

**TKLP:** Tower-Kleber Limited Partnership

**USGS:** US Geological Survey

**WPSC:** Wolverine Power Supply Company

# Introduction

Tower and Kleber dams operate on the Upper Black River in Northeastern Michigan. Their license is set to expire on April 30, 2024. A decision to relicense or remove the dams will need to be made by the Federal Energy Regulatory Commission and the dam owner within the next several years. We were asked to conduct a preliminary analysis of Tower and Kleber dams in order to scope the range of issues that need to be considered in future decision-making.

# PROJECT CONTEXT

The primary driver for this project and the broader discussion about Tower and Kleber dams is the upcoming formal relicensing process for the dams through the United States (US) Federal Energy Regulatory Commission (FERC) (see Figure 1). These licenses can be between 30 and 50 years in duration and define the operating terms for the licensee. Tower and Kleber dams are on a joint license that was last renewed for 30 years in 1994, meaning that the license is set to expire on April 30, 2024 (FERC, 1994). During the relicensing process, FERC seeks input from the public, non-governmental organizations, Native American tribes, and local, state, and federal agencies to identify environmental impacts and determine what additional studies may be needed to better understand identified issues (FERC, 2016d). In instances of relicensing, which is the case with Tower and Kleber dams, the current licensee must file a notice of intent with FERC at least five years before the existing license expires. This informs stakeholder groups that the more formal process is beginning, and gives those groups an opportunity to get involved in the process. For Tower and Kleber dams, this filing would occur in 2019.

**Who is FERC?**

The Federal Energy Regulatory Commission (FERC) is an independent federal agency that regulates and oversees the energy industry on behalf of the American people. In this role, FERC promotes development of new energy infrastructure and regulates the operation of existing projects. For hydroelectric dams, FERC issues permits and licenses to allow operation, enforces the conditions of those licenses, and conducts safety and environmental inspections. Source: FERC, 2016d

Negotiations between FERC and the dam owner are standard practice, but other parties can choose to intervene in that process in order to ensure their interests are taken into account. For the 1994 license, in addition to the Michigan Department of Natural Resources (MDNR), other interveners included the Michigan Water Resource Commission, the Anglers of the AuSable, the Great Lakes Council, the Federation of Fly Fishers, the Michigan United Conservation Clubs, and the Michigan Council of Trout Unlimited. One outcome of their involvement was a more explicit consideration of sturgeon management in the operation of the dams, including the creation of the sturgeon hatchery that is now situated next to Kleber dam.

While 2017 may seem early in the process, these discussions are happening now in order to initiate a similar conversation among an even wider and more diverse set of stakeholders. It is important to begin these conversations early to ensure that all stakeholders are involved in the process and their concerns can be addressed in an effective manner.

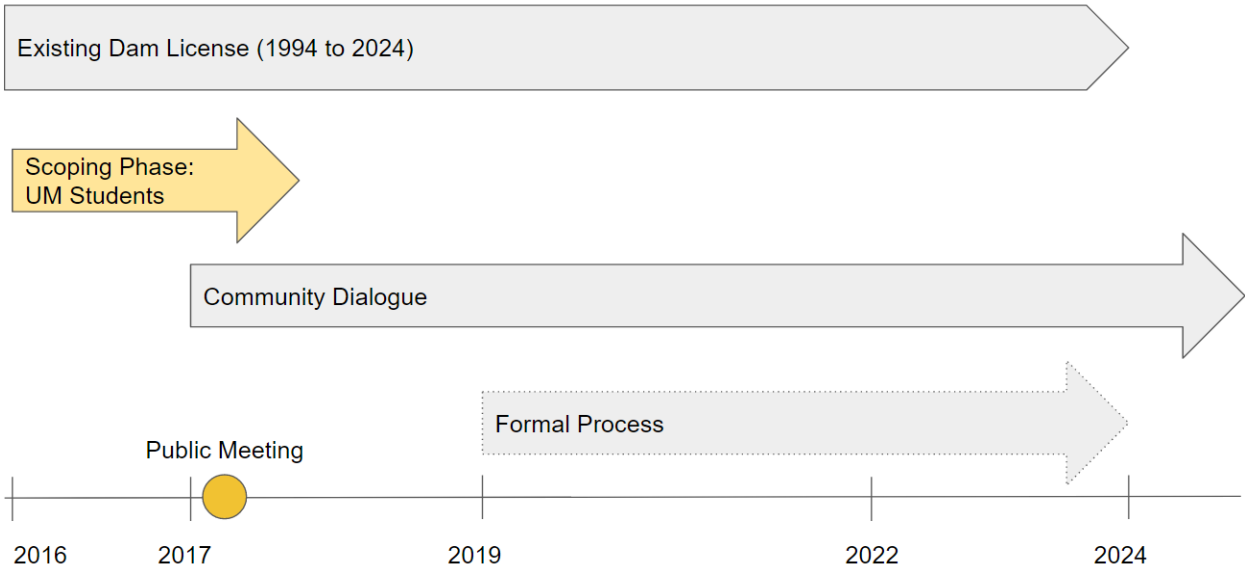


**Figure 1. Timeline of the Tower and Kleber Decision-Making Process**

## Important Considerations and Drivers

As called for in the MDNR Sturgeon Rehabilitation Plan and related efforts to restore Michigan lake sturgeon populations, there has been a push to examine the impacts of existing dams on sturgeon population viability (MDNR, 2012). In addition, in 2015 the Grand Traverse Band of Ottawa and Chippewa Indians (GTB) and the Little Traverse Bay Bands of Odawa Indians (LTBB) issued separate formal motions advocating the removal of the Tower and Kleber dams to restore sturgeon habitat, and by extension, sturgeon populations (see Appendix V). MDNR also has a policy that advocates for removal of dams that are in disrepair, high risk, or no longer serve a purpose for safety, economic, and environmental reasons (MDNR, 2016b). Finally, the dam owner has recently indicated an interest in transferring ownership of the dams, so now is an opportune time to begin the process of reexamining the dams and ensuring that their future is carefully considered.

# INTRODUCTION TO THE PLACE

Tower and Kleber dams are located upstream and south of Black Lake along the Upper Black River in Cheboygan County, Michigan. They are part of a three-dam system that includes Alverno Dam; however, Alverno is on a separate license and its impacts are therefore not considered in this project (Figure 3). Tower and Kleber dams have resulted in the formation of Tower Pond and Kleber Pond (Figure 3). The Black River eventually drains into the Cheboygan River before flowing into Lake Huron (Figure 2).

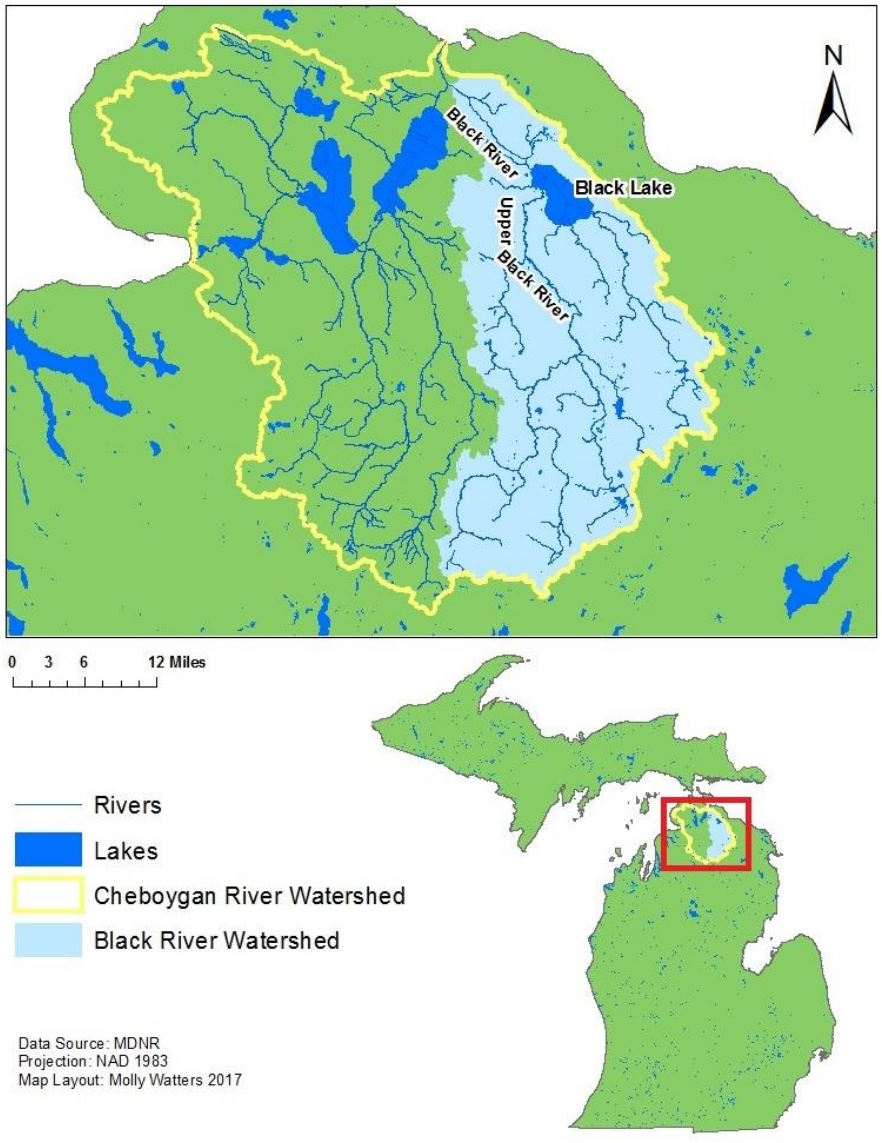


**Figure 2. Cheboygan River Watershed**

The Cheboygan River watershed covers 900,000 acres over Cheboygan, Presque Isle, Emmet, Charlevoix, Otsego, and Montmorency Counties. Lakes and rivers in the Cheboygan River watershed form the Inland Waterway, including Burt, Mullet, Douglas, Pickerel, Crooked, and Black Lakes. The Black Lake subwatershed drains more than 350,000 acres representing 38% of the entire Cheboygan River watershed (Cwalinski and Hanchin, 2011). Black Lake itself has a surface area of 10,113 acres (Breck, 2004) and is among the ten largest inland lakes in Michigan by surface area. For more information about the Cheboygan River watershed, see Appendix II.

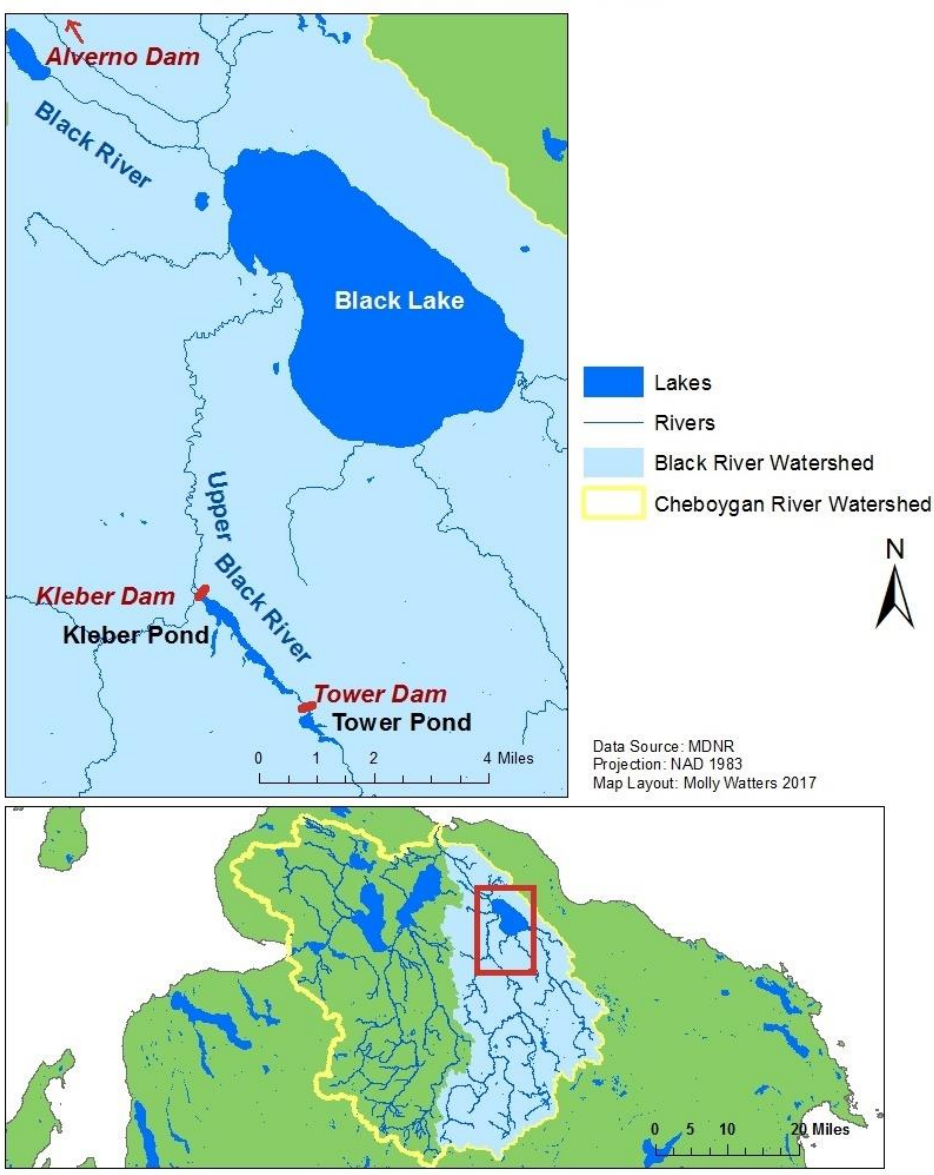


**Figure 3. Black River Watershed and Tower, Kleber, and Alverno Dams**

Black Lake is fed by the Upper Black River and Rainy River, as well as indirectly by Canada Creek and the East Branch of the Black River.[1] Black Lake watershed is mostly forested and open lands, with a small percentage of agricultural uses (Tip of the Mitt, 2016). The shoreline of Black Lake is mostly private residential land with some public riparian access located in a state park near the Upper Black River and state forest campground on the northeast shore. The water of Black Lake is tannin-stained dark, attributed this to historic logging industry and giving it its name. For more information about the Black Lake watershed, see Appendix II.

[1] Other tributary creeks include Tomahawk Creek, Milligan Creek, Stony Creek, Mud Creek, Hardwood Creek, Van Hellens Creek, Rattlesnake Creek, Packer Creek, and Fast Creek.

# PROJECT PURPOSE

The purpose of this project was to answer the following questions to best inform future stakeholder dialogue and the decision-making process:

- What are the current ecological, economic, and social impacts of Tower and Kleber dams?
- What are the potential impacts of dam removal?
- What are the key stakeholders, concerns, and considerations?
- What information and decision-making processes should be incorporated moving forward?

## Methods

We used public engagement and literature review to answer the four questions listed above. These methods built on each other iteratively to inform our public meeting and final report. We underwent three phases of public engagement in order to explore the range of interests and issues related to the dams. We explored available data and information specific to the Black Lake watershed as well as external scientific literature related to dam impacts and relevant topics.

### Public Engagement

Public engagement allowed us to build a broad and rich understanding of the issues and concerns related to Tower and Kleber dams. First, we identified key stakeholder groups based on conversations with our clients, MDNR and GTB, and our preliminary research into the communities near Tower and Kleber dams. We then conducted scoping interviews with selected contacts through semi-structured phone conversations. In general, this consisted of conversations with biologists, fishermen, sturgeon advocates, local business owners, pond landowners, Black Lake land owners, and individuals with experience in other dam relicensing or removal processes.

Second, we conducted formal interviews by phone and in-person between February 2016 and August 2016.[2] We also conducted phone interviews with additional individuals throughout the duration of the project. Our template interview questionnaire is provided in the Appendix VIII. All interviews were recorded and transcribed. For these formal interviews, we built upon the pool of

[2] We will be referring to these interviews throughout the report, but as these were done confidentially, the identities of interviewees are not included in this report. The authors retain a version of this report that contains the specific attributions of certain facts, quotes, or other statements.

stakeholders we spoke with in our scoping interviews to include additional contacts that emerged through those conversations, literature, and additional research on local communities. In total, we conducted 20 formal interviews.

Finally, we held a public meeting on Saturday, February 11, 2017 from 2 to 5pm in the Forest Township Hall in Tower, Michigan. For this meeting, we developed and circulated a flyer with general information about the meeting location and time, as well as a brief discussion of the project and the meeting purpose (see Appendix IX). Meeting notices were distributed through MDNR to organized stakeholder groups, and we also reached out to previous interviewees and others to help increase awareness of the event. Approximately 120 people attended the meeting. During the meeting, we presented our preliminary findings and then broke into smaller discussion groups, each facilitated by a member of the project team, as well as Patrick Hanchin of MDNR. During these smaller group discussions, we used flipcharts to record key concerns and questions raised by attendees. Building upon our interviews, these comments also allowed us to identify uncertainties and questions that must be answered over the course of the future decision-making process. Discussions were audio-recorded to allow for later review of key statements or important quotes. A list of public input and questions gathered at the public meeting are provided in Appendix X. A recording of the meeting, courtesy of Sunrise Cable Network's David LaClair, is available online here: https://vimeo.com/203940534.

**Literature Reviews**

Literature review and background research built a baseline understanding of the impacts of dams and dam removal processes, with specific focuses on their potential ecological, economic, social, and cultural impacts. This allowed us to synthesize existing research of relevant topics and compile current conditions of the specific Black River area. We explored two types of literature for this project: site-specific information about the dams and general scientific literature on the impacts of dams and dam removals.

The first was site-specific information about the Black Lake watershed and Tower and Kleber dams. Information was available through FERC, provided to us directly by our clients, or shared through stakeholder groups and interviewees. Site-specific information was mainly targeted to give us an understanding of the conditions of the dams and specific impacts that may have already been studied. Much of this consisted of formal documentation required by FERC, but other data came from surveys conducted by MDNR.

Our broader literature review was focused primarily on scientific studies on the ecological and economic impacts of dams and dam removal processes. We especially focused on research assessing how dams and dam removals affect fish and vegetation communities, lake sturgeon, water quality, sedimentation, invasive species, water levels, and property values.

Finally, we also explored available primary literature, news articles, and websites relating to select dam removal processes that would serve as case studies and provide lessons for Tower and Kleber dams. We primarily identified well-documented and comparable dam removals from the State of Michigan and a prominent out-of-state dam removal. Each of these case studies are intended to inform best practices (see Appendix VII).

# Findings

**Questions Addressed Below:**

- What are the key stakeholders, concerns, and considerations?
- What are the current ecological, economic, and social impacts of Tower and Kleber dams?
- What are the potential impacts of dam removal?

*"I believe in free-flowing rivers. I like to see dams eliminated for the most part. But there are lots of factors here. These dams have been here a long time. What about hydropower? Or riparian owners? There's a lot to consider."*

*– local resident*

# WHO ARE THE KEY STAKEHOLDERS?

We identified a diverse set of stakeholders likely to be affected by the dam decision. Many of these groups have already expressed interest in becoming directly involved with the decision-making process. Each stakeholder group is described below with a brief explanation of their interests in the dams and/or watershed.

## Tower-Kleber Limited Partnership

The Tower-Kleber Limited Partnership (TKLP) is the current owner and operator of Tower and Kleber dams. TKLP is managed by Mr. Nelson Turcotte, the President of Northwoods Hydropower (LinkedIn, 2017).

## Wolverine Power Supply Cooperative

Wolverine Power Supply Cooperative (WPSC) is the current licensee with FERC for Tower and Kleber dams. WPSC is a member-owned generation and transmission electricity cooperative based in Cadillac, Michigan and has a contract with TKLP that allows TKLP to distribute and transmit electricity generated at Tower and Kleber dams (Wolverine Power Supply Cooperative Inc., 2015).

## Michigan Department of Natural Resources

The Michigan Department of Natural Resources (MDNR) is the state agency responsible for managing and protecting Michigan's natural and cultural resources (MDNR, 2017a). Specifically, MDNR has "considerable management responsibility on rivers" that have FERC-licensed hydroelectric facilities (MDNR, 2017c). In this role, MDNR served as an intervener with FERC's licensing process for Tower and Kleber dams in 1994 to ensure impacts to Michigan's natural resources, such as fisheries, were adequately addressed (FERC, 1994).

MDNR is also the primary client for the SNRE master's project team on this project.

## Local Governments

Tower and Kleber dams, along with the broader Black River watershed, cross several government jurisdictional boundaries including (but not limited to) Cheboygan County, Presque Isle County,

Forest Township, Waverly Township, and Allis Township. Tower Village also is located directly on the shores of Tower Pond, and Onaway City is located less than three miles away.

## Tribal Nations

Tribal nations with potential interest in the dams include the Grand Traverse Band of Ottawa and Chippewa Indians, the Little Traverse Bay Bands of Odawa Indians, the Sault Ste. Marie Tribe of Chippewa Indians, the Bay Mills Indian Community, and the Little River Band of Ottawa Indians. In spring of 2015, the Tribal Councils of both the Grand Traverse Band of Ottawa and Chippewa Indians (GTB) and the Little Traverse Bay Bands of Odawa Indians (LTBB) approved motions calling for dam removal (GTB, 2015; LTBB, 2015). The language of each motion is nearly identical and advocate for removal of Tower and Kleber dams with the intention of rehabilitating the Black River sturgeon population (see Appendix V).

GTB is also the secondary client to the SNRE master's project team for this project.

## Universities and Academic Institutions

Michigan State University has been involved in sturgeon research and restoration since 1997 and currently maintains and runs several research projects out of the streamside sturgeon hatchery next to Kleber dam (Michigan State University).

## Environmental Organizations

There are several nonprofit environmental groups that have interests in Tower and Kleber dams. The Black Lake, Michigan chapter of Sturgeon for Tomorrow (SFT) works to improve the Black Lake sturgeon population through education, scientific inquiry, and assisting in management (Sturgeon for Tomorrow, 2017a). SFT also organizes the annual Sturgeon Shivaree that is hosted on Black Lake. The Black Lake Preservation Society (BLPS) consists of local and seasonal sportsmen and local property and business owners with the sole mission of protecting and preserving the ecology of Black Lake, its tributaries and watershed (Black Lake Preservation Society, 2016).

## Landowners

There are two primary groups of landowners with interests in Tower and Kleber dams. Over 100 privately owned parcels are located adjacent to the shores of Tower and Kleber ponds. Black

Lake is also home to many homeowners that may be affected by downstream impacts of the dams, and they are represented by the Black Lake Association, (Black Lake Association, 2017). Some landowners adjacent to the ponds and Black Lake use their properties as seasonal residencies; others are year-round.

### Fishermen

As discussed below, fishing is an important activity in the Black River watershed. The Michigan Darkhouse Angling Association is an organization focused on protecting "the rights of Michigan residents to harvest legal species by spearing from darkhouses," (Michigan Darkhouse Angling Association, 2016). Darkhouses are a specific type of windowless ice shanty used by spearfishermen that ensure a dark environment that allows them to see into the water.

### Tourism Organizations and Local Business

A wide variety of businesses are located in the watershed, including restaurants, hotels, and recreationally oriented businesses (e.g. fishing gear). These businesses are represented by the Onaway Community Chamber of Commerce, which aims to promote businesses in the broader Onaway area (Onaway Community Chamber of Commerce, 2016). As a result of the prominence of outdoor recreation and seasonal residency in the area, as discussed later in this report, tourism is important for local businesses.

## WHAT ARE THE IMPACTS OF THE DAMS?

A range of key topics emerged from our research and stakeholder input, which we then explored in greater depth. The following sections are intended to provide a basic understanding of how the dams are operating (**Physical Status of the Dams** and **Electricity Generation**), their impacts on local landowners (**Properties**, **Black Lake Water Level**, and **Sediments**), their impacts on recreational opportunities (**Recreation**), and their impacts on the local ecosystem (**General Ecological Health**, **Fish**, and **Sturgeon**). In each section, we address current conditions with the dams present and how those conditions may change in the case of dam removal. Providing this baseline, shared knowledge of current and future impacts will allow for a more informed dialogue among stakeholders as this decision-making process moves forward.

# PHYSICAL STATUS OF THE DAMS

| Snapshot of the Dams | |
|---|---|
|  <br>**Tower Dam** | **Date Built:** 1918<br>**Nameplate Capacity:** 560 kW<br>**Dam Type:** Concrete<br>**Height:** 29.3 feet<br>**Length:** 727 feet<br>**Impoundment**: 102 acres |
|  <br>**Kleber Dam** | **Date Built:** 1949<br>**Nameplate Capacity:** 1200 kW<br>**Dam Type:** Earthen<br>**Height:** 40 feet<br>**Length:** 535 feet<br>**Impoundment:** 295 acres |

**Physical Condition of the Dams**

Despite the age of Tower and Kleber dams, recent records indicate that they are in relatively good shape. One interviewee with knowledge of the dams' conditions indicated that FERC has listed Tower and Kleber as low-hazard dams, which means they only need to be inspected every 2-3 years. This designation is also a reflection of FERC's determination that these dams would result in "no probable loss of human life and low economic and/or environmental losses" in event of failure (FEMA, 2004). In addition, a recent Dam Safety Surveillance and Monitoring Report (DSSMR) by FERC in 2014 stated that, although there are some moderate priority issues at both dams, there were no significant issues or any adverse findings in 2012 and 2013 (TKHLP, 2014). Importantly, Kleber Dam was found to be working "properly," and Tower Dam was found to be working "satisfactorily." Both designations indicate that there are no major concerns regarding the maintenance and integrity of the dams.

However, the inspections did recommend actions related to a few moderate and minor issues (TKHLP, 2014). For example, the inspection identified some moderate concrete deterioration at Tower dam that needed repairs. Based on the DSSMR in 2014, this issue and others were expected to be addressed by the end of 2014. A more recent inspection would be helpful in identifying any new issues, if any, that have occurred since 2014.

Accordingly, the dam owner does seem to perform regular maintenance on the dams. A search in FERC's eLibrary points to several maintenance activities that have been planned or recently completed by the dam owner, including an evaluation of emergency spillway scour, the development of an emergency action plan for Kleber Dam and the installation of signage, an audible alarm, and a strobe light for Tower dam to notify about changes in flow due to operational changes (FERC, 2016; FERC Online eLibrary, 2016; TKHLP, 2016a).

**Perceptions of Integrity and Maintenance**

Although residents are aware of the issues with generation (inefficiencies, broken turbines, etc.), they appear to trust that the dams will be maintained properly. Through our interviews and other conversations with stakeholders, we did not hear concerns about the structural integrity of Tower and Kleber dams. Local residents appear to trust the dam owner to maintain the dams appropriately and into the future. This may be the result of notification requirements by FERC, as during some repairs on Tower dam on August 13, 2012, the dam owner notified the public prior to and during a temporary drawdown of the water levels to allow for concrete repairs (FERC, 2015c).

**Employment at the Dams**

In terms of staffing, there are currently two full-time and two part-time employees working at the Tower and Kleber dams. Glassdoor, an online job search and information database, indicates the lock and dam operators at the US Army Corps of Engineers make between $40,000 and $44,000 annually (Glassdoor, 2016). Based on these numbers and an assumption that part-time employment equates to a 50% commitment, the economic value of the dams for employment in the region is between $120,000 and $132,000 per year.

## Cost of Operation and Maintenance

**Operation and Maintenance Costs**

- Annual construction, operation, and maintenance expenses: $9,000
- Comparable dam maintenance costs: $1.24 million ($32,000-$2.9 million)

Although there are no significant issues with either of the dams at this point, there are still issues that would have to be resolved moving forward, in addition to normal operation and maintenance activities, all of which come with associated costs for the dam owner. The dam owner recently reported an annual construction, operation, maintenance expense of $4,500 for each dam, or $9,000 in total each year (FERC, 2015a; FERC, 2015b). Unfortunately, we do not have a good way of estimating the additional costs associated with more extensive maintenance activities. However, maintenance costs for dams in this size range (between 26 and 50 feet in height) range from $32,000 to $2.9 million, depending on maintenance requirements (ASDSO, 2009; ASDSO).

In 1994, FERC estimated a levelized net annual benefit from the dams of $69,350, which was based on a comparison of the cost of the dams ($173,600/year) and the cost of alternative power sources ($242,510/year) (FERC, 1994). Thus, they determined that Tower and Kleber dams are “economically beneficial” to the area. An updated analysis of the potential costs and benefits of the dams, if relicensed, would be necessary to determine how these values may have changed and if the project is still economically beneficial. However, as will be discussed later in Electricity Generation, Tower and Kleber dams may not be providing all the benefits originally anticipated in 1994.

## Cost of Dam Removal

The cost of dam removal can range widely depending on the size of the dam (American Rivers, 2016). American Rivers estimates that the cost to remove an individual dam can range from tens of thousands to hundreds of millions of dollars. While these costs can be significant, dam removal costs can be up to five times less costly than what it would cost to repair and then maintain the dam for the duration of a new license (MDNR, 2017b). Based on past dam removal processes in Michigan, the cost of dam removal varies widely depending on the characteristics of the dams (e.g. height, length) (MDNR, 2010). However, a comparably sized dam, the Sturgeon Dam in Dickinson County, was removed in stages from 2003 to 2005, resulting in a cost of approximately $2 million (MDNR, 2010). More recently at the Boardman River Dams Project, the removal of a comparably sized dam (Brown Bridge Dam) cost $4.4 million, and the removal of two other dams

(Boardman and Sabin) is anticipated to cost $12.9 million (MDNR, 2017d). The cost of removal is expected to come from public agencies (MDNR, FWS) and private foundations. More information about the Boardman River Dams Project is available in Appendix VII.

**Key Stakeholder Interests**

- Dam maintenance needs
- Cost of dam repair versus dam removal
- Dam ownership and sale

**Key Questions Moving Forward**

- Are there structural issues for the dams that need to be addressed?
- What maintenance will be required and when? How much will long-term maintenance cost?
- Are there differences in maintenance needs and costs because of their structural differences (e.g. Kleber is earthen, while Tower is concrete)?
- What would be the potential cost of removal for these dams?
- Is there a possibility of the dam owner “walking away”? If so, who would be maintaining the dams long-term?
- What is the progress of the sale of the dams, and could information about the sale be made available to the public?

# ELECTRICITY GENERATION

Although Tower and Kleber dams fell just short of the overall production target in their 1994 license in 2012, both dams are generating electricity and exhibit a level of reliability that is comparable to the national average for hydroelectric power.

## Significance of Electricity Generation

Alverno, Kleber, and Tower dams (in order of downstream to upstream) are all hydroelectric dams. Alverno Dam was constructed in 1903 on the Lower Black River and has a separate FERC license. The Tower and Kleber Dams have nameplate capacities of 1200 kilowatt (kW) and 560 kW, respectively, and were combined into a single FERC license in 1994. The most recent license agreement spans 1994 to 2024.

Several interviewees noted the importance of the dams for electricity generation from the standpoint of reliability (e.g. in the event of an emergency or storm for major city buildings), and they are also considered a greener form of energy than the alternative. On the other hand, there were also respondents who noted that the dams are generally less important for powering this region.

**Nameplate Capacity:** The maximum rated output for a dam.

> ***"There isn't enough power coming from [the dams] to make a difference […] it isn't going to save me from having electricity or not."***
>
> ***- local resident***

To understand if the dams are producing a significant amount of electricity, we accessed operational data from 2012 through 2013 (MDNR files). Based on the generation data, Tower and Kleber dams generated a total of 6,099.2 megawatt-hours (MWh) in a one-year period from December 8, 2012 to December 8, 2013 (1,673.7 MWh by Tower and 4,425.5 MWh by Kleber) (see Figures 13 and 14 below). Relative to local electricity consumption, this amount does appear to be significant. For the 450 households of Forest Township, projected residential demand for electricity is approximately 4,049.4 MWh per year. This is calculated based on a per-household annual electricity consumption of 8998.69 kilowatt-hours (kWh) from the US Energy Information Administration's (EIA) Residential Electricity Consumption Survey from 2009. While there is likely

to be some loss through transmission, these numbers indicate that the dams produce more electricity than estimated by many of our respondents. Fittingly, some community members did express that they appreciate the hydro-electric power for its reliability and cost benefits.

> ***"Our hydro-electric power is great! It keeps our energy prices low and we never have power outages."***
>
> ***- local resident***

Another way to determine if this generation is significant is to compare it to the 1994 license. In the document, FERC estimated that Tower and Kleber dams would generate 7,498.5 MWh of "clean, domestic, reliable, and renewable energy" each year, which it uses to determine whether the project is economically beneficial. Thus, the dams did not achieve their expected level of annual generation from December, 2012 to December, 2013. Instead, the dams produced 81.3% of that target, which could also reflect a decrease in the economic benefit the dams provide.

**Run-of-River Operation at Tower and Kleber Dams**

It is also important to note that both Tower and Kleber dams are operated as run-of-river dams instead of releasing water only at peak storage and maximizing generation (FERC, 1994). While run-of-river is ecologically desirable, it can also have impacts on generation of the dams themselves (Jager and Bevelhimer, 2007; Kotchen et al., 2006). Based on studies of other dams, Jager and Bevelhimer (2007) found run-of-river operation to result in an average decrease of 3.6% in generation efficiency, which if applied to Tower and Kleber dams, would be lost generation of approximately 227.8 MWh per year for the dam owner based on the generation data shown above. However, a more thorough investigation of historical generation data for Tower and Kleber dams would be needed to conclude if run-of-river operation has resulted in any change in overall electricity generation.

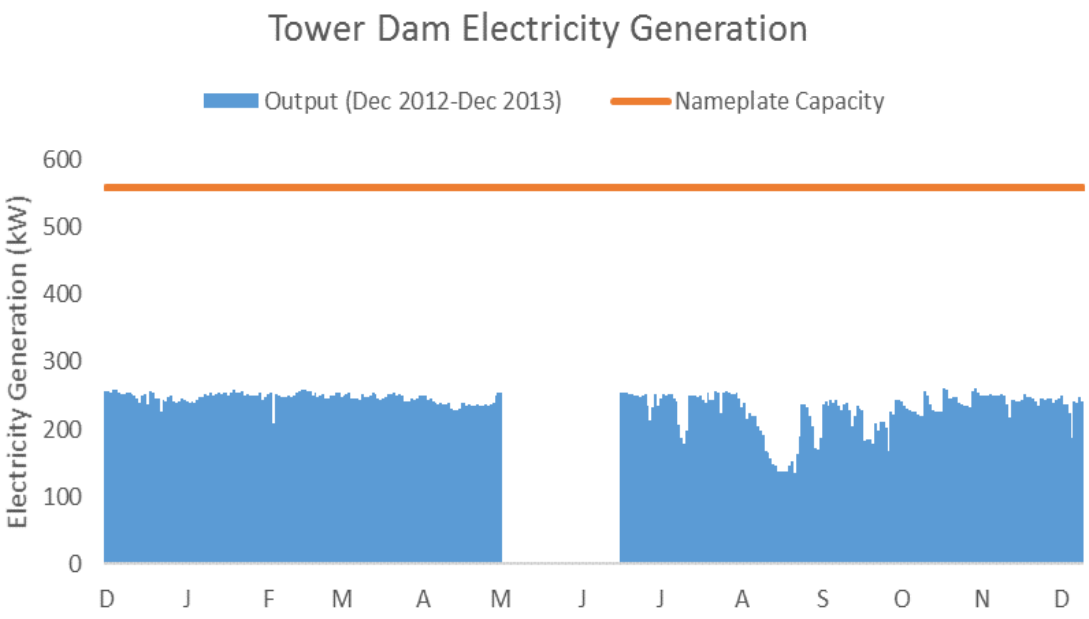


**Figure 4. Tower Dam Electricity Generation and Nameplate Capacity from December 2012 to December 2013 (TKHLP, 2014)**

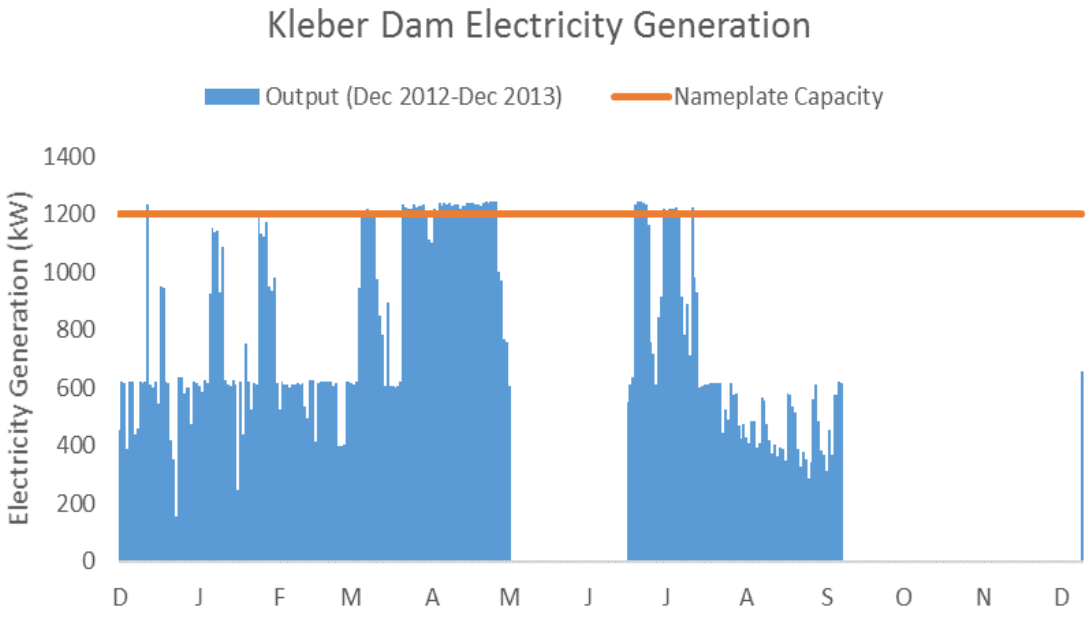


**Figure 5. Kleber Dam Electricity Generation and Nameplate Capacity from December 2012 to December 2013 (TKHLP, 2014)**

## Reliability of Electricity Generation

**Capacity Factor:** The ratio of the amount of electricity produced by a dam as compared to the theoretical amount of electricity that could have been produced at continuous full power operation during the same time period.

When evaluating the reliability of electricity generation, the EIA reports a power source's capacity factor. The capacity factor is "[t]he ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period" (US Energy Information Administration). Therefore, if Tower and Kleber dams were producing at capacity factors of 100%, they would be producing 560 kW and 1200 kW every hour for totals of 4,905.6 MWh and 10,512.0 MWh of electricity each year, respectively. Instead, Tower and Kleber dams produced 1,673.7 MWh and 4,425.5 MWh in 2013 (see Figures Figure 4 and Figure 5). This results in capacity factors of 34.1% and 42.1%, respectively, or a total capacity factor of 39.6% if taken together. While this may seem like an unreliable capacity factor, the nationwide average capacity factor for conventional hydropower was 38.9% in 2013 (and 38.0% in 2016) (US Energy Information Administration, 2017). Therefore, from a reliability standpoint, both Tower and Kleber dams are close to the national average for the reliability of their generation.

The data also point to a key difference in why Tower and Kleber dams are not achieving higher capacity factors. For Tower dam, the data indicate that one of the two turbines is not functioning at all, a finding that is corroborated by observation by local residents and by the DSSMR report discussed in Physical Condition of the Dams (see Figure 6) (TKHLP, 2014). On the other hand, for Kleber Dam the reduced generation does not seem to be due exclusively to a single faulty turbine, as there are instances throughout this period that both turbines are generating at full capacity (see Figure 7).

In addition to evaluating the amount of time the dams are producing no electricity, it is also important to understand how often they are providing only minimal electricity. In fact, one interviewee noted that a previous owner of the dam installed several diesel engines, as well as a jet engine, to deal with times when the dams are not producing sufficient electricity, so it is possible this has been an ongoing issue for the dams. This inconsistency is especially important for facilities that are rely more directly on the dams for electricity. For example, while the sturgeon

hatchery receives free electricity from the dams, they maintain backup power so that their experiments are not negatively impacted by reduced generation.

**Efficiency of Tower Dam**

- Proportion of nameplate capacity: 34.1% (1,673.7 MWh in 2013 out of 4,905.6 MWh/year)
- Percentage of year operating at <5% capacity: 13.3% in 2013

**Efficiency of Kleber Dam**

- Proportion of nameplate capacity: 42.1% (4,425.5 MWh in 2013 out of 10,512.0 MWh/year)
- Percentage of year operating at <5% capacity: 26.5% in 2013

To address this question, we evaluated how often the dam were generating at less than 5% of nameplate capacity, since those may be times at which there is insufficient electricity for the hatchery or other facilities directly linked to the dams. Tower dam was generating at less than 5% of nameplate capacity for 13.3% of the year. A similar trend is evident for Kleber Dam as evidenced in Figures Figure 5 and Figure 7, and Kleber Dam generated at less than 5% of nameplate capacity for 26.5% of 2013. From these numbers, there appear to be significant periods of time where Tower and Kleber dams are not providing sufficient electricity for facilities that rely directly on them, which requirements additional investments by those facilities in backup generation capacity, which can be costly. For example, backup generators for homes can cost anywhere from $2,000 to $20,000 depending on the capacity needed and installation costs (Sims, 2015).

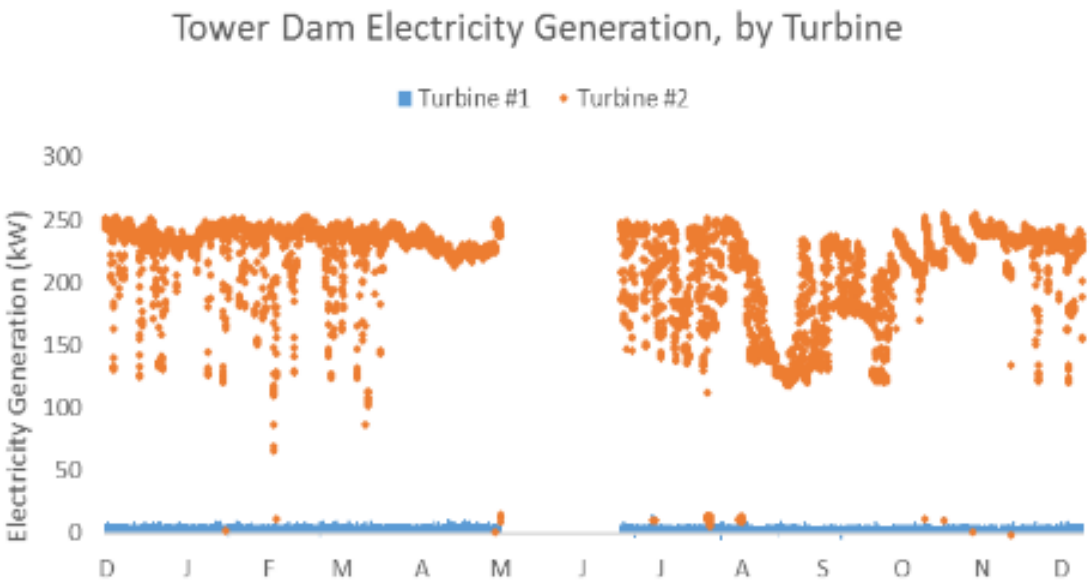


**Figure 6. Tower Dam Electricity Generation by Turbine from December 2012 to December 2013 (TKHLP, 2014)**

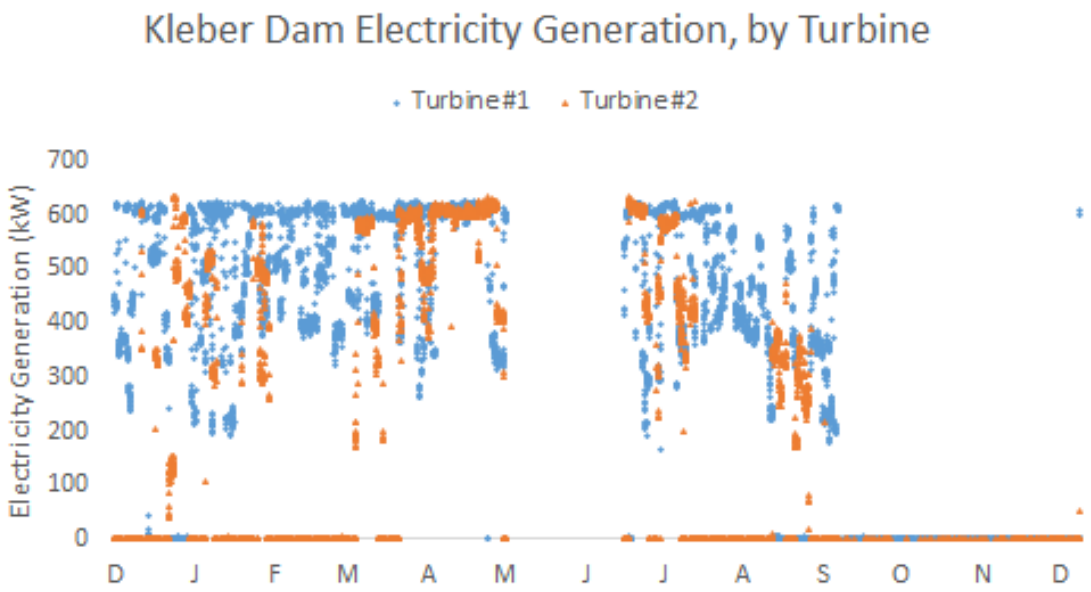


**Figure 7. Kleber Dam Electricity Generation and Nameplate Capacity from December 2012 to December 2013 (TKHLP, 2014)**

## Electricity Transmission

While reliability is important to facilities that receive electricity directly from Tower and Kleber dams, the only facilities that receive electricity directly are the sturgeon facility and the Forest Township Hall. The remaining electricity is distributed to the regional grid and is in fact sold to seven of Wolverine Power Supply Cooperative's (WPSC) nearby wholesale cooperative customers (FERC, 1994). Unfortunately, revenues associated with wholesale distribution into the broader electricity grid were unavailable. However, the cost of transmission that WPSC charges the TKLP to distribute to the grid could be identified. Based on a recent amendment to this distribution agreement, TKLP must pay Wolverine Power $736.07 each month, an increase of 9.1% from their agreement prior to 2014. (Fulbright & Jaworski LLP, 2014; MISO, 2014). This figure, especially if paired with a future understanding of revenue from selling electricity, will give a better understanding of the cost-effectiveness of the dams as sources of electricity generation.

**Key Stakeholder Interests**

- Reliability of electricity generation
- Cost of hydroelectric power
- Upkeep of dam and impact on electricity production

**Key Questions Moving Forward**

- How much revenue do the dams generate through electricity production? How is this expected to change in the future based on projected changes to production capacity?
- Why are the dams inconsistent in their generation?
- How is electricity from the dams distributed in the grid?
- What is the impact of losing the electricity the dams provide on the grid (e.g. grid reliability, electricity prices)? How would that loss be offset?

# PROPERTIES

When dams are built on a flowing water body, the water level is raised and a portion of the landscape upstream of the dam structure is flooded. This flooding creates a reservoir of water behind the dam, also referred to as a pond or an impoundment. Depending on the local landscape, the flooding can expand the amount of shoreline available for development, and neighborhoods are commonly found along the shores of these man-made ponds. The properties that are developed along the impoundment have access to unique waterfront characteristics that their landowners often point to as reasons for purchasing the property to begin with. These characteristics include the aesthetic value of a waterfront view and direct access to water-based recreation, such as fishing, boating, and swimming. It is crucial to understand the values impoundment landowners place on their properties and, especially, the inherent trade-offs associated with keeping or removing the dams. The following section: (1) examines the potential impacts of dam removal on specific concerns expressed by impoundment landowners, (2) explores the properties along Tower and Kleber ponds, and (3) evaluates the value of properties in this watershed.

**Impoundment**: a body of water, such as a pond or reservoir, that is formed by obstructing flow in a river.

## Impacts of Dam Removal

Overall, the individuals we spoke with had a variety of primary and secondary concerns about a dam removal scenario. Impoundment landowners are generally supportive of keeping the dams because they value their waterfront property and do not want their ponds to disappear. One even told us he “can’t imagine the negative impacts of the dams on the area.” The section below explores the specific characteristics that were identified and the potential impact of dam removal on those characteristics.

### Aesthetics and Recreation

Some of our respondents were especially attached to the ease of access they had to recreational activities from their backyards and attached docks. One landowner also mentioned that there are two side ponds that feed into Kleber Pond and are commonly used for specific types of fishing, which would also be affected if the water were drawn down due to dam removal. Similarly, having bought their property with the current aesthetic (waterfront impoundment land), that aesthetic is something they value, and some indicated a desire to pass that onto their children in the future. Some landowners also expressed a general desire to avoid change in the area.

> ***As you get older, the more sameness you like.***
>
> ***- local resident, in reference to conditions of Tower and Kleber ponds***

If the dams were to be removed, the water levels would decrease, resulting in an increased distance from the water's edge for certain landowners based on where the resulting river established itself. One landowner speculated that the river would end up establishing several hundred feet from their property. This increase in distance could impact their ease of access to recreational activities from their backyards, in addition to changes to the available recreational activities themselves (discussed in the Recreation chapter).

**Connectivity of Transportation**

Respondents also had concerns related to Kleber Dam and the access road that runs along the top of its structure. This bridge provides public access and community connectivity, and is likely used by many local residents for transportation and commuting. This road is the only one that traverses the western and eastern sides of Black River for several miles along this stretch of the river, providing a more convenient connection between communities on either side of the water. It also provides access to the sturgeon hatchery, which is located on the northern shore of the river. According to one interviewee, this road is currently owned and maintained by the dam owner instead of by the county. Therefore, if Kleber dam is removed, individuals would lose their access to the other side of the Upper Black River. Using Google Maps, we determined that the next nearest crossings across Upper Black Rivers are 2.5 miles upstream (south) and 4 miles downstream (north) of the current crossing over Kleber Dam. Depending on the routes taken, this could add a significant amount of additional travel time.

**Property Rights**

One of the other concerns several local residents brought up in our interviews was in regards to property rights and boundaries. Some respondents, especially riparian landowners, seemed concerned about who would end up owning the additional exposed land once it is no longer a lakebed. One resident hypothesized that some owners, depending on their distance from the resulting river channel, would gain several hundred feet of property since their ownership rights would extend to the riverbank itself. This hypothesis appears to be supported by a 1995 court holding in *West Michigan Dock and Market Corporation v. Lakeland Investments*. In that case, the court held that ownership goes to riparian landowners adjacent to the inland bottomlands "unless those lands have been sold in fee title." Therefore, unless the landowners (or the original

property developers) explicitly sold their rights to the bottomlands, the exposed lands would go to the property owners currently living adjacent to the water.

However, in other instances of dam removal in Michigan, this expansion of private property ownership has been challenged by local governments, who claim the newly exposed land should be owned by the public instead (Walker, 2009). If local residents do not end up owning the additional land, they may be upset that they not only lost their waterfront aesthetic but also direct, private access to the water.

**Property Taxes**

On the other hand, some residents may find ownership of additional land to be problematic from a property tax standpoint, as they now will be responsible for payment of additional property taxes. In fact, one waterfront resident indicated concerns about potential increases in property values in the area, which would result in higher property tax payments.

> ***"The worse it looks around here, the better it is for my taxes. It isn't an investment. It's where I live. And I'll keep living here as long as my taxes are less than six, seven hundred, that's just fine with me."***
>
> ***- local resident***

**Property Values**

On the other hand, some residents indicated during the public meeting that they view their properties as financial investments and are concerned that any impacts on property value, even if temporary, could negatively affect their ability to retire. For example, while studies of similar dam removal scenarios have pointed to either neutral or beneficial impacts on property values (see "Dam Removal and Property Values" below), it is unclear what the consequences would be immediately after removal, especially as some benefits of dam removal (e.g. riparian green spaces) may not be fully realized in a shorter time frame.

**Ecological Transition**

Some respondents also brought up issues related to the transition period from impoundment to river. If the dam were removed, much of the water in the impoundment would drain down, exposing significant amounts of muddy lakebed. While vegetation would eventually grow, and create a riparian area, residents are unlikely to enjoy looking out at acres of mudflats from their backyards in the interim. Importantly, there is considerable uncertainty about how long this

transition period would be. An analysis of several dam removals in Wisconsin found that the mud flats naturally revegetated between three and 49 years after removal (Lenhart, 2000). On the other hand, two other studies found the area to be covered with vegetation following the first growing season (Orr and Stanley, 2006; Shafroth et al., 2002). Those studies, however, point out that this first-growth of vegetation is generally dominated by plants that grow rapidly, a characteristic that may favor invasive species.

Removal would also affect the water itself. “It would be a similar problem to what happened at the Pigeon River with the Song of the Morning Dam. It took about two years or so to clear up before it ran clean again.” Considering many of the landowners are retirees, there may generally be an aversion to changing conditions, especially if the transition period will take a long time. However, based on experiences from other watersheds, this transition period has generally been relatively short (pers. comm. P. Hanchin).

## DAM REMOVAL AND PROPERTY VALUES

Impacts of dam removal on property value was consistently brought up throughout our interviews with impoundment landowners. In order to better understand those financial impacts, we have explored scientific literature for studies that have examined that question in comparable dam removal scenarios. Two key studies are profiled below.

**Provencher et al. (2008)** compares property values in three different sites in south-central Wisconsin near Madison: 1) those by an intact dam, 2) those by a dam that was removed, and 3) those by a free-flowing river or stream. Their study relied on market sales data from 1993 through 2002. The results of their analysis indicate that dam removal has little impact on property values in the short-run (two years in this study) and can, in fact, increase property values in the long-run as the newly exposed river and riparian zone mature or are managed as open space. It is important to note that waterfront properties in this study gained newly exposed bottomlands following the removal of the dam. For waterfront properties, their direct frontage access to the water converts to a riparian-type frontage, which increases the properties' values.

**Lewis et al. (2008)** evaluated the effect of removal of the Edwards Dam on properties near the Kennebec River in Augusta, Maine by comparing them to properties upstream near the Ft. Halifax and Lockwood Dams. Their study found that, historically, properties closer to the dams had a property value penalty relative to those further away. Importantly, that penalty decreased over time, and they pointed to the removal of the Edwards Dam as a potential contributing factor. One important caveat to this finding is that this effect may also be part of a broader restoration effort of the Kennebec River, of which the removal was an important part. If the broader restoration is an important factor in improving property values, then those positive benefits may not be realized immediately. In this study, they had data for six years following the removal of the dam.

### Properties on Tower and Kleber Ponds

Tower dam creates a 102-acre reservoir while Kleber dam holds a 295-acre reservoir accounting for 2.72 and 6.74 miles of shoreline, respectively (FERC, 2015a; FERC, 2015b). Resulting from

the expanded waterfront area, there has been a significant amount of development on the shorelines, which is especially evidenced along Tower pond (Figure 8). Many of these residents appreciate living on the impoundments because of the ease of access to recreational opportunities, such as boating and fishing, from their backyards. Landowners also appreciate the ponds' and wildlife. The deepest connection these landowners have with their property is the family legacy they have from decades or generations of living there. Since their waterfront property exists because of the dams, impoundment landowners would be disappointed to see the dams removed.

> ***"I've never heard anything negative about [the dam]. It's just an integral part of our community here. It's always been here, and everybody just kind of coalesces around it."***
>
> ***- local resident***

Based on our interviews, some properties are utilized as seasonal homes for individuals who work in other parts of Michigan or other states. These individuals come to this area to spend leisure time with access to outdoor recreation. As such, the property market here is likely different from a typical housing market in that many parcels may still be less developed in order to be used for camping or other temporary and seasonal purpose. However, in some instances some of these seasonal landowners have since retired and built more permanent structures to live on the property year-round.

In total, there are 111 individual private property parcels that are owned by landowners (57 on Tower Pond, and 54 on Kleber Pond), as opposed to parcels owned by the state, the dam owner, the regional utility, or other businesses (Cheboygan County GIS) (see Figure 8 and Figure 9). Based on aerial imagery and parcel data, we were able to distinguish between property parcels that have are developed (e.g. presence of permanent structures) and those that are not, of which there were 75 and 36, respectively (see Figure 10 and Figure 11). Finally, we were able to determine, based on ownership information, that there are 42 parcels (15 on Tower, and 27 on Kleber) that are owned by seasonal residents (individuals whose permanent addresses are elsewhere), making 69 of the impoundment landowners permanent residents of the ponds.[3] Proportionally, it appears that Kleber Pond is a more popular location for seasonal residents, likely

[3] For privacy considerations, we have chosen not to visualize property owned by seasonal residents.

because its neighborhoods are more recent than those along Tower Pond. Of those 42, seven are in fact out-of-state seasonal residents. Finally, 22 of the developed parcels are owned by seasonal residents.

In addition, it appears that much of the shoreline real estate development has also resulted in not only growth but also improvements in the overall housing market in this area by building those neighborhoods outwards. While there are 111 landowner property parcels with direct access to the shores of Tower and Kleber ponds, these properties are part of neighborhoods that at times extend a few blocks off the waterline, although most of the houses within them are still in close proximity to the water (see highlighted parcels in Figure 12). For properties that are within the same neighborhoods but not directly adjacent to the water, they still have access to the ponds but may have to utilize public access points (e.g. state or township lands) instead of private access (see Figure 8 and Figure 9). Therefore, when evaluating the future of the dams, it is important to consider the interests of this set of landowners as well.

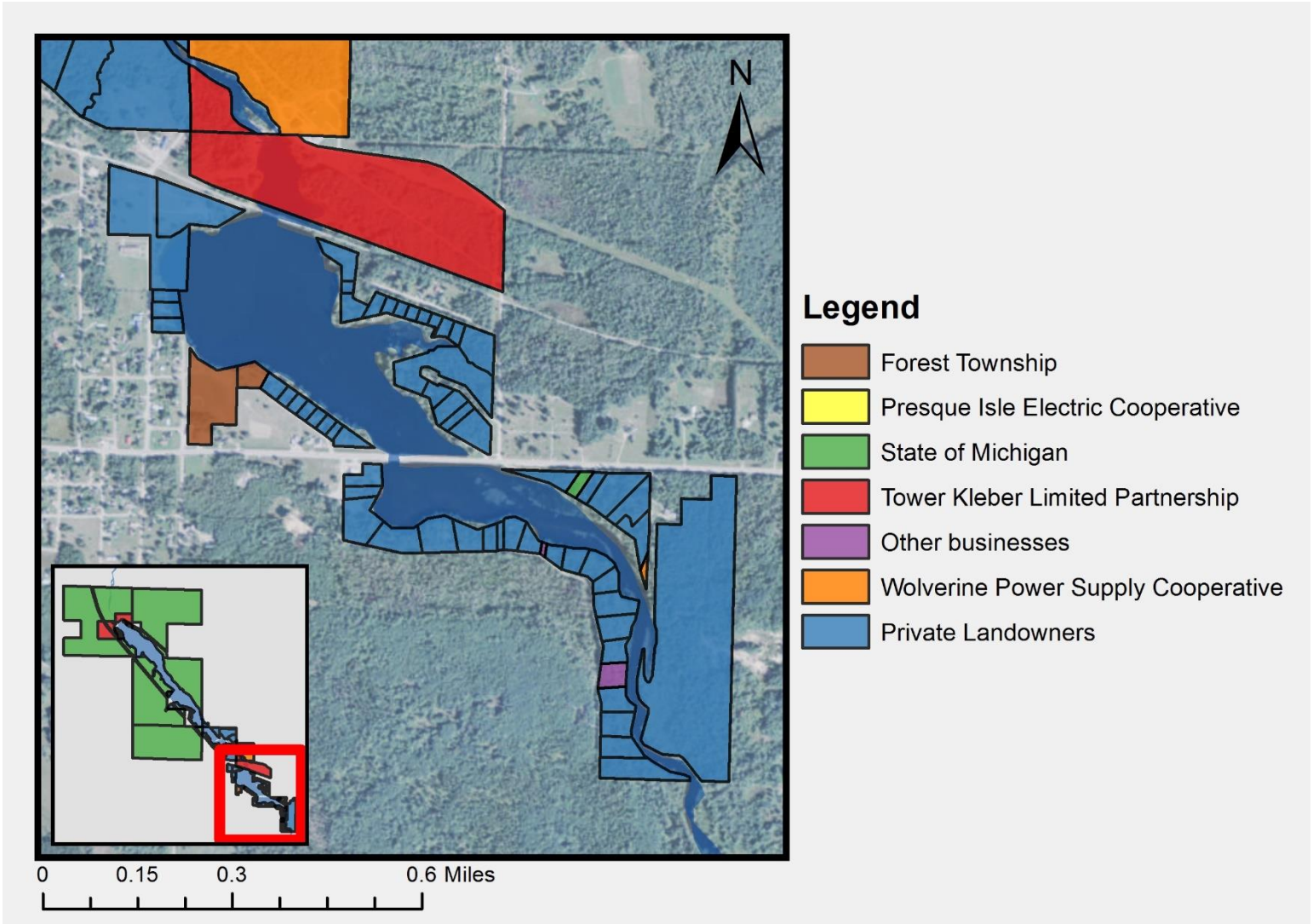


**Figure 8. Property Parcel Ownership Along Tower Pond (Cheboygan County GIS)**

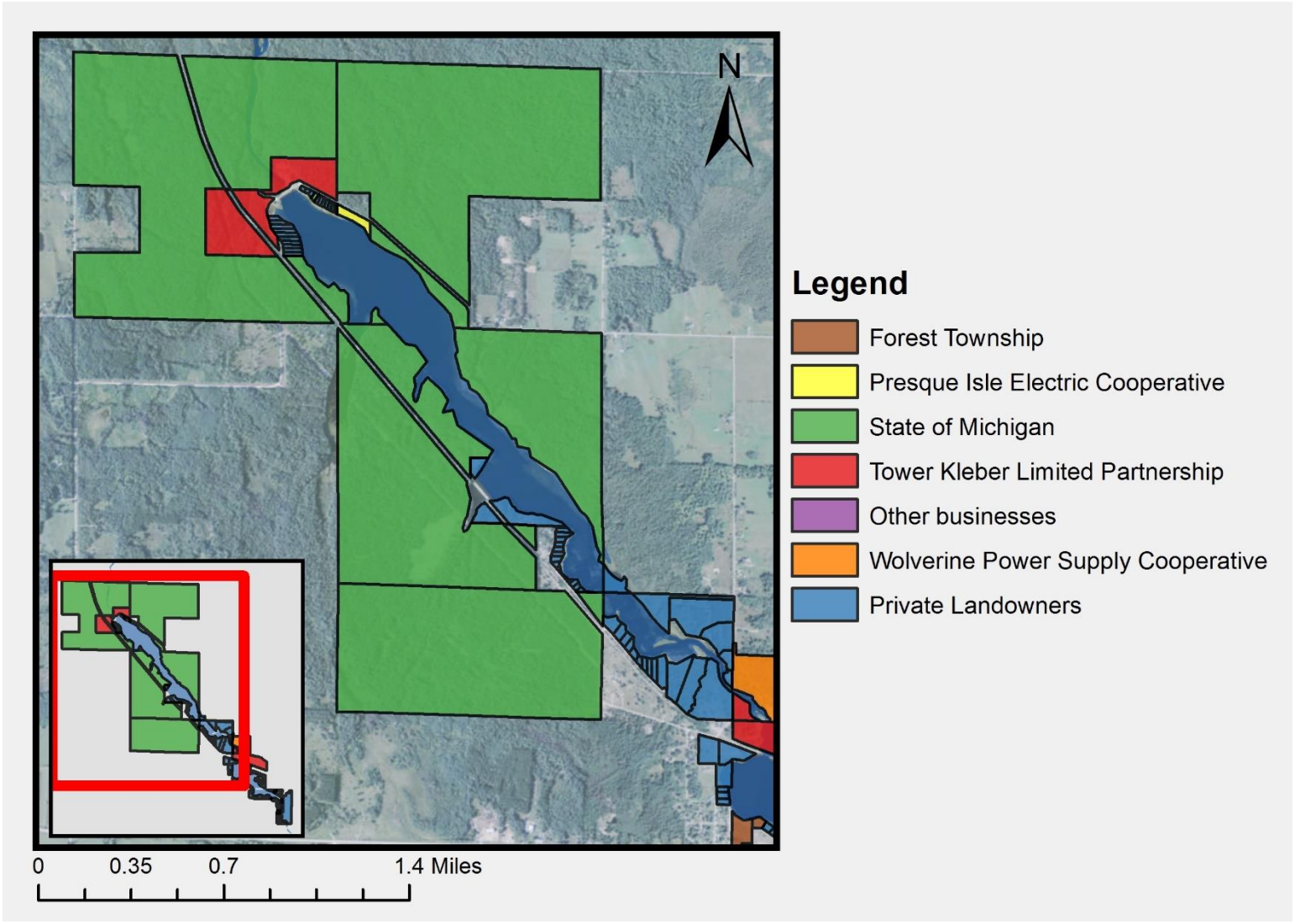


**Figure 9. Property Parcel Ownership Along Kleber Pond (Cheboygan County GIS)**

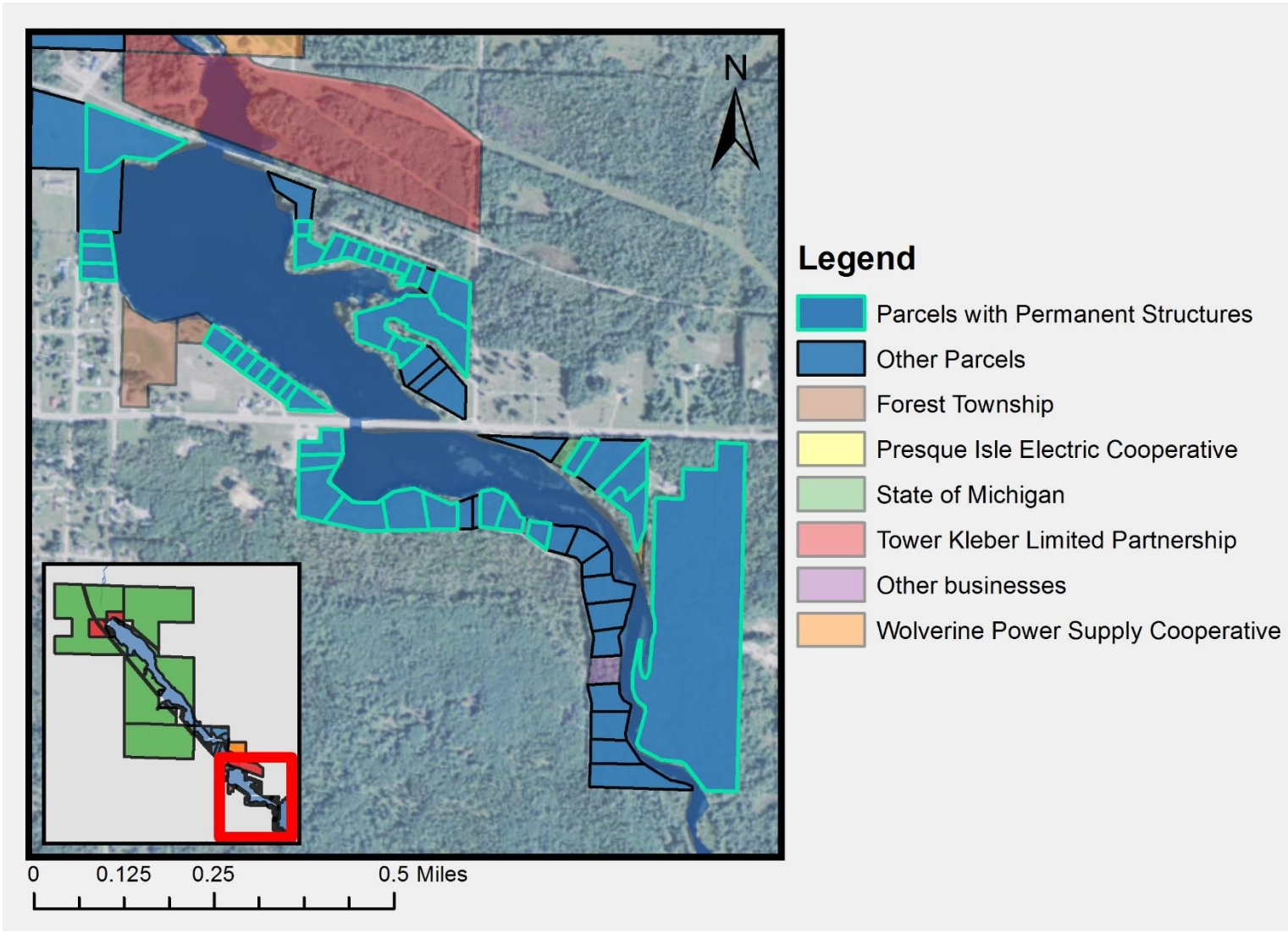


**Figure 10. Private Property Parcels with Permanent Structures on Tower Pond (Cheboygan County GIS)**

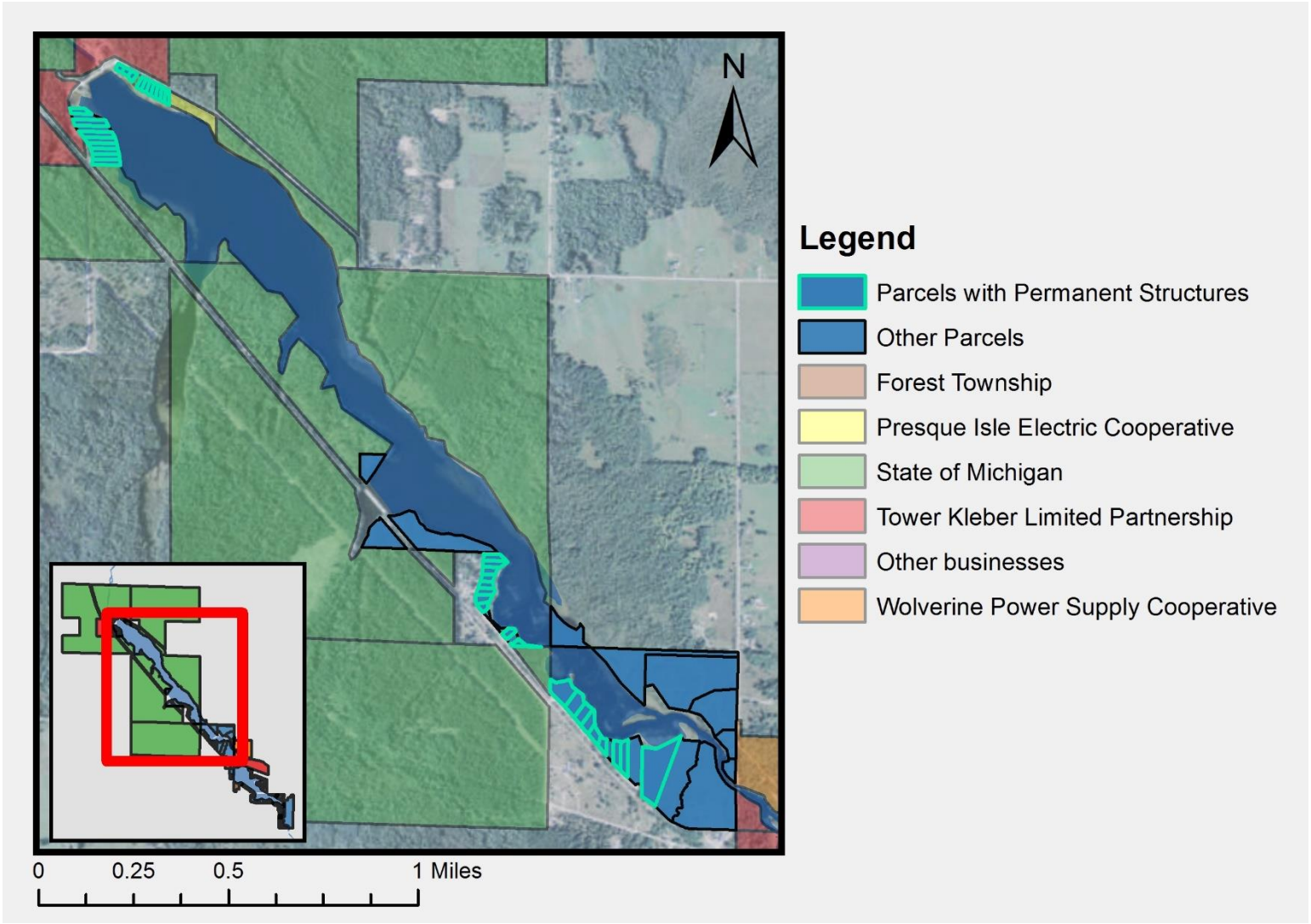


**Figure 11. Private Property Parcels with Permanent Structures on Kleber Pond (Cheboygan County GIS)**

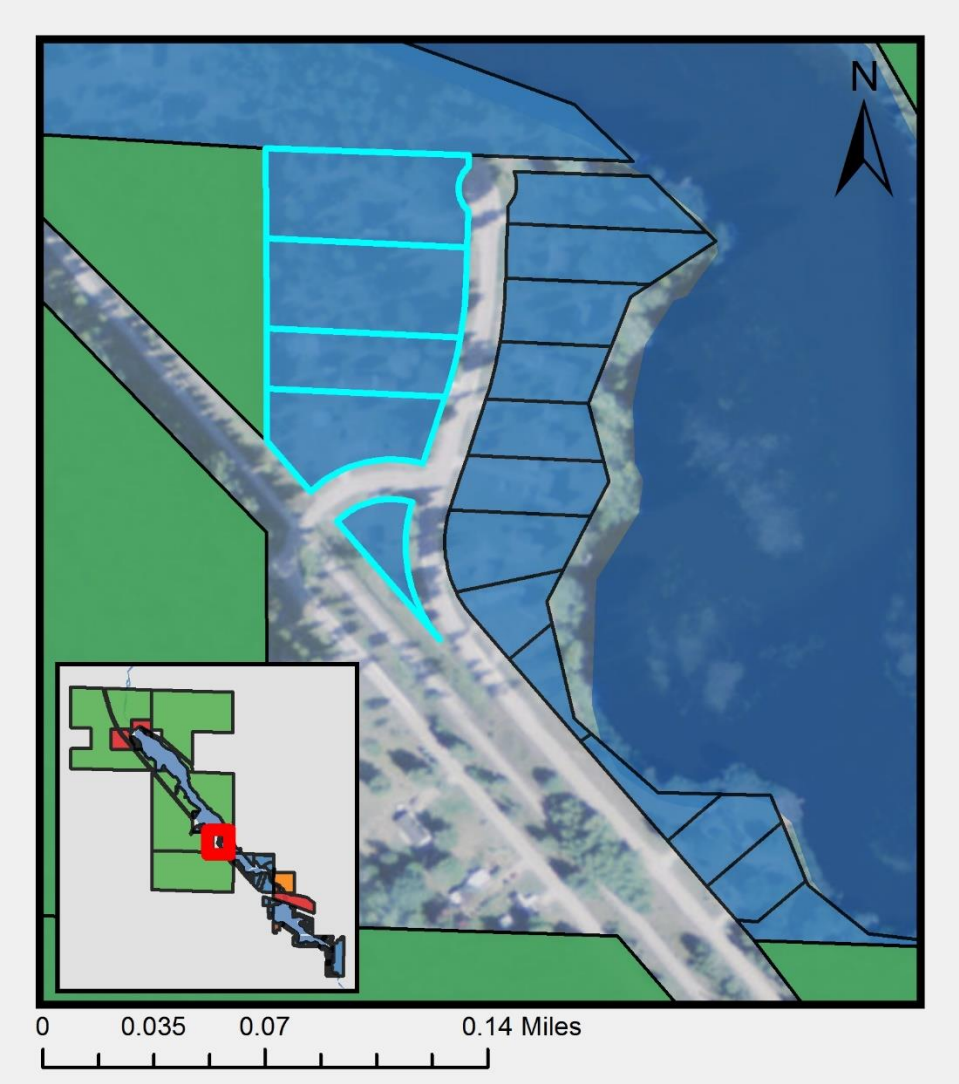


**Figure 12. Non-Waterfront Properties in a Neighborhood on Kleber Pond (Cheboygan County GIS)**

## Value of Waterfront Properties

With the potential impacts of dam removal and extent of property development on Tower and Kleber ponds in mind, we also sought to develop a baseline understanding of property values in the area so that future analyses of the potential impacts of dam removal have a reference point.

### Tower and Kleber Pond Property Values

As noted previously, there appears to be a significant amount of property development on the shores of the two ponds. Based on data available on Zillow.com, property on the Tower and Kleber ponds sold for an average of $79,849.89. This points to property as an important investment for local landowners. According to the US Census Bureau (2014), 15.3% of the population in Forest Township[4] is under the poverty line, and the median individual income is $24,778. While this figure encompasses a broader geographic region than just impoundment landowners, it does suggest that properties here serve as significant investments that require multiple years of financial savings.

In evaluating the values of these properties, we also categorized properties based on the impoundment they adjoin and whether they are waterfront or not. As stated earlier, there are distinct differences in the experience of living near the impoundments for those on the water relative to those that must use public access points. Because of this difference in ease of access, we might expect there to be differences in the property values as well. Notably, if those properties are more desirable to the average landowner, we might expect waterfront properties to be more expensive relative to non-waterfront properties, holding other factors equal (Lansford, Jr. and Jones, 1995). In fact, Bohlen and Lewis (2008) project a 15.8% increase in property value for waterfront characteristics.

**Average property values**

- Waterfront property: $93,858
- Non-waterfront property: $51,833

**Average per-acre property values**

- Waterfront property: $122,866
- Non-waterfront property: $15,572

Before looking at the Zillow housing transaction data in greater detail, it is important to emphasize that there are not enough recent transactions to make any conclusive statements in comparing property prices related to various

[4] Forest Township encompasses Tower Village, which is the main area of population near the impoundments. More information about Forest Township and the other geographic units are available in Appendix III.

house characteristics. However, the data do suggest a price premium for living closer to the water. The waterfront properties by the impoundments are listed for significantly more ($93,858) than their neighboring properties not along the water ($51,833). Furthermore, the average per acre property value is $122,886 for waterfront properties ($94,350 for Kleber and $137,154 for Tower) but only $15,572 for non-waterfront properties ($29,605 for Kleber and $1,538 for Tower).

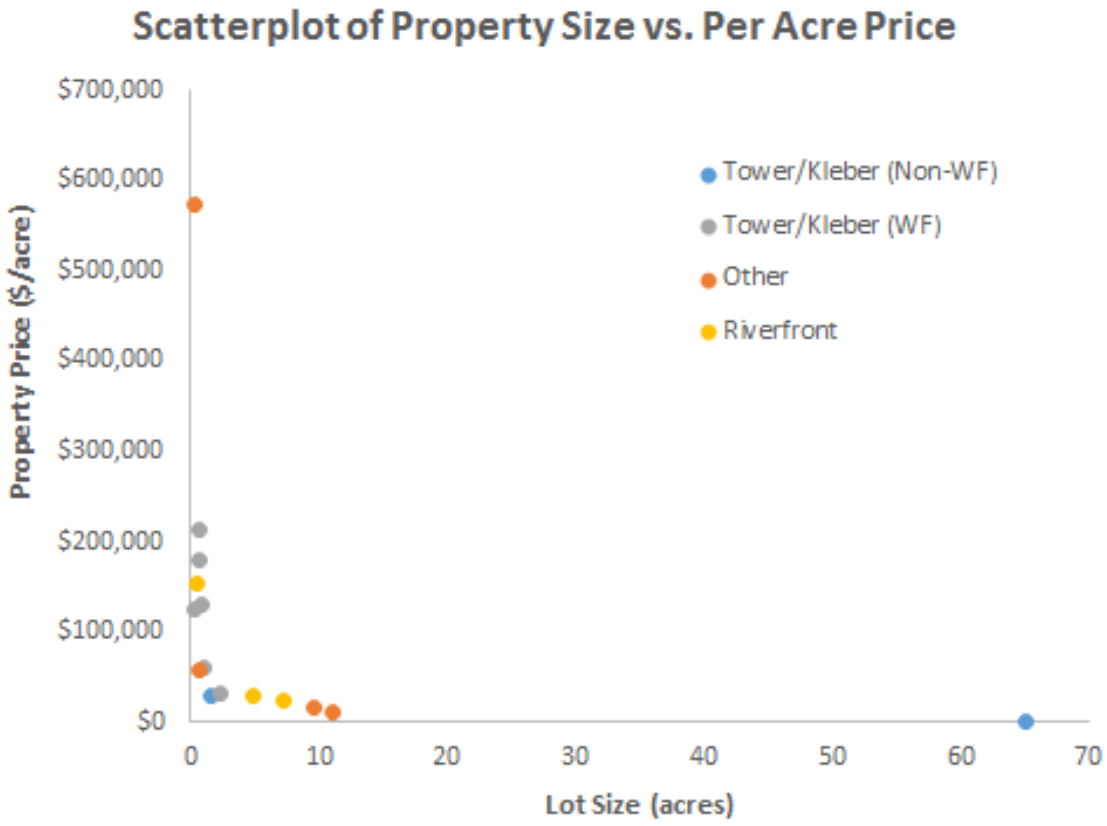


**Figure 13. Scatterplot of Property Size vs. Per-Acre Prices for Properties Near Tower and Kleber Ponds**

While we do not have enough data to evaluate the reasons underlying this difference, there may be two factors that play into it. Waterfront properties have direct access to recreation on the impoundments, which makes fishing and boating opportunities much more accessible and


convenient as discussed previously. In addition, waterfront properties have frontage, which offers nicer views of the water, and the price difference may represent the value of that aesthetic.

In addition, there are differences between properties near the impoundment and those further away. The average per acre value for non-waterfront properties further away from the impoundments is $164,208 and is $69,330 for properties along riverine portions of Black River upstream of the impoundments. The difference in prices between these properties and those along the Tower and Kleber Ponds may be due to significant differences in the characteristics of those properties, such as greater seclusion and access to land-based recreation (e.g. hunting) or larger contiguous tracts of land. A more detailed study of these property parcels would be necessary to make any conclusive statements about this region.

**Black Lake Properties**

In addition to properties that are directly along the shores of Tower and Kleber ponds, there is also a significant amount of housing development along the shores of Black Lake. Many of these landowners are concerned about potential downstream impacts of dam removal, as changes to sediment flow or flood control have the potential to influence their properties as well. These perceptions and potential impacts are explored in depth in the following two sections of this report.

**Average property values**

- Waterfront property: $75,111
- Non-waterfront property: $192,663
- Riverine property: $162,583

**Average per-acre property values**

- Waterfront property: $511,023
- Non-waterfront property: $23,874
- Riverine property: $70,210

In the past few years, 61 properties were sold along Black Lake (Zillow, 2016). Based on these 61 transactions, property along Black Lake sold for an average of $146,861 between 2013 and

2016 (Zillow, 2016). When equalizing for size, the average per acre value was $259,526. These values are significantly higher than those along Tower and Kleber ponds and are likely a reflection of the higher aesthetic and recreational appeal of living along Black Lake.

**Key Stakeholder Interests**

- Avoiding ugly and costly transition periods
- Maintaining property rights
- Maintaining property value
- Preventing trespassing
- Having access to information

**Key Questions Moving Forward**

- Who currently owns the impounded land underneath Tower and Kleber ponds?
- What is the legal status of property rights allocations for newly exposed bottomlands stemming from dam removals in Michigan, and specifically for properties on Tower and Kleber ponds? Where can residents go to find this information?
- Where would the new waterline be? How long would the transition from pond to river take?
- Are there implications for regulatory takings if a dam removal process were to proceed?
- What direct impacts on the housing market could be expected if a dam removal were to move forward?
- What opportunities would there be to restore exposed bottomlands as green space? Who would be responsible for the restoration and costs?
- How would the two ponds be impacted differently? (aesthetics, clarity, rapids, property values, etc.)
- Does dam removal significantly impact neighboring groundwater supply?

# BLACK LAKE WATER LEVEL

Many residents and landowners are concerned with the water level in Black Lake and are accustomed to a perceived sense of control offered by Tower and Kleber dams. However, under normal flow conditions, Tower and Kleber dams do not hydraulically control the water levels.

A key concern expressed by residents on both Black Lake and the impoundments, as well as seasonal and recreational visitors, is the ability to maintain water levels in Black Lake and avoid damages to shoreline property. Tower, Kleber, and Alverno dams appear to offer control over the hydrology in the Black Lake watershed and many fear losing the perceived control. However, Tower and Kleber dams may not offer flood protection or hydraulic control over Black Lake water levels. While not a focus of this project and not up for license renewal, we discuss Alverno dam below since it does appear to have hydraulic control on water levels.

A primary concern for riparian landowners and residents on Black Lake is maintaining the proper water levels in Black Lake to avoid damage to property. Rapid fluctuations or high water levels as well as high winds and waves can lead to destructive erosion problems along the shoreline and lake shore. Residents have noted expensive property damage due to ice and high water levels during winter months. During March and April of 2016, property owners experienced damage to shoreline and property due to high water levels, above-average precipitation, and high winds (BPLS, 2016). These property owners express anger and concern about events like these and are vocal about preventing them in the future.

Boaters also expressed interest in maintaining water levels so that they can clear boat hulls, avoid weedy vegetation, and utilize docks in the shallow shoals of Black Lake. Although not directly related to lake levels, similar concerns were expressed by kayakers and canoers regarding water levels in Black River, expecting that water be deep enough for rivercraft. Shallow waters and “washed-up muck” lead to disused beaches. “If they could guarantee that taking out those dams would not affect lake level [or] cause any more problems to the residents around the lake, I’m sure everybody would be happy,” said one resident. To address these concerns, better understanding is needed among community members about the factors influencing Black Lake's water levels.

## Effect of Alverno Dam on Water Levels

The primary structure controlling the Black Lake water levels is Alverno Dam, downstream of Black Lake. It is through this structure that the flow coming from Black Lake must pass. The county Drain Commissioner is the "delegated authority" regarding inland lake levels as stated by a statute in the Michigan Environmental Protection Act, Act 451 of 1994. According to the Cheboygan County Drain Commissioner, the Black Lake water level "is controlled at the Alverno Dam in Benton Township" (Jankoviak, 2013). An engineering feasibility study inspected Alverno Dam in 1995 and found that "if Alverno was partially removed, water level would drop 3-4 feet on Black Lake and Black River. If removed entirely, 30% of Black lake would become mud flats" (Fargo, 1995).

**Water Levels by Court Order:**

- Summer: 612.2 feet
- Winter: 610.2 feet

**Transitions periods:**

- April 15th to May 15th
- November 1st to November 30th

On August 25, 1964, the State of Michigan Circuit Court in the County of Cheboygan ordered that the legal summer level of Black Lake shall be 612.2 feet above sea level from May 15th through October 31st and that the winter level shall be 610.2 feet above sea level from December 1st through April 15th. It also ordered that the waters be raised from the winter level to the summer level during the period April 15 to May 15th and that the waters shall be lowered to the winter level during the month of November. Control of the water level in Black lake is to be achieved via discharge adjustment through Alverno dam. The FERC-issued dam operation license for Alverno acknowledged that "because the project serves as the hydraulic control for Black Lake at some flow levels, the Alverno Project should be operated to pass more or less than inflow to maintain the water surface elevation of Black Lake" (FERC). Alverno is now operated in a non-peaking, modified run of the river mode in order to maintain court ordered water levels. The Black River Limited Partnership (BRLP), which operates Alverno dam and is also managed by Nelson Turcotte, has received complaint letters regarding the water levels in Black Lake and is working toward compliance despite variables such as temperature, precipitation, and Smith Rapids discharge (TKHLP, 2016b). Black River Limited Partnership and Black Lake Preservation Society both suggest lengthening the period of drawdown to lower Black Lake water level to winter levels (TKHLP, 2016b, BLPS, 2016).

The Smith Rapids, located between Black Lake and Alverno Dam, can hydraulically control the water levels in Black Lake under medium-high flow conditions. Described in a study done by the

Army Corps of Engineers (ACOE) in the 1960s, “the Smith Rapids section is a channel constriction that restricts the flow of water to the point that the Smith Rapids, not the dam, controls the outflow from Black Lake during periods of high water.” From the ACOE report, a discharge value between 0 to 800 cubic feet per second (cfs) passes unconstricted through the rapids, making Alverno dam the hydraulic control structure. Discharges greater than 900 cfs are restricted by the Smith Rapids, thus controlling the water levels (ACOE, 1965). When Smith Rapids are the controlling structure, releasing additional flow from Alverno Dam will not impact the water level in Black Lake. At the time of the court order for water levels, however, it was thought that Smith Rapids would be reconstructed, thus leaving Alverno Dam as the only hydraulic control.

In March of 2017, the Black River Limited Partnership conducted an observational trial to test the hydraulic control of Alverno dam on Black Lake water levels. The goal was to see if drawing down Alverno Pond could drawdown water from Black Lake by allowing for greater discharge (approximately 750 cfs) through the dam. Since this trial was run during warm, spring temperatures, the snowmelt and spring runoff is assumed to be high. BRLP found that Black Lake water levels continued to increase despite the drawdown at Alverno. This implies that Smith Rapids act as the hydraulic control during the time of the trial, at which the discharge was estimated to be 750 cfs. BRLP has since requested that the ACOE reexamine the hydraulics of Black Lake, Smith Rapids, and Alverno to update their understanding from the 1965 report.

## Effect of Tower and Kleber Dams on Water Levels

Under normal precipitation and flow conditions, the storage in Black Lake is largely determined by downstream controls, given that Tower and Kleber are operated run-of-river. Run-of-river operation requires that the inflow entering the impoundments be equal to the discharge released out of the dams. According to local perception, the three dams together form a “balancing act” of water level control. The operation of the three dams in respect to each other may affect the water level in Black Lake, however, it is the balance between the inflows and outflow which determine water levels. Inflows include the Upper Black river, Rainy river, and other tributary creeks, all of which have variable discharges related to the rates of precipitation, snowmelt, and infiltration. Black River drains Black lake and flows toward Smith Rapids and Alverno Dam. The discharge from the lake depends on the water surface

**Run-of-river operation**: operation of a dam such that inflow entering the impoundments is equal to the discharge released out of the dams.

elevation and the relative water surface elevations of the lake, the pond in front of Alverno, and the backwater in front of the rapids.

In the case of a large storm, measured by intensity or duration, the dams could offer storage in the impoundments and the operator's ability to control discharge through the dams has potential to mitigate damage from high water levels. However, Tower and Kleber would only be able to attenuate, or store, some of the peak flow collected by Black River; other inflows to Black Lake would still contribute higher-than-normal flow. Stormwater storage offered by the floodplain of the Upper Black River should be investigated as a potential mitigation for high flows.

**Key Stakeholder Concerns**

- Maintaining Black Lake water levels
- Preventing flooding (stormwater management)

**Key Questions Moving Forward**

- What is the extent of control on water level in Black Lake by Tower and Kleber?
- How does Alverno affect Black Lake levels?
- How would Burt and Mullet Lakes water levels be affected by dam removal?
- How do the dams control stormwater flows?
- What storage can the floodplain offer in storm events?

# SEDIMENTS

Impoundment landowners and lake residents both express concern regarding the potential for property damage and shoreline erosion. The presence and removal of dams will impact sediment transport locally.

Rivers can shape the landscape on a regional and local scale through erosion and deposition processes (Ligon, 1995). Hydroelectric dams are built to utilize the potential energy in rivers by forcing drops in elevation. This can, however, impact the sediment transport in the river, leading to buildup of sediment before the dam and often scour pits behind (Petts, 1984). Homeowners around the ponds and Black Lake both express concerns related to property damage and shoreline erosion.

**Concerns about Sediment**

- Build-up and potential release behind dams
- Cost associated with sediment removal
- Shoreline erosion and property damage
- Vegetation growth and effect on recreation
- Inhibited nutrient transport into Black Lake

Even without formally studying the Black River system, residents and river-goers intuitively know this area well. Homeowners are aware of the vegetation growth, varying stream and pond depths, and have watched the erosion and deposition over time. According to some impoundment property owners, they have an idea of where the river would form, if the system returned to free-river system. This idea is largely based on the presence of vegetation growth in areas that have collected sediment build-up, and outline where the deepest part of the river would form. Some residents have an awareness of the transport of sediment in Black River, particularly at depositional sites like the river mouth or erosion sites at certain bends in the river.

## Sediment Build-up

Most stakeholder groups expressed concerns regarding silt build-up behind the dams. Many worry about who is responsible for maintaining appropriate water level and capacity in the ponds. Others expressed concerns about the potential for contaminants or toxins to be present in the sediment build-up due to local knowledge of a former landfill site near Tower pond. Additional worries were expressed regarding the physical maintenance of the dams along with addressing the buildup of sediment, to reduce risk of damage in the—albeit unlikely—case of a dam breach. Residents assume the dam owner would cover the cost of maintaining the ponds behind the dams, including removal of sediment; however, the responsibility of who would bear the cost of removal has yet to be determined.

Concerns regarding the transport of sediment and chemical loads are supported by scientific literature. In a free-flowing system, nutrient rich sediments can be carried downstream, and the deposits can offer diverse types of habitat (Eckman, 1983). By introducing a dam and creating an impoundment, the backwater storage allows for sediment and chemicals to settle out behind the dam. Build-up of sediment deposits behind the dam reduces the water-storage capacity, as well as reducing the ability to produce hydroelectric power (Ligon, 1995). This collection of sediment is rich in nutrients and provides substrate for vegetation to grow. In the case of dam removal, the sediment released has potential to alter or burry habitat for spawning, feeding, or staging. Downstream of the dam, the changes to substrate can vary, depending upon the flow regime and can create highly unstable habitat (Bain et al., 1988).

**Sediment Removal in Impoundments**

Sedimentation was brought up by a few interviewees as a significant issue needing to be addressed, especially in Tower Pond. This not only affects the recreational benefits of the impoundments, but can also result in increased maintenance costs for dam operation itself as sediments damage turbines and other equipment (HydroCoop, 2013). Furthermore, in event of dam removal, sediment must often be managed to minimize downstream sediment loading and resulting ecological impacts, such as fish kills. One method for addressing sedimentation in the reservoir is dredging. This can be a significant expense for dam owners, with estimates at around $6 per cubic yard of material (ASDSO). This value is likely assuming the sediment is free of contaminants. Other reported values for sediment management range from $1-25 per cubic yard for clean sediment and $50-500 per cubic yard for contaminated sediment (Melchior et al.).

To apply the $6 value to Tower and Kleber dams, we determined what a “typical” dam maintenance requires in terms of sediment removal. ASDSO reports that a slightly smaller dam (22 feet high) required removal of a total of 5,000 cubic yards (ASDSO). If we extrapolate this value to Tower and Kleber dams based solely on height (29.3 and 40 feet, respectively), that amounts to a cost of approximately $39,954 and $54,545, respectively (or 6,659 and 9,091 cubic yards). It should be noted, however, that height does not directly correlate to the size of the impoundment itself depending on topography and other factors. As a result, it is important to conduct a more extensive study of the sediment loading for Tower and Kleber dams to better understand the amount of sediment that would need to be removed for maintenance or removal reasons. This study should also attempt to approximate the life-expectancy of the dams in terms of acting as a sediment trap and losing storage capacity.

Given that this is a two-dam system; it is possible the owners would need to dredge both dams separately. However, some interviewees hypothesized that Tower dam functions as a sort of sediment trap which collects sediment before reaching Kleber pond. This seems to be corroborated by a corresponding lack of concern about sedimentation in Kleber pond. Alternatively, the lack of sediment build up in Kleber may simply be a function of the younger age of Kleber pond. However, there is still suspended sediment in the water of Kleber pond, as the sturgeon hatchery notes the importance of filtering out sediment from the water it pumps from the reservoir (MSU, 2017)

Alverno dam also acts as a sediment trap downstream of Black Lake, but does not seem to present cause for concern. In 1995, an engineering feasibility study looked at the status of the Alverno dam and determined that there was a small amount of sediment stored behind dam, which was unlikely to require removal by dredging (Fargo, 1995).

**Erosion and Property Damage**

Furthermore, residents are concerned about the potential for erosion along the river and have an interest in avoiding damage to their property resulting from stream bank erosion. Downstream of the dam, hydrologists refer to the water as “hungry water” because of its apparent eroding power. The erosion damage is due to the rate of erosion remaining constant, and the rate of deposition decreasing, since material accumulates in the reservoir (Poff and Hart, 2002).

**Vegetation Growth**

Both seasonal and permanent residents have expressed concerns regarding the rate of vegetation growth in Black Lake along areas of sediment deposition close to the mouth of Black River. The nutrient-rich sediments are deposited at the river mouth and northwestern beaches and provide nutrient-dense substrate for accelerated growth of vegetation. Residents lament over disused beaches, often ignored due to weedy shallows. Boaters are concerned about clearing their propellers and avoiding catching weeds. Vegetation growth is also apparent in the impoundments behind the dams. Residents have noticed Tower pond getting shallower and increased vegetation growth in collected sediment.

## Current and Future Research

A research project at the streamside hatchery at Kleber dam is investigating the substrate characteristics of Black River downstream of Kleber dam. Through side-scan sonar techniques, researchers are looking to characterize the substrate along Black River, as well as gather data on depth and bottom hardness, in order to understand the longitudinal pattern. By calibrating readings with known substrates—cobbles, sand, silt, etc.—researchers can create a "map" of the river around the dams. With information about the substrate, cross-sectional depths, and energy requirements for sediment transport, a model may be developed to understand the dynamics of the system given potential future changes. Software programs developed by the Hydrologic Engineering Center (HEC) within ACOE would be useful to visualize the flow regime, sediment distribution, and useable habitat under free-flowing and dam conditions.

**Key Stakeholder Interests**

- Avoiding sediment deposition and related fish kill
- Avoiding contaminated or toxic sediment

**Key Questions Moving Forward**

- What would happen to the built-up sediment and who would deal with it?
- Are there toxins or contaminants in the sediment in the ponds? If so, how will they be dealt with and who will deal with them?

# RECREATION

Recreation is woven into the character of the Black Lake watershed, where a variety of activities have long been enjoyed by local community members and visitors. This section explores recreation's current use, future considerations, and economic impacts.

## Current Recreational Use

The Black Lake watershed currently facilitates a variety of recreational opportunities that provide many social and economic benefits to nearby communities. In the area overall, activities include fishing, boating, hiking, biking, snowmobiling, ATV use, wildlife viewing, and sturgeon-related events. Pond recreation, recreational fishing, and recreational boating are especially rich opportunities that should be considered in the dam decision-making process.

### Pond Recreation

Tower and Kleber ponds support many types of recreation that are highly valued by the area's residents and visitors. Fishing, as described below, is a common pastime for local residents and visitors. The ponds are also used for many different types of boating including rowboats, jet skis, canoes, kayaks, sailboats, rafts, and stand up paddleboards. Family or community events, such as the Mother's Day canoe race, take place on or around the ponds. Many residents shared how much swimming goes on in the ponds, especially Tower, where children swim every day in the summer and even jump off the bridge to have fun. During the winter, popular activities include ice skating, ice fishing, and snowmobiling. The dam owner facilitates these recreational activities through public access points and amenities such as boat launches and portages (FERC, 2015a; FERC, 2015b).

In addition to these water-based activities, state land around the ponds offer primitive camping. The local parks and recreation department is currently working on sites around the ponds to turn into community parks. The Rails to Trails program is adding to recreation opportunities in the area, stretching from Detroit all the way to Mackinac. Trails such as the North Eastern State Trail and other nearby trails provide ample

opportunities for snowmobiling, biking, hiking, and ATV use. People also value the ponds for the habitat they provide for wildlife like loons, eagles, and deer.

**Dam Owner Recreation Report**

*Tower Pond (FERC, 2015b)*

- 964 total visits in 2015
- Popular recreational amenities: boat launch area, reservoir fishing, trails

*Kleber Pond (FERC, 2015a)*

- 1,490 total visits in 2015
- Popular recreational amenities: tailwater fishing, visitor center, boat launch area

The dam owner recently reported on recreational use of the Tower and Kleber dams and associated impoundments for FERC (FERC, 2015a; FERC, 2015b). The reported use for these dams is based on a variety of methods, including visitor counts, surveys, attendance records, and staff observation. According to these reports, 95% of the shorelines for each of the impoundments (2.72 miles for Tower and 6.74 miles for Kleber in total) are available for public use, which likely promotes the amount of use reported. In total, there were 1,490 visits to Kleber and 964 visits to Tower in 2015 (FERC, 2015a; FERC, 2015b). During the most popular weekends, there were an average of 63 and 69 visits over a full weekend to Tower and Kleber, respectively. These reports reinforce that the ponds are locations for a lot of recreational use. Some residents noted that recreational use of the ponds has increased over time.

**Recreational Fishing**

Regardless of their preferred fishing methods, all the fishermen we spoke with agreed on one thing: fishing is important to them for both recreational and cultural reasons. They all mentioned in some way that fishing is woven into the identity of the area, whether the people fishing are local residents or visitors. One resident told us, “The first thing people ask when they find out I’m from here is: how’s the fishing?”

The Black Lake area is home to a passionate and polarized fishing community, which implies differing priorities for fishery management. Fishermen tend to have favorite target species and are generally indifferent toward the others. People also have different views depending on whether they prefer lake or river fishing, bait or fly fishing--the attitude and recreation experience is different for the two methods. Overall, these preferences often seem central to a person's identity as a fisherman, and sometimes is manifest as a rivalrous or negative attitude toward other types of fisherman.

*Stream Fishing*

The Upper Black River, including Tower and Kleber ponds, is designated as a trout stream (Fisheries Order 210) and is "among the best brook trout streams in Michigan" (MDNR, 2017f; MDNR, 2017g). One seasonal visitor mentioned, "there's great brook trout fishing on the Black River, there's a secret spot I like to go to on the Black. I can't tell anybody about it."

**Major Species**

- Brook trout
- Bluegill
- Common shiner
- Yellow perch

Fly fishing is commonly done in the Upper Black River; reaches above Tower Pond remain cold and unaffected by beavers and logjams, offering habitat for brook trout. Some enthusiasts describe fly fishing as experiential, challenging, and even spiritual. One seasonal visitor describes his fly-fishing experience on the Black: "It makes it more of a challenge, because to get to those trout, they are embedded under that bank under all these briars growing overhead and there's a river and muck and rocks and stuff and it makes it so hard to get them that, when you do get them, it's just way worth it."

> ***"The Upper Black River has long been considered one of Michigan's finest brook trout fisheries."***
>
> ***- Upper Black River Council***

Although fly fishing can also be a passionate pastime of local residents, fly fishing seems to be more popular with visitors and seasonal residents than with year-round residents. One seasonal resident discussed his love for fly fishing but explained that he has to go to the headwaters: "I'm a fly fisherman, so I love the natural lands at the headwaters of Black River. You can't really find brook trout by the ponds." Fly fishing on the Upper Black has been historically popular as well, with Ernest Hemingway fishing and writing about his experiences there in his 1935 book, "Green Hills of Africa."

> ***"It's just like when we were kids and we heard about a river no one had ever fished [the Black] out on the huckleberry plains beyond the Sturgeon and the Pigeon."***
>
> ***[…]***
>
> ***"Big trout?"***
>
> ***"The biggest kind."***
>
> ***"God save us," said Pop. "What did you do then?"***
>
> ***"Rigged up my rod and made a cast and it was dark and there was a nighthawk swooping around and it was cold as a bastard and then I was fast to three fish the second the flies hit the water."***
>
> ***- Ernest Hemingway, "Green Hills of Africa" (p. 150-151)***

*Lake and Pond Fishing*

Where fly fishing is described as challenging and engaging, lake or pond bait fishing is described as relaxing, social, and a way to catch your dinner. Landowners along local lakes and impoundments generally prefer bait fishing. Some local residents perceive pond fishing to vary seasonally as well, noting that they see it as most socially and economically important in the winter when ice fishing is possible. One interviewee caught a "29-inch walleye out here ice fishing" and describes how their whole family enjoys the sport: "our kids come up a lot now...ice fishing, they come up just for that."

> ***"Sometimes we've gone up there [Tower] because they have a lot of good bass size. Five-, six-pounders. It's a lot of fun to go up there and try for them there."***
>
> ***- local resident***


K. He

Black Lake offers many opportunities for fishing several types of fish including muskellunge, northern pike, yellow perch, walleye, and bass (Cwalinski and Hanchin, 2011). Black Lake is also known for its short spearfishing season for targeting lake sturgeon. The most popular of these

fisheries in Black Lake are walleye and muskellunge. To indirectly protect other species, the limits on northern pike, a predatory fish, are relaxed to encourage fishing for pike thereby controlling population size. Pike are common in Black Lake in the vegetated shallow areas.

**Major Species**

- Muskellunge
- Northern pike
- Yellow perch
- Walleye
- Smallmouth bass

Tower pond is included in the Black River system that is known for a wild brook trout population and is currently included in the designated trout stream (Fisheries Order 210; MDNR, 2017g). Designation as a trout stream means that the conditions and habitat support a trout population, which can be fished within limits. These often include relaxed limits on Northern Pike in an attempt to lessen the predatory pressure they place on trout. Tower pond offers open access to all fish from April through September, but remains open to northern pike spearing in winter months (Fisheries Order 214 and 219; MDNR, 2017g). Based on the small number of catch reports from this pond, interest in fishing opportunity in this pond is relatively low. More information on the quantity and economic impact of fishing is described below.


**Recreational Boating**

Boating is a popular recreational activity in the Black Lake watershed. Similar to fishing, boating experiences are different on a river than on a pond or lake. Pond landowners take their boats out to fish on the ponds. Other types of watercraft used on the ponds include canoes, kayaks, rowboats, jet skis, sailboats, rafts, and stand up paddleboards. Residents seem to have less strong preferences for boating than they do for fishing, and seem more likely to do multiple types of boating. For example, some Black Lake residents take their powerboats or jet skis on Black Lake, but also enjoy kayaking on the Black River.


Other local residents especially enjoy canoeing on the Upper Black River below Kleber dam to see things like fall colors, sturgeon, and wildlife. Kayaking and canoeing is generally more popular on the river than the ponds or Black Lake, especially since most of the land along the river is "natural" undeveloped state land that is considered beautiful for exploring in this type of boat. However, several canoers and kayakers describe current difficulties with navigating the river due low water levels that require dragging boats along the upper reaches of the Upper Black River.

## Future Considerations

The decision to relicense or remove the dams would affect the variety of recreation currently occurring at the ponds and surrounding watershed. Tradeoffs would likely occur with new river-based recreation replacing some pond-based activities. Pond property owners, local community members, visitors, and others all express concern for losing pond recreation. However, some also express excitement about new opportunities that could come with dam removal. This section explores those concerns and opportunities.

### Stakeholder Concerns

*Concerns about Overall Recreation*

Recreation is an integral part of why people love living near or visiting the ponds. It follows that there is a great deal of concern over the potential disappearance of the ponds and the activities associated with them. Beyond the social and cultural value, the ponds' recreational opportunities are also important for the local economy. One resident explained that this is especially true for the town of Tower where "there is no economy other than recreation and tourism...if you take away the pond there would be nothing left."

Residents share perceptions of community changes over time, including demographic shift and a decline in industry (see Appendix III), which underlie and likely amplify current concerns. People describe some features no longer present at the Kleber pond, such as a swimming beach, the

Shanty Rapids, and a pavilion. People seem to miss the pavilion, at which dances, parties, and other events were held; it has not been replaced by any new gathering place. Some also perceive, with some disappointment, that Tower pond used to be deeper and cleaner than it is today. These past changes lay the groundwork for strong concerns that more will be lost.

Members of nearby communities express concerns about changes in public access to the ponds with a potential dam removal. Any changes to public access, especially increased land area from potential shoreline or mudflat, should be carefully considered; landowners are worried about increased trespassing, which has been an issue in the past with boaters and fishermen. People also raise the question of how camping and access would change on the state land adjacent to the pond. Several canoers and kayakers, explaining that the Upper Black River is already very shallow and difficult to navigate, wonder how river levels would change and affect boating opportunities. Many people, even those who do not live directly on the ponds, call for decision-makers to give adequate weight to the rights and concerns of pond-front property owners.

*Concerns about Fishing*

People are concerned about how fish communities would change in the case of dam removal. People who target river species express excitement to see a return to a free-flowing system and an increase in river miles. On the other hand, people who fish the two ponds would be upset if the ponds disappeared. Some pond fishermen have perceived that fishing has already declined, and worry about how future dam scenarios would make that worse. They enjoy fishing the ponds for bluegill, bass, and pike, and are concerned about future management of those species especially if the dams were removed. They also tend to be indifferent to trout or other river fish and do not see those as management priorities that should influence the decision about the dams. Even some local residents who value both types of fishing believe there is already enough river fishing in the area, so the focus should be on managing pond and lake fisheries: “I go a couple miles in any direction and I find all the river fishery I want.” Although they generally favor free-flowing streams, local environmental groups also acknowledge that it is important to consider the benefits the dams bring and the possible impacts of removal. One member of a local environmental organization wondered, “would we have colder water without the dams? Would sturgeon handle it? Would we have trout? Would it be a mixed fishery?” They wonder if the dams might actually benefit fish species they care about by maintaining warmer-water habitat and trapping sediment so that rocky bottom habitat is preserved.

**Perceived Opportunities**

Dam removal has the potential to bring several new recreational opportunities to the area. New recreation seems to center on increased river mileage, allowing boats to travel farther without portaging and offering fly fishermen access to more trout habitat. Future visions also include the potential emergence of whitewater at the dam sites. These recreational opportunities highlight some social and economic benefits that could be brought about by dam removal.

*Increased River Miles*

Many fly fishermen seem to be in favor of dam removal because returning to a meandering, free-flowing river could increase trout habitat. A free-flowing river means you can canoe, kayak, or otherwise boat farther. Without Tower and Kleber dams, people would have uninterrupted boating access to more river miles on the Upper Black River. Many local and tourist boaters would be excited to have this opportunity. However, several residents and seasonal visitors express concerns about logjams and shallow stretches below Kleber dam that currently prevent passage and wonder how these would play into a dam removal scenario. Opening additional areas of river including whitewater could add another form of recreation, aesthetic appeal, tourism, and business potential.

Aside from the dam decision, some residents also envision exciting opportunities for marina development on Black Lake and elsewhere that could facilitate increased boating access and popularity. They believe this would expand business opportunities if the relevant towns, organizations, and agencies focused on developing this kind of infrastructure.

*Future Whitewater Opportunity*

It is also important to understand the state of the river channel under the impoundments. Dams are generally built in river segments with the highest gradient in order to provide the greatest potential for hydropower. It is therefore likely that a significant gradient is submerged beneath one or both of the dams, producing rapids and whitewater.

Some community members remember the Shanty Rapids just upstream of Kleber dam, which would likely be exposed if the pond were drained. They also describe a vertical drop-off or waterfall that would be uncovered at the site of Tower Dam. Many people express excitement in rediscovering the aesthetic and community value of these sites through drawing down Tower Pond. This could present a unique opportunity for communities in the area to add recreational activities, community spaces, and tourism. For example, the City of Petoskey created a whitewater park by removing five dams along a quarter-mile stretch of river through the downtown. The plan for the park, drafted in the 1980s and finished in 2011, was well-supported by community members and has become an exciting community asset for local residents and visitors alike (City of Petoskey).


*Future Economic Opportunities*

Recreational opportunities for both residents and tourists, especially surrounding boating and fishing, could also help strengthen the local economy. The area's current recreational activities support some businesses, especially related to fishing such as Parrott's Outpost and Northeast Flyfishing in Onaway. However, several respondents expressed that, based on the level of interest in these activities, these types of businesses may be able to expand and grow. Some people in the community even perceive a decrease in tourism lately, which might be related to a decrease in fishing and has led some local businesses to close. Community members have identified a variety of avenues to help expand these businesses. Some people call for the development of boating infrastructure or a Black Lake marina. Whitewater creation and increased river miles could allow for new boating outfitters. Some fishermen say improving fish populations other than sturgeon would help business the most. Other community members believe improving the sturgeon population and habitat would be the biggest benefit based on an associated increase in spawning run tourism.

## Economics of Recreational Activities

Since dam removal can create opportunities for new forms of recreation, it is important to understand the potential for dam removal to impact the local economy through those changes to recreational opportunities (Headwaters Economics, 2016). Our analysis relies on the fact that there are already river- and pond-specific forms of recreation in the watershed, as discussed above. Specifically, we focus on our understanding of fishing in the region, as there are data we can use to estimate the relative economic value of river fishing and pond fishing. These estimations are driven by an assumption that the value of river-specific fishing (e.g. flyfishing) can be calculated by subtracting the value of pond fishing from the value of fishing overall in the watershed. Before proceeding, this is purely an illustrative calculation that can, and should, be refined through a clearer understanding of the popularity of these different types of fishing.

These estimates rely on state-level data and are extrapolated to this watershed based on the population of Forest Township (see Appendix III) relative to the statewide population. These numbers are also extrapolated to Tower and Kleber ponds through our understanding of property ownership along their shorelines. It is important to note that Forest Township does not encompass all of Tower and Kleber ponds, so it is technically a mismatch to compare the population of Forest Township overall with that of Tower and Kleber. However, this does allow for an isolation to purely river and pond fishing without taking into account fishing on Black Lake, which is a very prominent recreational destination. This initial analysis provides a gross estimate that can assist with future discussions, especially as these numbers are refined through fishing surveys as noted above.

### Watershed-level Estimates

Our first estimate is of the revenue MDNR derives through selling fishing licenses to local residents. In 2015, 696,889 licenses were sold to Michigan residents (pers. comm. P. Hanchin, MDNR). For this calculation, we focus on the "Resident Annual" fishing license[5], which costs $26 per year (eRegulations, 2016). In addition, we assume that a large proportion (50 to 75%), but not all, residents in the area participate in fishing. Therefore, if using the Forest Township population of 1,045 residents, we assume that between 522 to 784 residents purchase fishing licenses annually, resulting in between $13,585 to $20,378 in annual revenue for MDNR (eRegulations, 2016).

[5] There are other types of fishing licenses that are shorter term or for specific demographics that are not included in this calculation in order to make the calculation more simplistic.

In order to estimate the importance of fishing inclusive of its other economic impacts, we can create a rough estimation based on the overall value of recreational fishing in the Great Lakes Basin, which has been studied. A recent literature review of recreational fishing studies in the Great Lakes Basin pegs the net value of recreational fishing at between $20 and $75 per day in 2012 dollars (Poe et al., 2013). Furthermore, the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, as conducted by US Fish and Wildlife Service (FWS) and the US Census Bureau, estimates a total of 19.7 million angler days distributed across 1.7 million anglers, or 11.6 angler days per angler (US Department of Interior et al., 2011). Using the estimate of total fishing participation by local residents, we estimate between 6,055 and 9,082 angler days per year in this watershed, resulting in between $121,097 and $681,171 in economic value to the region (in 2012 dollars).

**Impoundment-level Estimates**

Using the number of developed parcels along the shores of both impoundments (75) and the average household size of Forest Township (2.32), we estimate that the impoundment population is 174 (US Census Bureau, 2010). For the purposes of this calculation, we do not include non-waterfront landowners or owners of non-developed parcels and assume that between 75 to 100% of these 174 residents fish.[6] Based on those numbers, fishing on the impoundments results in between 130 and 174 licenses, or between $3,393 and $4,524 in annual revenue to MDNR (eRegulations, 2016). When incorporating broader economic impacts associated with fishing, we get a range of between $30,245 and $151,226 annually when using the same method as described above for the watershed-level estimate.

**River Fishing Estimates**

The economic value of river fisheries varies seasonally, and is highest in the spring when trout season opens. River fisheries provide unique opportunities for local businesses through fishing supply stores or potential local guides to take people out on the river. These opportunities are amplified by river fishing because it entails specialized gear and requires more guidance and

[6] While both of these assumptions may be unreasonable, they likely counteract. Based on our conversations, we do recognize that non-waterfront landowners do engage in fishing on the ponds. Furthermore, it is also possible that waterfront landowners that have not developed their property parcels also engage in fishing, but we are assuming that the addition of permanent structures on a parcel is a signal of an interest in recreational activities specifically on the ponds as opposed to elsewhere. On the other hand, we have already shown that some developed parcels are owned by seasonal residents and may come up to fish infrequently relative to others. Some local residents also indicated that they do engage in fishing beyond the boundaries of the ponds, so attributing their entire fishing to the ponds may also be an overestimate.

support. Unfortunately, as we do not have a way to estimate the number of river fishermen in the area, we are unable to estimate the economic value of this specific fishery from a use standpoint. Instead, if we assume that river fishing is any non-pond fishing that occurs in this watershed, then the value of river fishing is between $90,852 and $529,944 if subtracting the impoundment-level estimates from the watershed-level estimates.

**Value of Different Types of Fishing**

Another way to compare pond fishing and river fishing is to evaluate the values of different fish. In addition to reporting the value of an average fishing day, Poe et al. (2013) also reported the value per fishing day for specific fish as well. A few categories that are most relevant to this watershed are reported below:

- Trout: $48.30
- Other coldwater: $47.25
- Bass: $67.99
- Walleye: $74.03
- Other warmwater: $50.40

**Takeaway**

The values presented above are largely speculative and serve as an estimate to better understand the relationship between fishing and its impact on the local economy. Further analysis should compare estimates to other fishing communities and economies and evaluate the importance of riverine fishing (as opposed to impoundment fishing) as well. Furthermore, this initial analysis only explored the relative importance of different forms of fishing, but fishing is only one component of recreation, which is also just one component of the overall economy of the watershed.

**Key Stakeholder Interests**

- Maintaining ability to fish
- Maintaining/improving pond fish populations
- Improving trout populations
- Ensuring scientifically-sound, balanced fishery management
- Improve fishing tourism
- Maintaining ability to swim
- Maintaining ability to boat on ponds and river
- Maintaining ability to camp
- Maintaining vibrant recreation scene at Tower Pond
- Strengthening/maintaining the economy
- Adding additional recreation opportunities (like whitewater/Shanty Rapids)
- Improving canoe/kayak opportunities and having adequate river depth

**Key Questions Moving Forward**

- Would boating opportunities increase with dam removal?
- What whitewater opportunities would emerge with dam removal?
- The river is already very shallow for canoeing; what would the new river depth be? How would the channel and velocity change?
- How would fishing access change if dams were removed, especially for pond landowners?

## GENERAL ECOLOGICAL HEALTH

Regardless of their specific uses, local groups generally support the broad goals of maintaining a healthy environment, retaining a strong community identity, and fostering a connection to the natural world. Local environmental groups' interests may seem to simultaneously be positively and negatively impacted by the dams, but a closer look may explain nuances. Impacts of dam removal on the overall ecology of Black River and the potential impacts of invasive species should be considered during the decision-making process. Most stakeholder groups express an interest in maintaining overall ecological health and prefer a decision that would improve ecological health or prevent invasive species.

> ***"A healthy stream is an ecosystem that is sustainable and resilient, maintaining its ecological structure and function over time while continuing to meet societal needs and expectations."***
>
> ***- Meyer, 1997***

While there is an interest in improving "ecological health," no formal definition or common understanding was identified. Ecological health is typically understood by ecologists by using indices which account for metrics such as diversity, species richness, or ecosystem function. Indices offer a way to quantify health, which is sometimes described as resilience, or the capability of self-restoration after suffering external disturbances. Often, species that are particularly sensitive to pollutants or other conditions are used as indicator species. As a slow growing species with cultural value, lake sturgeon can also be used as an indicator. Other metrics, like disease, build-up of waste, or loss of key species, serve as indicators of poor health. For river ecosystems, indicators using physicochemical, biological, habitat availability, or flow regime metrics can track changes in health.

**Indicator Species:** an organism whose presence, absence or abundance reflects a specific environmental condition. May be used as a proxy to diagnose the health of an ecosystem.

Furthermore, the meaning of ecological health may be understood as it relates to the values and interests of communities utilizing the river: "A healthy stream is an ecosystem that is sustainable and resilient, maintaining its ecological structure and function over time while continuing to meet societal needs and expectations" (Meyer, 1997).

## Ecological Health and Natural Character

Residents and environmental groups care about water quality criteria, sustainable fish populations, and maintaining the overall natural character of the lake; residents enjoy Black River's recreation opportunity and beauty. As discussed in previous sections, homeowners and tourists feel a deep connection to this area because of the "wildness" and natural character. Regardless of the presence of dams and measures of ecological health, the community craves certain aspects of this area that define their wildness. Residents on the impoundments and Black Lake both take enjoyment from living close to plentiful wildlife, such as wild turkey, deer, songbirds, ducks, wood turtles, and eagles.

**Riparian Zone**: the interface between land and a river or a stream which serves an important ecological role through soil stabilization, biofiltration of water, and support of biodiversity

Scientific literature on the subject suggests dam removal would benefit ecological health overall, not just for aquatic species (American Rivers, 2002). In free-flowing systems, large precipitation events or rapid spring snowmelt could lead to flooding events, where water spills over the stream bank and inundates the riparian areas. These transitional areas are crucial for ecosystem health due to the heterogeneous habitat provided and ability to support various life-stages for macroinvertebrates, fish, birds, small mammals, etc. Terrestrial species often depend on these species and riparian areas for access to resources and nutrients. Dams allow for water storage during high flow events, a process referred to as peak flow attenuation, which reduces the frequency of inundation of riparian areas and may mean that certain macroinvertebrates and riverside vegetation are less successful (Ligon, 1995). These effects on riparian zones have impacts on terrestrial species like bears and eagles, which residents value for their charismatic value.

The wood turtle, another species valued by community members, could be directly impacted by the presence or removal of dams due to their vulnerability to sediment transport. Wood turtles live in rivers with sandy-bottomed streams and egg-laying occurs in the sunny areas of exposed river sand banks. The population of wood turtles in Michigan has declined in recent years and is now protected by Michigan law as a species of special concern. Wood turtles have seen a reduction of nesting areas through stream bank stabilization, and sedimentation can also impact turtle survival (MDNR, 2017i).

## Invasive Species

Often, the presence of aquatic invasive species is used as an indicator for poor ecological health of a river. Invasive species tend to introduce new interactions with native species, typically outcompeting for resources and habitats. Invasive species could potentially have negative impacts on the ecological health overall. Given the negative economic impacts invasive species are reported to have on the interests of various stakeholders in this watershed (e.g. recreational fishing), any potential protection offered by Tower and Kleber dams to the areas upstream of each respective dam could result in positive economic benefit. However, this benefit would only be realized if other exclusion and management techniques were utilized.

Some residents expressed concern regarding the introduction and spread of aquatic invasive species in the Black River system and argue for retaining the dams to protect against invasive species introduction. “The only thing that’d be kind of scary is if, I don’t know how quickly or if it would be possible for (sea) lamprey or other species to invade, I’m not sure if they can invade that far, but I would assume they could…” However, this concern may not be directly addressed by Tower and Kleber dams, as downstream dams may have more influence on excluding invasive species.

**Watch List: Invasive species in the Great lakes**

- Zebra and Quagga mussels (genus *Dreissena*)
- Rusty crayfish (*Orconectes rusticus)*
- Sea lamprey (*Petromyzon marinus)*
- Round goby (*Neogobius melanostomus*)

In general, the connectivity of rivers is crucial for certain ecological processes in a riverine system; dams can also offer protection from aquatic invasive species by limiting the spread of such species. However, that protection is circumstantial based on current exclusion and management of other modes of introduction. Some invasive species of concern in the Great Lakes area are zebra and quagga mussels (genus *Dreissena*), rusty crayfish (*Orconectes rusticus),* sea lamprey (*Petromyzon marinus)*, and round goby (*Neogobius melanostomus*).

With the introduction of quagga and zebra mussels in inland lakes—including Black Lake—of the Great Lakes basin, increased water clarity allows for vegetation growth, shifting energy flow into the bottom of the food web. Long-term monitoring at Black Lake has shown a general increase in water clarity since 1997 (Tip of the Mitt, 2016). Increased vegetation growth could support macroinvertebrate populations, reducing the foraging effort of benthivores. However, one study

has shown that juvenile lake sturgeon avoid areas with zebra mussels (McCabe et al, 2006), likely due to the complication of foraging by the presence of mussels. Adult lake sturgeon can utilize zebra mussels as a food source, but the hard-shelled zebra mussels are a less energy-dense food source than the typical soft-bodied macroinvertebrate.

The rusty crayfish, a native of the Ohio River Basin, has become a threat to the Great Lakes Basin and native crayfish species. This species is likely to spread throughout the Great Lakes region due to its aggressive and avoidance behavior, ability to withstand colder temperatures, and ability to outcompete native crayfish species for food and habitat (Bobeldyk and Lamberti, 2008). According to current range map by the Tip of the Mitt Watershed council, rusty crayfish are not currently established in the Black River system, disconnected by Alverno dam, but some individuals have been sighted by residents (Tip of the Mitt, 2016).

Sea lamprey are not present in abundance greater than 200 individuals above the dam in Cheboygan (NILCFAC, 2015). Alverno dam also serves as a potential barrier to the Black River system by preventing upstream fish passage on Cheboygan River. While invasive sea lamprey are not yet present in Black River, lamprey removal could be detrimental to lake sturgeon. Lampricide (3-trifluoromethyl-4-nitrophenol, or TFM) treatments are costly, and TFM has both lethal and sub-lethal effects on lake sturgeon (Sakamoto et al., 2016).

Although not currently present above the Cheboygan dam according to the US Geological Survey (USGS) nonindigenous aquatic species register, the impact of round goby would be complex. Round goby would compete for macroinvertebrate food sources and predate on eggs and larvae of fish such as sturgeon, walleye, and trout. Round goby can also contribute to the bioaccumulation of toxic substances through predation on *Dreissena* mussels (Kornis, 2012).

**Key Stakeholder Interests**

- Maintain species diversity
- Maintaining migratory bird populations
- Prevent invasive species such as lamprey
- Achieving stable new ecosystem
- Avoiding contamination/damage from old landfill
- Maintaining habitat for eagles, wood turtles, ducks, etc.

**Key Questions Moving Forward**

- How would the larger Cheboygan River watershed be affected by potential dam removal?
- Which measures of ecological health are most important for evaluating dams?
- How do you compare new ecosystems to historical before the dams were built?
- How are the dams impacting terrestrial species?
- To what extent do the dams serve an important barrier to the spread of invasive specie upstream of the dams?
- How does shading from riparian trees and shrub affect the aquatic ecosystem? How would that change in a post-dam removal scenario?

# FISH

Fish communities are defined by the assemblages of species and their interactions, and are limited by habitat availability. Habitat selection is based on several factors--water quality, substrate, depth, etc.--and conditions are altered by the presence or absence of the dams.

Fish are the largest and most mobile biological factors in aquatic systems and the assemblages of species can offer insight to the health of the river. Fish contribute to the movement of nutrients through the physical system and food web, and have top-down interactions as opportunistic feeders. Since the fisheries in the Black River system are popular sport fisheries, data from fishing reports can detail current conditions within the Black River system. First, a look at these fish surveys in each respective habitat type will provide an understanding of the current continuum of fish communities. Finally, a discussion of the impact of dams via abiotic and biotic factors on fish communities can illustrate possible outcomes of changes to the system. Understanding how water conditions affect fish species, and how dams affect those conditions, can help predict future dam scenarios for fish communities.

## Current Fish Communities

These physical and chemical conditions (listed here) depend on external landscape scale factors like climate region, topography, geology, hydrology, and primary productivity (or plant growth). On a local scale, these conditions can be altered into microhabitats by in-stream structures such as felled trees, root wads, boulders, constructed weirs, or dams. Individuals within fish populations select habitat by physiological tolerance ranges, availability of suitable habitat, and often compete with other individuals within and between species. Water depth, velocity, and substrate type together determine different habitat types within a river reach. Within a river, for example, riffles and coarse cobbles are found together while pools and sandy substrate are correlated. A limiting factor for fish populations is the availability of habitat that satisfies requirements, such that density-dependent effects are avoided.

**Conditions of Water:**

- Temperature
- Dissolved Oxygen
- Sediment
- Flow regime

**Habitat Selection:**

- Tolerance (Temperature and Dissolved Oxygen)
- Substrate, Depth, Velocity
- Life History
- Life Stage and Behavior

For a given species, tolerance curves detail the depth, velocity, and substrate types in which habitat is usable. Typically, information is presented for various life stages and sometimes describes certain behaviors. For example, tolerance curves for walleye might show usable habitat for adult (Figure 14) versus juvenile, as well as foraging, spawning, or staging behaviors. The tolerance curves for walleye show that deep (>3 meters) and slow (15 cm/sec) water is most suitable. Additionally, larger substrates seem to be more favorable.

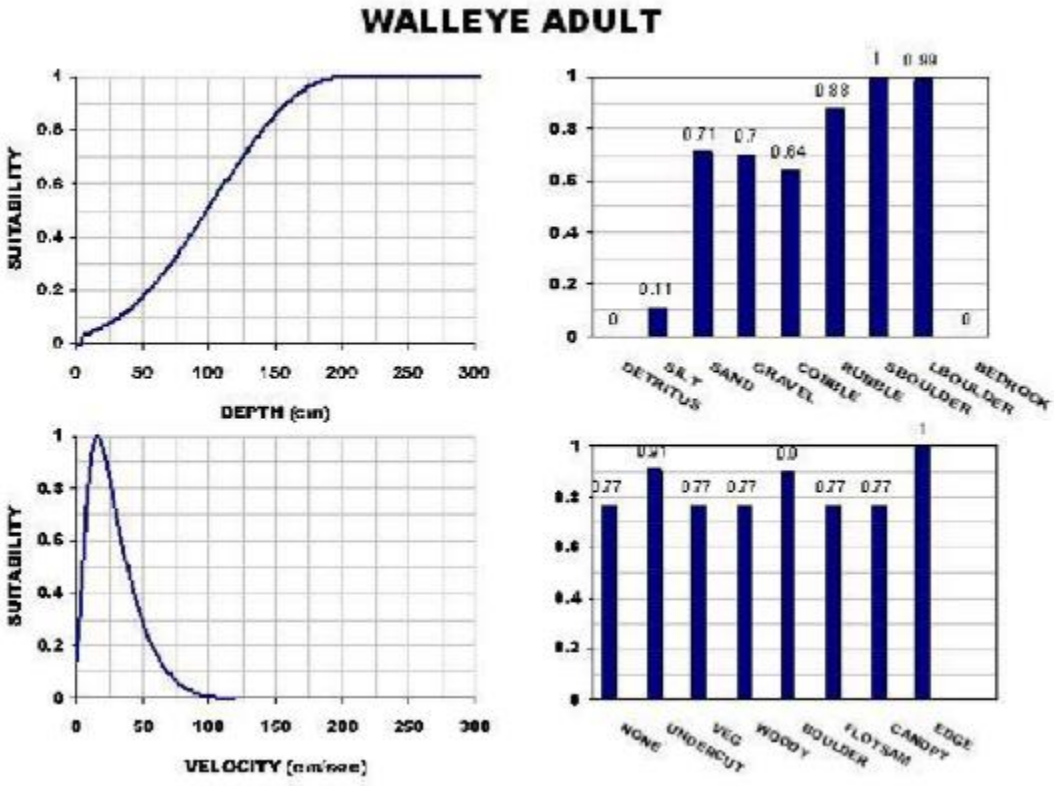


**Figure 14. Tolerance curves of adult walleye (Minnesota DNR)**

Applying these concepts to the Black River system, longitudinal trends in fish communities can be understood in the context of suitable habitat type availability. Typically, species prefer conditions that are either associated with free-flowing river habitat or deep, slow lake or pond habitat. Some species are generalists and do well in both habitat types.

River: The upper reaches of Black River above Tower dam is known for its high-quality brook trout habitat. Differences in the water temperature between the pond and reaches of the Black River allow for seasonal habitat and refuge for brook trout; Tower pond serves as an overwintering habitat for brook trout (Cwalinski, 2012). According to a survey performed on river habitat between

the Tower dam and Kleber pond, common shiner, smallmouth bass, and yellow perch were the most common. The survey described a large amount of vegetation and high turbidity at the inlet to Kleber pond (Cwalinski, 2016).

Pond: Common species found in Kleber pond were Bluegill, Pumpkinseed, black crappie, yellow perch, and rock bass, comprising 78% of the community (Cwalinski, 2016). Northern pike, walleye, smallmouth and largemouth bass made up 4%. Other species present include black bullhead, common shiner, white sucker, golden shiner, and Iowa darter. Kleber pond has a diverse community, but population growth has been slow. Low numbers of predators lead to good recruitment through natural reproduction (Cwalinski, 2016).

Lake: Black Lake is considered a mesotrophic lake with some data trending toward oligotrophic, which means there is moderate-to-low vegetation growth. Adequate vegetation, depth, space, and prey species allows Black Lake to offer habitat to support fish species in higher trophic levels, such as pike, bass, and muskellunge. The oligotrophic nature of the lake may explain the slow population growth of these predatory species.

**Shifting Fish Communities**

Within the Black River system, changes in fish communities have been noticed through the years, with emphasized focus on desirable fishes such as walleye, smallmouth bass, and brook trout. Historically, the walleye population was sustained by wild recruitment. As with any naturally reproducing population, fluctuations in numbers are normal due to cyclical good-year classes and bad-year classes. In recent decades, however, the walleye populations became unstable and the age structure was trending toward adult fish, as shown by a survey in 2005 (Cwalinski, 2005). This implies that wild recruitment was becoming less reliable. Consequently, the walleye fishery is supplemented through stocking efforts; MDNR stocks up to 200,000 spring walleye fingerlings in Black lake annually for three out of the last five years (MDNR, 2016a). The decreased effectiveness of natural reproduction could have been influenced by a number of things; a possible connection was drawn between the introduction of zebra and quagga mussels and the competition for zooplankton (BLA, 2015). In response to the age structure becoming older, the stocking efforts were initiated to recreate a stable age structure. Larger walleye populations may impact smallmouth bass and perch populations through competition for resources.

## Impacts of Dams on Fish

Dams impact the physical and chemical conditions of the river in ways that alter the distribution of fish species. Both creating a lake system by constructing a dam and returning to a free-flowing system by removing a dam will modify fish communities in predictable ways. For context regarding the spatial scale of Black River, the current total length of river habitat is approximately 7.8 miles with 3 miles of pond habitat (Figure 3). The section lengths are currently as follows: Tower pond: 1 mile (102 acres), Tower dam to Kleber pond: 1 mile, Kleber pond: 2 miles (295 acres), and Kleber dam to Black Lake: 6.8 miles.

Returning to a free-flowing river would imply an increase in the mileage of river habitat, first from conversion of ponds to river and also lengthening due to natural meander. However, this would also imply a trade-off of pond habitat. In addition to the changes in relative amounts of pond and river habitat, the physical and chemical conditions in-stream would be altered in ways that could be predicted using modeling software in future studies. Many fly fishermen express curiosity about dam removal based on the potential to increase trout habitat by returning to a free-flowing river, while others express concerns about losing access to pond habitat species.

**Dam impacts on water quality factors:**

- Warmed water downstream of dams
- Low dissolved oxygen downstream of dams
- Sediment deposited upstream of dams and erode sediment downstream of dams
- Reduced variability of discharge

### Temperature and Dissolved Oxygen

These two water quality criteria are well understood and have clear implications for fisheries; rivers downstream of dams, tend to have higher temperatures and lower dissolved oxygen. Even in shallow ponds, lake stratification can occur due to gradients in temperature and density of water (Branco and Torgersen, 2009). Water held in the impoundments is delayed and warmed at the surface by sunlight. Cooler, denser water tends to sink to lower layers. Effluent temperature, dictated by the height of the intake, can have direct influence on the fish communities throughout the system. Kleber pond does experience some thermal stratification (pers. comm. T. Cwalinski). Tower does not tend to stratify, but still accepts thermal input.

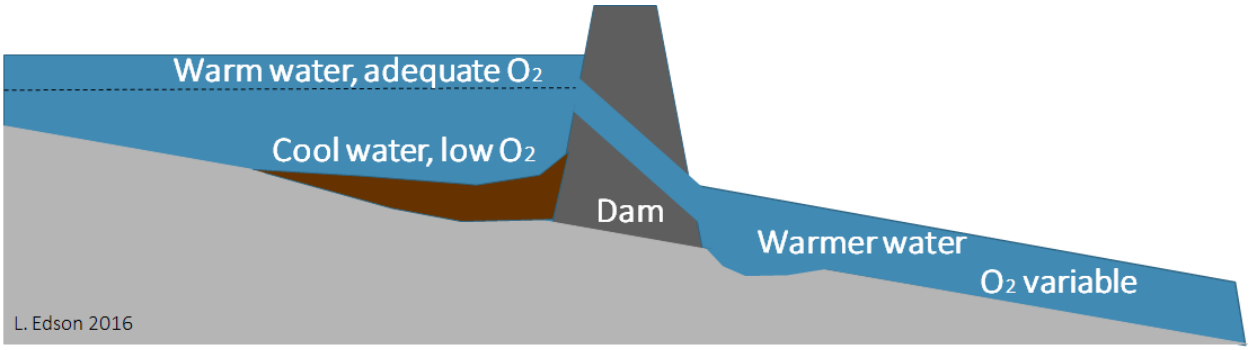


**Figure 15. Trend of impact of dams on temperature and dissolved oxygen**

In addition to the temperature of the water being impacted by the impoundments, the concentration of dissolved oxygen in the lower portion of water can be affected. If stratification occurs and mixing between layers is reduced, this could imply low concentrations in dissolved oxygen in the effluent, which can directly impact the ecology immediately downstream of the dam. Ensuring the water temperature and dissolved oxygen is appropriate for certain fish species downstream of the dams is an implied concern for stakeholders who express concern for desired target fish.

**Sediment and Discharge**

Structures in rivers typically result in a transfer from potential energy to kinetic energy and has implications on the ability to transport sediment; rivers will deposit sediment upstream of dams and erode sediment downstream of dams. Additionally, the discharge, or amount of water coming from the dam per unit time, can also influence the suitability of habitat zones for certain species. While the Tower and Kleber dams are operated as run-of-river, there is some attenuation, or storage, of peak flows in storm situations that reduce the variability of flow downstream. Tolerance curves typically describe the habitat requirements by depth and velocity, both of which can be impacted by in-stream structures. Future studies can utilize an understanding of the tolerance curves, sediment transport, and hydrology in order to predict the impacts of dams or dam removal either through general assumptions or by using modeling software such as Hydrologic Engineering Center Ecosystems Functions Model (HEC-EFM).

**Key Stakeholder Interests**

- Maintaining opportunities for pond fishing
- Improving pond/lake fish populations
- Improving trout populations
- Ensuring scientifically-sound, balanced fishery management

**Key Questions Moving Forward**

- What are the realities of shifting fisheries and what are the causes?
- How would water temperature, sand traps, and changing habitat affect fish diversity?
- What is stratification like in the ponds and how does it affect fish?

# STURGEON


## STURGEON SNAPSHOT

*Social & Cultural Significance*

- Culturally and spiritually important for tribal nations
- A community icon: Shivaree, spawning run, sturgeon in the classroom, hatchery
- Historically fished for subsistence and other products

*Life History*

- Live up to 100 years
- Late-maturing:  15-20 years for males, 20-25 years for females
- Up to 8 feet and 260 pounds; growth rates depend on temperature, food availability, and water quality
- Bottom-feeders (benthivorous)
- 10-20% of adults migrate into the rivers to spawn in spring

*Habitat Preferences*

- Dimly lit, moderately turbid, warm (10-16°C), nearshore (15-30 feet deep) water
- Gravel or rapids in rivers for spawning
- Juveniles require sandy habitat to avoid predators
- Relatively tolerant of temperature changes, sensitive to dissolved oxygen decreases

*Black Lake*

- Population: 1,113 adults based on unpublished data from the 2016 spawning run
- Spear fishing season: quota of ~1.2% (14 individuals in 2016; 7 to state, 7 to tribes)
- Sturgeon currently have access to about 11 km of river upstream of Black Lake
- Challenges: limited spawning and nursery habitat

*Rehabilitation Effort*

- Threatened in Michigan, Black Lake is home to MI's largest inland lake population
- MDNR's Sturgeon Rehabilitation Plan
- Management Plan for Lake Sturgeon in Black Lake
- Formal statements by the Grand Traverse Band and Little Traverse Bay Band

Lake sturgeon draw attention in the Black Lake area for ecological, social, cultural, and economic reasons. Sturgeon are threatened in Michigan as the result of historic poaching activity, dams, and other pressures, leading to an emphasis on rehabilitation through research, management, and education initiatives by groups such as MDNR and Sturgeon for Tomorrow. This section first describes the social and cultural value of sturgeon, through events like the annual spawning run and spearfishing Shivaree. This is followed by a discussion of the current status of the Black Lake population, with emphasis on habitat limitations, hatchery role, current research, and stakeholder concerns and perceptions. For a scientific background on lake sturgeon, see Appendix IV.

## Social and Cultural Value

Sturgeon are a prehistoric creature dating back to the Triassic era, looking something like a cross between a dinosaur and a shark. Reaching six feet long, they are the largest freshwater fish in North America and can live to be about a hundred years old. Their distinctive appearance, ancient history, ecosystem presence, and human-like age and size make sturgeon fascinating and special for local residents and tourists alike. The species has become a community icon in the Black Lake watershed, with Onaway calling itself the “Sturgeon Capital of Michigan.” Similarly, tribes such as GTB and LTBB have an interest in sturgeon because of their unique qualities, ancestral connections, totem associations, and implications for fishing rights. Many different groups are excited to witness the seasonal spawning run and care deeply about this fish’s survival.


### Sturgeon Education

As an iconic local species and important member of the ecosystem, sturgeon also serve an educational role in Michigan communities. Sturgeon in the Classroom, a statewide cooperative initiative between Sturgeon for Tomorrow and MDNR, has been placing young sturgeon in K-12 classrooms since 2013. Schools as far south as Detroit adopt a fingerling raised at the hatchery, manage the feeding, water conditions, and tank maintenance through the year, and release the sturgeon at the end of the school year. The program aims to increase awareness, understanding, and appreciation of sturgeon, while teaching ecology concepts. “By

raising this native fish, students are learning about threatened and endangered species, clean air, clean water and the importance of stewardship" (Sturgeon for Tomorrow, 2017b). Eight classrooms across Michigan participated in the 2015-2016 school year. One Onaway high school service learning class not only raises a sturgeon but takes it to other schools in the area to teach younger kids about the species. Students shared with us how much they love their pet sturgeon named Glacier (pictured above), because they have a personal connection from raising him, think he's the most interesting animal at their school, and appreciate that their home is the "Sturgeon Capital." Sturgeon from this program also serve as a travelling educational exhibit or are permanently housed at museums and the Seaquarium.

The streamside hatchery at Kleber dam also offers educational opportunities through public tours. MDNR provides educational curricula and materials in partnership with FWS, SFT, GTB, and others.

**The Spawning Run**

Currently, sturgeon spawning season is a unique annual phenomenon drawing locals and tourists alike. Because of dams such as Tower and Kleber, the sturgeon are concentrated to a short segment of the Black River where they congregate to spawn at a few main pools. This means that the fish, normally out of reach in the deep water of lakes, are highly accessible to humans for viewing and researching. People are excited to come from all over the state and country for a chance to see these unique fish.

> ***"I think people just really value the whole experience here. We had a young family from out of town who was camped just up the river [to participate in Sturgeon Guard] with three kids … there's that joy when you see that first fish. Last night we were having dinner at the camper and one of those kids came up and knocked on the door and said, 'we've got fish!' His little sister had heard one splashing, and they were all excited because they hadn't seen one before. … We get people who come back year after year, once they get started, it kind of gets in your bloodstream."***
>
> ***- Sturgeon Guard volunteer***

Due to staging and spawning behavior, groups like MSU and MDNR conduct various sturgeon research studies, further described in the Hatchery Research section below. Fisheries biologists

and managers also have an interest in studying and rehabilitating sturgeon populations as an important piece of the Great Lakes ecosystem through the Lake Sturgeon Rehabilitation Strategy (see Appendix IV).

However, the enhanced access to sturgeon during the spawning run has also historically made for a significant amount of poaching. Sturgeon for Tomorrow has been using their “Sturgeon Guard” program to help protect the fish for over 16 years by providing a watchful eye along the Black River. Several of our respondents indicated that the Sturgeon Guard has contributed to the decline in poaching and has also, through local and regional participation, sparked renewed appreciation for the living fish.

Tourism surrounding the spawning run, especially including Sturgeon Guard participants, has economic as well as social and ecological value. Each year, Sturgeon for Tomorrow recruits and organizes about 400 volunteers to help watch over the sturgeon during the spawning season throughout the stretch of the Upper Black River up until they meet the Kleber dam. While some local residents have taken part in the Sturgeon Guard, the group also pulls interested individuals from throughout the state, who spend a weekend to several weeks camping along the river to prevent poaching. In total, this amounts to over 4,200 hours of time spent by volunteers protecting the sturgeon over the course of the 6-week spawning period. This influx of non-local people can contribute economic activity through food and other purchases in the area, especially when considering the population of all of Forest Township is approximately 1,000 (US Census Bureau, 2010).

**Sturgeon Season**

Harvesting lake sturgeon is currently allowed in the Black Lake population with strict limits. On Black Lake, the harvest is only open for a short spear fishing season. Each year, the quota is set at approximately 1.2% of the adult population and is to be allocated equally to the tribes and state (MDNR, 2012). In 2016, the quota was set to 7 individuals each for the tribes and state, and the state spearing season lasted under one hour. Sturgeon spear fishing permits are available at all licensed vendors, but anglers must pre-register. Sturgeon for Tomorrow hosts the Sturgeon Shivaree each year at the opening of Black Lake Sturgeon season to spread awareness of conservation efforts focused on lake sturgeon. This family-friendly event, first held in 1961, was

M. Watters

designed to bring families, community members, and regional visitors together to celebrate lake sturgeon and northern Michigan. Black Lake is the only location in Michigan to offer spear fishing of lake sturgeon.

The Shivaree and sturgeon fishing season are important economically as well as culturally. This weekend-long festival brings in a substantial number of local residents as well as people from across Michigan, with 1,500 - 2,200 participants each year. The Shivaree itself generates an additional $25,000 - $30,000 in revenue each year through activities related to the event. The past several years of sturgeon spearing participation is provided in Table 1 (pers. comm. T. Cwalinski, MDNR). While sturgeon spearing licenses do not entail additional charges to the fishermen, they are required to hold all-species fishing licenses, which cost $26 for residents and $68 for non-residents. However, it is highly likely that most participants are also traditional fishermen, so that may not be a new source of revenue for MDNR.

**Table 1. Participation in Sturgeon Fishing in the Annual Black Lake Shivaree**

| Year | Total Registration | Allocation | Voluntary Quota | Actual Harvest |
|---|---|---|---|---|
| 2010 | 255 | 5 | 5 | 5 |
| 2011 | 330 | 7 | 7 | 11 |
| 2012 | 197 | 7 | 2 | 2 |
| 2013 | 268 | 7 | 6 | 6 |
| 2014 | 228 | 6 | 5 | 6 |
| 2015 | 303 | 6 | 5 | 5 |
| 2016 | 261 | 7 | 6 | 7 |
| 2017 | 332 | 7 | 6 | 8 |

While these Shivaree numbers are already substantial with regard to a single event, there are some groups that feel that sturgeon spearing quotas (Table 1) could be higher than they are now,

expressing “a limit of 4 or 5 or 6 sturgeon to me is ridiculous, I don’t know how many man-hours the DNR puts into it but it seems like it’s way out of proportion.” Larger quotas would potentially allow for overall greater participation in the Shivaree, resulting in a greater economic impact on the local economy.

## Current Population Status

The population in Black Lake has been studied recently with the efforts guided by the streamside hatchery and production facility just downstream of the Kleber dam. In Black Lake, the population of adults was last estimated at 1,113 adults based on unpublished data from the 2016 spawning run. Background information on sturgeon ecology (i.e. life history, reproduction, feeding behaviors, habitat needs, etc.) can supplement an understanding of the Black Lake population (Appendix IV).

### Habitat Limitations on Natural Reproduction

Black Lake has been found sufficient to support the growth and gamete production of lake sturgeon (Smith and Baker, 2005). This suggests adult sturgeon are successful in growing to maturity and developing reproductive cells; meaning that Black Lake and the currently accessible Black River is able to facilitate spawning behavior. However, limits to both spawning and nursing habitat in the Upper Black River restrict the success of natural reproduction and self-sustaining nature of the Black Lake sturgeon population.

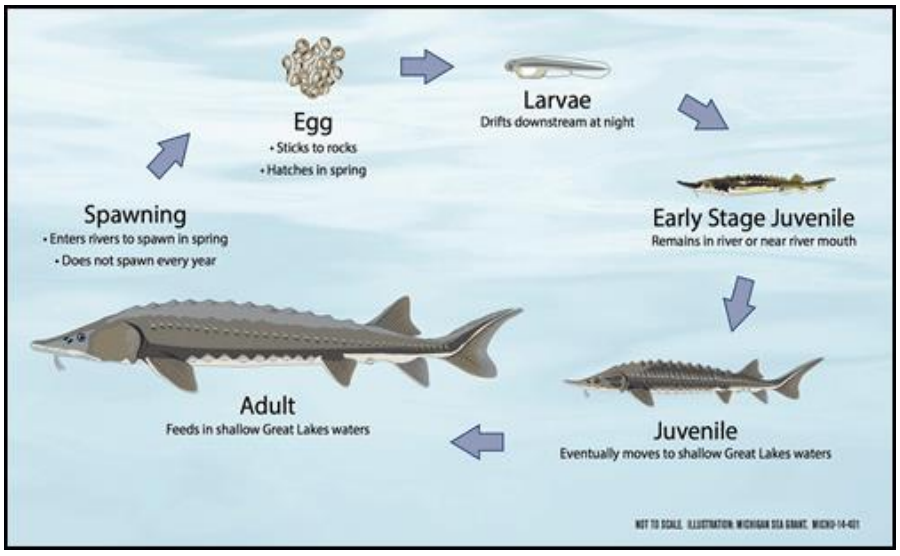


**Figure 16. Lake sturgeon Life Cycle (FWS)**

Available spawning habitat is limiting adult reproduction opportunities. Research suggests that managers should set the target for combined lake and river habitat at 50 km for restricted self-sustaining populations (Auer, 2011), yet Black Lake sturgeon only have access to 11 km. The Black Lake sturgeon population does not have access to enough river mile habitat to successfully reproduce naturally. Limited spawning habitat means that adult sturgeon must compete spatially and temporally for access to spawning grounds. Additionally, Adult lake sturgeon are most vulnerable during the spawning season; staging in shallow and easily accessible areas and energy allocation to gonad production both reduce defenses against harvest.

Nursery habitat, sandy bottom habitat that allows hatchlings to hide and forage, is also limited. Spawning does not occur far enough upstream to offer river habitat sufficiently long for larval drift, and hatchlings cannot survive to their stronger juvenile stages. Therefore, fisheries managers have expressed that expanding river habitat for sturgeon spawning would be beneficial and reduce the dependence on hatchery function of the Black Lake sturgeon population for reproduction.

*Hatchery Role of Supplementing Reproduction*

The hatchery and rearing facility was built by TKLP in connection with SFT, MDNR, and MSU, in response to the limitations on natural reproduction of lake sturgeon in the Black River. Each year, eggs, milt, and larvae are collected and reared in the streamside facility to increase survivorship. They supplement natural reproduction by collecting gametes from spawning adult sturgeon, thus increasing effective spawning habitat. The hatchery also fills the life cycle gap by collecting larval drift, rearing to early juvenile stages, and releasing to Mullett, Burt, and Black Lakes (Figure 16). Juvenile sturgeon are not included in the population estimates until reaching sexual maturity. Although resident perceptions vary about the relative success of sturgeon populations, they generally seem to appreciate the hatchery's functions and see it as "an added insurance policy."

## Current Research and Hatchery Operations

As discussed above, there are varying perceptions of the state of the Black Lake sturgeon population. A variety of research is being done, both in and outside of the Black Lake population, to help strengthen a collective understanding of sturgeon population dynamics and health.


M. Watters

A number of lake sturgeon populations have been studied in North America and the Great Lakes region. Specifically, populations have been studied in the following areas: Ontario, Lake St Clair/Detroit River, Wisconsin, Menominee River in the western Upper Peninsula. Wisconsin and Michigan both have a management plan specifically for sturgeon. The Great Lakes Restoration Initiative combines a number of partnerships in the Great Lakes basin with the focus being lake sturgeon. Restoration activities such as the construction of artificial reefs have been attempted in southeastern Michigan (Johnson et al., 2006). Research and work from other populations can help inform an understanding and planning effort for the Black Lake area.

In addition to supplementing the natural reproduction of lake sturgeon each year, the streamside rearing facility houses various research projects under Principal Investigator Kim Scribner, several of which are focused on the sturgeon population. One study is looking at adult spawning behavior and the larval development in Black River. Another is looking at predation during larval drift, determining which species predate on sturgeon at this vulnerable life stage. Another study is determining the microbial community in the developing GI tract of larval sturgeon. Finally, the effectiveness of rehabilitation efforts is being documented to transfer to other sturgeon populations.

The streamside hatchery is operated by MSU and MDNR. While we do not have exact cost information, the hatchery receives electricity as part of the operation license for Tower and Kleber dams. The hatchery pumps water from Kleber pond at a depth of approximately 3-4 meters, likely to pull in colder water (MSU, 2017). In addition, supporting research and rearing sturgeon, this

hatchery also provides opportunities for education through free public tours offered each year (Sturgeon for Tomorrow, 2016).

## Community Concerns and Perceptions

### Dam Impacts

Sturgeon advocates generally believe removing the dams would increase sturgeon spawning and nursery habitat, and would therefore improve the natural reproduction of sturgeon populations. However, there is a general acknowledgement of uncertainty regarding the Black Lake sturgeon population and how dam removal would alter the river. Some advocates fear negative consequences of dam removal, expressing the worry that sediment and other changes from dam removal might actually inhibit sturgeon spawning. They call for more science to determine specific impacts.

From a social perspective, some sturgeon advocates worry that, if the spawning fish were no longer concentrated along such a short stretch of river and in such a high density, it would be more difficult for scientists to research the fish, for the public to view and appreciate them and for Sturgeon Guard volunteers to keep them safe from poachers. On the other hand, biologists and sturgeon advocates believe that the increased spawning grounds would increase the reach and potential of the spawning event. Additionally, if spawning locations shifted to the dam sites, they would be much more accessible to larger audiences. Some people see dam removal as an opportunity to make more area towns the “sturgeon capital of the world” and attract tourism, spark new local businesses, and strengthen community identity. This could help improve local economies and sense of community.

> ***“Would there even be suitable spawning habitat beyond the dams? We don’t know. Would the sturgeon even try to go up there? Would they no longer be concentrated in 2 or 3 spots? Would it make them less vulnerable to poaching because they’d be more spread out? Would there be less predation? Would we have stronger reproductive success if we had more space? This all needs to be researched.”***
>
> ***–local environmental organization member***

**Sturgeon Management**

Some community members, generally including fishermen and groups with broader interest in ecological health, perceive an overemphasis on sturgeon management. This does not appear to reflect a dislike of sturgeon; some who hold this view say they like and respect sturgeon while others say they "don't much care one way or the other" and "just sort of ignore them." This group also tends to think that sturgeon already have enough habitat, populations are stable, and therefore dam removal isn't necessary to improve their populations. Even if the sturgeon could benefit, several people have expressed that it would *not* be worth removing the dams solely for the sake of improving sturgeon populations.

Many local fishermen express frustration with how much emphasis is being placed on protecting the sturgeon because it is only one of many local fish. Some believe local people in general do not care very much about the sturgeon, and instead the interest in sturgeon is driven by specific groups and tourists from elsewhere. Fishermen, some local residents, and some ecology-based groups all express the wish that there was more emphasis on managing other species, such as walleye. Fishermen point out that there is hardly any sturgeon fishing allowed anyway, whereas fishing a myriad of other species is important for the community and tourism. However, in the past there was no quota at all and sturgeon fishing was much more popular and prevalent (MDNR, 2017h).

People who share this perception of an overemphasis on sturgeon also believe that the fish have enough habitat and are doing fine. Impoundment residents commented, "my feeling is that it [the Black Lake population] is coming back," and "they've got all the spawning beds they need from Kleber dam downstream." One factor in this belief is that the hatchery exports fingerlings to other lakes to help support those populations, so people think the Black Lake population must be stable enough to divert resources and attention elsewhere.

> ***"The massive amount of attention [sturgeon] received has completely turned the population around. We're producing way more fish than the water system needs. We're exporting fish to other water systems. I think it's been a phenomenal turnaround, and I think it's time to take a new realistic look at the species itself, and I think we're kind of overprotecting it, and there's more opportunity there as a fishery right now."***
>
> ***- local resident***

One community member expressed the belief that Sturgeon Guard volunteers are no longer needed to protect the fish from poachers, calling them “sturgeon vigilantes.” People also express the belief that the drop-off river gradient at the dam sites would prevent sturgeon spawning from proceeding even without the dams.

**Key Stakeholder Interests**

- Maintain cultural significance of sturgeon (tribes and local communities)
- Improve/maintain sturgeon population and habitat
- Increase sturgeon tourism (e.g. increase allowable harvest)

**Key Questions Moving Forward**

- How would dam removal impact the hatchery’s ability to function and perform research?
- How significant is the subsidization of maintenance and electricity costs for the sturgeon hatchery by the dam owner?
- How would dam removal affect the sturgeon population?
  - How would dam removal impact the amount of accessible sturgeon habitat?
  - How are social or community activities (e.g. Sturgeon Guard and sturgeon tourism) affected by the size and condition of sturgeon habitat?
  - Would rapids/gradient under current dams restrict access to upstream habitat?
- What alternative habitat is offered by other tributary creeks to Black Lake?
- How can results of sturgeon science be better communicated to stakeholders?
  - What research is currently being done that may affect the decision-making?
- Will hunting and fishing rights of sturgeon be renegotiated?

# Conclusions

Deciding the future of Tower and Kleber dams will be an ongoing process. In this report, we provide a baseline exploration of the ecological, economic, and community impacts of the dams. We also identify and illustrate the issues and stakeholder concerns that should be involved with the decision. We hope our work can help inform community conversations, further research, and future decision-making processes. To conclude this report, we highlight key findings, provide recommendations for moving forward in the dam decision-making process, and summarize stakeholder interests and questions.

# FINDINGS TAKEAWAYS

Based on the background information gathered, interviews with stakeholders, interaction with the community, and input from the public meeting, we have synthesized a set of overarching findings. These findings are grouped by dam status, ecological factors, and public concerns.

## Dam Status

***Tower and Kleber dams are in satisfactory condition.*** Neither Tower nor Kleber have significant structural issues, although there are some moderate and minor issues that would need to be addressed in future maintenance activities. The electricity production from both dams is comparable to nationwide efficiency levels but falls slightly short of their documented expectations. Costs of future maintenance and operation are important to compare against the current generation capacities but are not clear at this time.

## Dam Impacts on Ecology

***Tower and Kleber dams influence water conditions and habitat availability for many species.*** In-stream structures like dams can affect the local conditions of the water for the following: temperature, dissolved oxygen, sediment load, and flow regime (volume and timing of water). Based on the local changes in these conditions, dams can determine where along the river is favorable habitat for a given species. Some species are particularly sensitive to temperature, like brook trout, whereas other species can require certain water depths or substrate at varying life stages, like lake sturgeon. In creating Tower and Kleber ponds, the dams affect the water conditions of Upper Black River, limiting brook trout habitat to headwaters while allowing for pike and bass habitat in the impoundments.

***Tower and Kleber dams do not have much of an impact on water levels in Black Lake.*** Under normal flow conditions and run-of-river operation, Tower and Kleber dams do not contribute to changes in the water level of Black Lake. Downstream, Alverno dam and Smith Rapids have more control on the output from Black Lake. In storm events, Tower and Kleber ponds would offer minimal storage, while other creeks and surface water inputs to Black Lake would continue to increase water levels.

***The sturgeon population is viable with help of the hatchery, but natural reproduction could be improved with dam removal.*** The hatchery and rearing facility supplements natural

reproduction and mitigate the limits on spawning and nursery habitat due to the presence of Tower and Kleber dams. With the research and operations at the hatchery, the Black Lake sturgeon population is slowly growing; however, with improved natural reproduction, the sturgeon population would be able to self-sustain and fewer resources would need to be devoted to supplemental reproduction.

**Public Concerns**

***Community members are passionate about recreation in their area and are worried about losing those opportunities.*** Recreation is a key part of why people love living in the Black Lake and Black River area. Whether or not they live directly on the ponds, residents enjoy fishing, boating, and other types of recreation. Removing these opportunities would alter community members' relationship with their home, and would be felt as a powerful loss. Recreation is also intimately tied to the local economy, and people worry that losing pond recreation would accelerate economic decline. New recreational opportunities could emerge with dam removal, such as whitewater kayaking, and could strengthen the social and economic vitality of the community. However, it is difficult for many residents to imagine this making up for a loss of current pond activities.

***A passionate and polarized fishing community is interested in differing management priorities, beyond a focus on sturgeon.*** Both resident and tourist fishermen have different preferences for pond, lake, or river fishing with different target species. These fishermen, especially local residents, care deeply about their fishing opportunities and are concerned about access and maintaining populations of their target species. Because preferred opportunities and species vary, they imply different priorities for fishery management which would become even more controversial and difficult to balance in the case of dam removal.

***Landowners that live on Tower and Kleber ponds feel the most threatened by discussions of dam removal.*** These landowners highly value their current properties for financial, aesthetic, recreational, and other purposes, and, importantly, believe dam removal will result in the loss of these property values. As a result, they may perceive discussions about the future of the dams to be a threat to what they care about.

***Black Lake landowners are convinced that Tower and Kleber dams give them protection and control over water levels.*** While many landowners are aware of the run-of-river operation

of the Tower and Kleber dams, most are in favor of keeping the dams in order to maintain a sense of control over water levels, especially in heavy precipitation and flooding events. In situations where control by Alverno dam is limited, landowners want to have Tower and Kleber in place to provide water storage, even if storage is minor.

***There is skepticism about tribal motivations and a lack of understanding of tribal rights.*** The opinion of tribal nations by local, non-tribal residents appears to be colored by negative experiences in other areas of Michigan. There is also confusion about the role tribal nations have in this decision-making process and their rights to natural resources in the watershed (see Appendix VI for a primer on tribal rights). As a result, local residents around Tower and Kleber dams are suspicious as to why the tribal nations are involved in the discussions about the dams, especially as there seems to be a perception that the tribal nations are trying to be involved from far away.

***Some people are excited about the idea of dam removal due to its potential to improve trout habitat, sturgeon populations, and river boating opportunities.*** Individuals across stakeholder groups express a curiosity and interest in potential improvements to recreational opportunities, especially as it relates to popular fish species. Brook trout populations will likely benefit from dam removal, assuming river habitat will increase and water temperatures remain cool along the Upper Black River. Those that advocate for sturgeon are hopeful that harvest numbers will increase and there will be more interaction with the public after dam removal increases habitat. Dam removal may increase opportunities for river watercraft, as whitewater would likely be exposed, and other recreational improvements can be included in the process.

# MOVING FORWARD

There is uncertainty, confusion, and emotion surrounding current impacts of the dams, the idea of dam removal, and the related decision-making process. Steps moving forward should seek to address these as elements of potential conflict by providing information, interpreting science, and acknowledging deeply held concerns.

## Information Needs

***There are misconceptions and confusion about impacts of the dams on the watershed***

***It is important for information to be available and accessible to the public.*** It is important that any information associated with the decision-making process, both existing information and new information gathered in the future, for Tower and Kleber dams are easily available for the public to access. However, it is even more important that that information is developed in a way that is understandable for all audiences. Scientific information about dams and their associated impacts can at times be overly technical. Therefore, a focus on making all findings equally accessible to technical and non-technical audiences will ensure that the decision-making process is fully transparent to all stakeholder groups and the general public.

***Site-specific information is needed for ecological and economic impacts.*** While at times it is necessary to extrapolate findings from studies of other regions of the United States to this locality, some stakeholder groups strongly prefer more site-specific information about the potential impacts of dam removal. For example, although scientific studies may point to positive benefits of dam removal on local property values, local landowners may be skeptical unless the data is site-specific. It would be helpful to work with a locally-knowledgeable real estate agent to establish property value data and predict how these would change in the event of dam removal. We would also suggest creating a hydrologic model to help landowners visualize what changes to their property would look like.

***Clarity is needed to gauge if the dams' electricity generation is a net benefit.*** While the available information about Tower and Kleber dams' electricity generation indicates it is not insignificant, stakeholders may have a hard time understanding how meaningful that generation is without something tangible to compare it to. For example, information about the dams' importance to the regional grid or operational cost information for the dams would serve that purpose.

## Process Recommendations

### *There is confusion, emotion, and conflict surrounding the issue and the decision-making process*

***Clarify the decision-making process.*** Our experience throughout this project emphasized in numerous occasions that many of the stakeholder groups are unclear about the decision-making process about the future of Tower and Kleber dams. This has led to a lack of clarity about their roles and ability to be a part of and influence the resulting decision. While there should continue to be an emphasis on the importance of a collaborative process, a first step towards a formal decision-making process is to clarify two key roles: 1) who holds the final decision-making power about the future of the dams, and 2) who has responsibility over bringing together the diverse set of stakeholders. The first role is likely the dam owner and FERC, but this need to be made clearer to all participants. To the second question, MDNR has thus far taken on some of this responsibility, but this should be made more explicit as the process moves forward and ensure that all stakeholders are comfortable with that allocation of responsibility.

***Acknowledge the full range of concerns held by stakeholders and validate emotions.*** There is a wide variety of issues involved with the dam decision that need to be considered moving forward. These issues are associated with fear and deeply held emotions, which could lead to significant conflict. For example, recreation should be a top consideration in future discussions because it is deeply tied to the local community. Discussing all interests and acknowledging associated emotions is important in engaging stakeholders in a productive conversation where everyone feels that their voice is heard and conflict can be avoided. This is the case even if some parties may deem a concern to be less important or scientifically negligible, such as Tower and Kleber dams' influence on Black Lake water levels.

***Build visions and scenarios for the future.*** It appears that many of the stakeholders involved in the process are heavily focused on the negative or potential for loss associated with dam removal, but thus far, there is less discussion of the potential benefits of dam removal for all stakeholders. While this loss-aversion is understandable, a shift in perspective away from the status quo and towards visions of future possibilities (e.g. for recreation or economic growth) may assist in promoting more open-minded, productive conversations across stakeholder groups and decision-makers.

***Directly involve tribal nations or otherwise help improve perceptions by non-tribal residents.*** During our interviews, informal conversations, and feedback at the public meeting, we heard non-tribal residents express skepticism about tribal motivations. There is confusion about tribal rights based on historic treaties and concern about changes to hunting and fishing quotas. Directly involving tribal nations in the dam decision-making process and clarifying tribal goals, roles, and rights may help improve perceptions and relationships between the tribes and non-tribal residents.

# SUMMARY OF QUESTIONS AND INTERESTS

The table below consolidates the key questions for future analysis and stakeholder interests that are explored in greater detail in the findings sections above.

| Topic | Stakeholder Interests | Questions for Further Analysis |
|---|---|---|
| *Physical Dam Status* | • Dam maintenance needs<br>• Cost of dam repair versus dam removal<br>• Dam ownership and sale | • Are there structural issues for the dams that need to be addressed?<br>• What maintenance will be required and when? How much will long-term maintenance cost?<br>• Are there differences in maintenance needs and costs because of their structural differences (e.g. Kleber is earthen, while Tower is concrete)?<br>• What would be the potential cost of removal for these dams?<br>• Is there a possibility of the dam owner "walking away"? If so, who would be maintaining the dams long-term?<br>• What is the progress of the sale of the dams, and information about the sale is, or could be, available to the public? |
| *Electricity Generation* | • Reliability of electricity generation<br>• Cost of hydroelectric power<br>• Upkeep of dam and impact on electricity production | • How much revenue do the dams generate through electricity production? How is this expected to change in the future based on projected changes to production capacity?<br>• Why are the dams inconsistent in their generation?<br>• How is electricity from the dams distributed in the grid?<br>• What is the impact of losing the electricity the dams provide on the grid (e.g. grid reliability, electricity prices)? How would that loss be offset? |

| Topic | Stakeholder Interests | Questions for Further Analysis |
|---|---|---|
| *Properties* | • Avoiding ugly and costly transition periods<br>• Maintaining property rights<br>• Maintaining property value<br>• Preventing trespassing<br>• Having access to information | • Who currently owns the impounded land underneath Tower and Kleber ponds?<br>• What is the legal status of property rights allocations for newly exposed bottomlands stemming from dam removals in Michigan? For properties on Tower and Kleber ponds? Where can residents go to find this information?<br>• Where would the new waterline be? How long would the transition from pond to river take?<br>• Are there implications of regulatory takings if a dam removal process were to proceed?<br>• What direct impacts on this housing market could be expected if a dam removal were to move forward?<br>• What opportunities would there be to restore exposed bottomlands as green space? Who would be responsible for the restoration and costs?<br>• How would the two ponds be impacted differently? (aesthetically, clarity, rapids, property values, etc.)<br>• Does dam removal impact neighboring groundwater supply? |
| *Water Levels* | • Maintaining Black Lake water levels<br>• Preventing flooding (stormwater management) | • What is the extent of control on water level in Black Lake by Tower and Kleber?<br>• How does Alverno affect Black Lake levels?<br>• How would Burt and Mullet Lakes be affected?<br>• How do the dams control stormwater flows?<br>• What storage can the floodplain offer in storm events? |
| *Sediments* | • Avoiding sediment deposition and related fish kill<br>• Avoiding contaminated or toxic sediment | • What would happen to the built-up sediment, and who would deal with it?<br>• Are there toxins or contaminants in the sediment in the ponds? If so, how will they be dealt with, and who will deal with them? |

| Topic | Stakeholder Interests | Questions for Further Analysis |
|---|---|---|
| *Recreation* | • Maintaining ability to fish<br>• Maintaining/improving pond fish populations<br>• Improving trout populations<br>• Ensuring scientifically-sound, balanced fishery management<br>• Improve fishing tourism<br>• Maintaining ability to swim<br>• Maintaining ability to boat on ponds and river<br>• Maintaining ability to camp<br>• Maintaining vibrant recreation scene at Tower Pond<br>• Strengthening/maintaining the economy<br>• Adding additional recreation opportunities (like whitewater/Shanty Rapids)<br>• Improving canoe/kayak opportunities and having adequate river depth | • Would boating opportunities increase with dam removal?<br>• What whitewater opportunities would emerge with dam removal?<br>• The river is already very shallow for canoeing; what would the new river depth be? How would the channel and velocity change?<br>• How would fishing access change if dams were removed, especially for pond landowners? |
| *General Ecological Health* | • Maintain species diversity<br>• Maintaining migratory bird populations<br>• Prevent invasive species such as lamprey<br>• Achieving stable new ecosystem<br>• Avoiding contamination/damage from old landfill<br>• Maintaining habitat for eagles, wood turtles, ducks, etc. | • How would the larger Cheboygan River watershed be affected by potential dam removal?<br>• Which measures of ecological health are most important for evaluating dams?<br>• How do you compare new ecosystems to historical before the dams were built?<br>• How are the dams impacting terrestrial species?<br>• To what extent do the dams serve as an important barrier to the spread of invasive species upstream of the dams?<br>• How does shading from riparian trees and shrub affect the aquatic ecosystem? How would that change in a post-dam removal scenario? |

| Topic | Stakeholder Interests | Questions for Further Analysis |
|---|---|---|
| *Fish* | • Maintaining opportunities for pond fishing<br>• Improving pond/lake fish populations<br>• Improving trout populations<br>• Ensuring scientifically-sound, balanced fishery management | • What are the realities of shifting fisheries and what are the causes?<br>• How would water temperature, sand traps, and changing habitat affect fish diversity?<br>• What is stratification like in the ponds, and how does it affect fish? |
| *Sturgeon* | • Maintain cultural significance of sturgeon (tribes and local communities)<br>• Improve/maintain sturgeon population and habitat<br>• Increase sturgeon tourism (e.g. increase allowable harvest) | • How would dam removal impact the hatchery's ability to function and perform research?<br>• How significant is the subsidization of maintenance and electricity costs for the sturgeon hatchery by the dam owner?<br>• How would dam removal impact the sturgeon population?<br>  ○ How would dam removal impact the amount of accessible sturgeon habitat?<br>  ○ How are social or community activities (e.g. Sturgeon Guard and sturgeon tourism) affected by the size and condition of sturgeon habitat?<br>  ○ Would rapids/gradient under current dams restrict access to upstream habitat?<br>• What alternative habitat is offered by other tributary creeks to Black Lake?<br>• How can results of sturgeon science be better communicated to stakeholders?<br>  ○ What research is currently being done that may affect the decision-making?<br>• Will hunting and fishing rights of sturgeon be renegotiated? |

# About the Authors

**The SNRE Team** (from left-to-right: Molly Watters, Kevin He, and Lauren Edson)

We are a team of three graduate students from the University of Michigan's School of Natural Resources and Environment (SNRE). SNRE requires its students to complete a "master's project" as a capstone experience. The master's projects are client-based team projects that are sourced from non-profit organizations, private companies, and government agencies. This project was proposed by the Michigan Department of Natural Resources and the Grand Traverse Band of Ottawa and Chippewa Indians.

**Lauren Edson:** Lauren is a master's student studying conservation ecology at SNRE with a specific focus on water resources. Before coming to SNRE, Lauren studied environmental engineering at the University of Michigan.

**Kevin He:** Kevin is a master's student studying environmental policy and conservation ecology at SNRE with a focus on land management and conservation. Prior to SNRE, Kevin studied environmental science at Duke University and went on to work as an environmental consultant for the US Environmental Protection Agency and other government agencies.

**Molly Watters:** Molly is a master's student studying environmental planning and communication at SNRE. Before coming to SNRE, Molly studied environmental studies at Carleton College and worked as an interpretive park ranger for the National Park Service at Homestead National Monument.

# Appendix I

## GLOSSARY OF TERMS

**Nameplate capacity:** the maximum rated output of a dam.

**Capacity factor:** the ratio of the amount of electricity produced by a dam as compared to the theoretical amount of electricity that could have been produced at continuous full power.

**Social value:** an appreciation for something (e.g. boating) based on an association with friends and family, enjoyable experiences, and fond memories.

**Cultural value:** an appreciation for something (e.g. Black Lake) based on its connection to personal identity and sense of place.

**Attenuation:** reduction in the peak of a hydrograph resulting in a broad, flat hydrograph. Storage of storm flows in routing or reservoirs.

**Indicator species:** an organism whose presence, absence, or abundance reflects a specific environmental condition. May be used as a proxy to diagnose the health of an ecosystem.

**Run-of-river:** operation of a dam such that inflow entering the impoundments is equal to the discharge released out of the dams.

**Watershed:** an area or ridge of land that separates waters flowing to different rivers or basins; colloquially used to describe the catchment basin itself, whereas it is truly only the outline.

**Catchment basin:** the area from which rainfall flows into a river, lake, or reservoir.

**Impoundment:** a body of water, such as a pond or reservoir, that is formed by obstructing flow in a river.

**Riparian zone:** the interface between land and a river or a stream which serves an important ecological role through soil stabilization, biofiltration of water, and support of biodiversity.

# Appendix II

## SUMMARY OF THE WATERSHED

### The Cheboygan River Watershed

The Cheboygan River watershed covers 900,000 acres over Cheboygan, Presque Isle, Emmet, Charlevoix, Otsego, and Montmorency Counties. The watershed drains into the Cheboygan River, releasing into Lake Huron, and includes what is known as the Inland Waterway, referring to Burt, Mullet, Douglas, Pickerel, Crooked, and Black Lakes. Other main tributary rivers include Crooked River, Maple River, Sturgeon River, Pigeon River, and Black River.

The topography of this area was defined by glacial movements, scouring and deposition characterize the moraine ridges, glacial till deposits, and kettle lakes. The area has large proportions of forested lands and wetlands. Additionally, the area is home to several endangered or threatened aquatic species, such as the Michigan monkey-flower *(Mimulus glabratus var. michiganensis)*, Hungerford's crawling water beetle *(Brychius hungerfordi)*, and the lake sturgeon *(Acipenser fulvescens)*. These wetlands provide nesting habitat for rare birds such as the bald eagle *(Haliaeetus leucocephalus)*, the common loon *(Gavia immer)* and the black tern *(Chlidonias niger).* (Tip of the Mitt, 2016).

### The Black Lake Sub-watershed

The Black Lake watershed drains more than 350,000 acres representing 38% of the entire Cheboygan River watershed (Cwalinski and Hanchin, 2011). Black Lake itself has a surface area of 10,113 acres (Breck, 2004) and is among the ten largest inland lakes in Michigan by surface area. Black Lake is fed by the Upper Black River and Rainy River, as well as indirectly by Canada Creek and the East Branch of the Black River. Other tributary creeks include Tomahawk Creek, Milligan Creek, Stony Creek, Mud Creek, Hardwood Creek, Van Hellens Creek, Rattlesnake Creek, Packer Creek, and Fast Creek. Black Lake watershed is mostly forested and open lands, with a small percentage of agricultural uses (Tip of the Mitt, 2016). The shoreline of Black Lake is mostly private residential land with some public riparian access located in a state park near the Upper Black River and state forest campground on the north east shore. The water of Black Lake is tannin-stained dark, and residents often attribute this to historic logging industry.

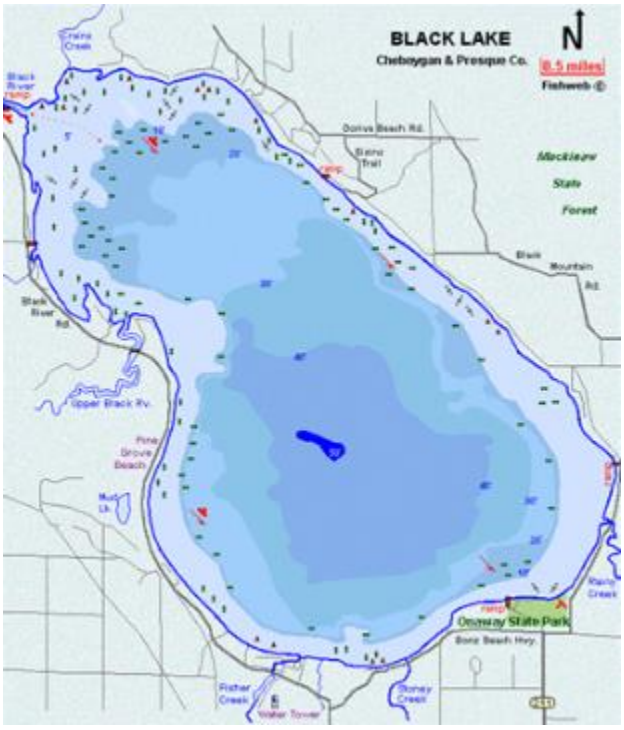


**Figure 17. Map of Black Lake**

Bathymetry maps show that the greatest depth in Black Lake is 50 ft., while large portions of the lake are considered shallow shoals. Shoal widths average 330-ft. wide up to a quarter mile. The substrate found in the Black is mostly sand, lending to sparse vegetation, with some areas of silt and emergent rush beds. Limnological profiles of the lake reveal that there is a typical declining trend for both dissolved oxygen and temperature and no thermocline. Seasonal variation in solar input likely has impacts on the vertical mixing of the lake. (Cwalinski and Hanchin, 2011).

# Appendix III

## DECLINING ECONOMY AND ECONOMIC SHIFTS

The communities in this area were settled as logging towns. Several residents have expressed that the communities have faded from what they once were, especially Tower. Logging, which was the prominent industry when the towns were settled, is still active in the area, especially on public lands. For example, the area around the impoundments is scheduled for entry in 2017 (see Figure 18), meaning logging may occur there soon (MDNR, 2015). However, timber in the area is a far less intensive industry than it was in the past. Many residents perceive it as a significant drawback that there is currently no major industry in the immediate area to provide jobs and attract commercial activity: “There’s just not the money up here to hold a lot of people. My son lives in Florida, he started out up here in Michigan but had to shut down.”

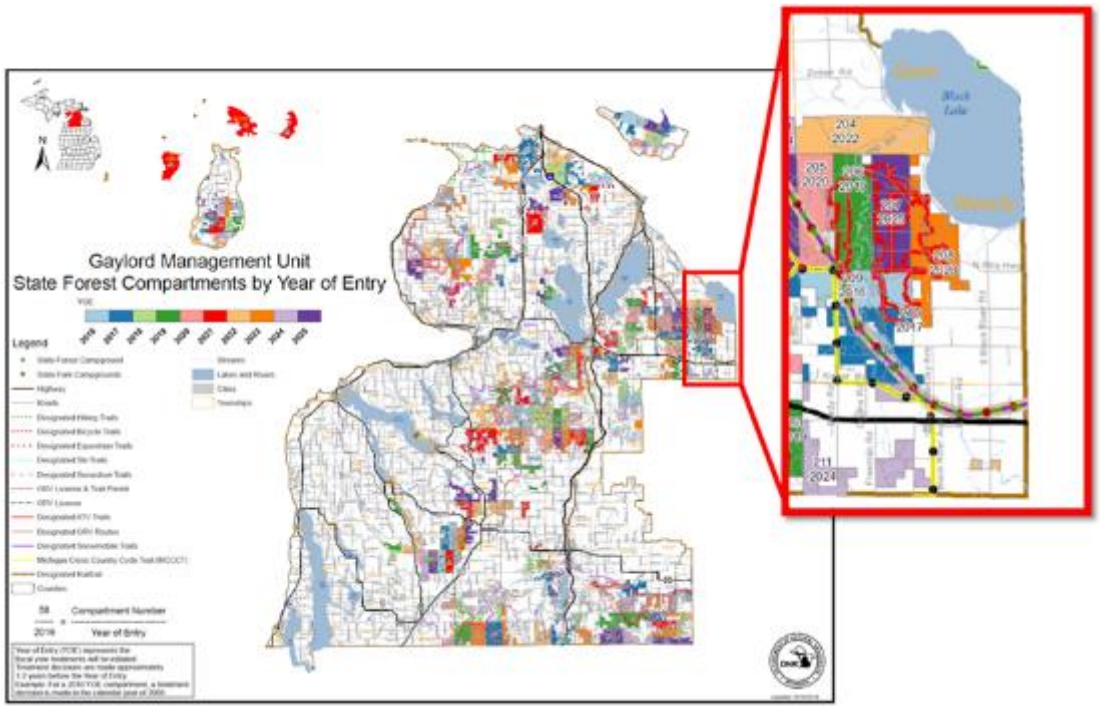


**Figure 18. Map of Planned State Forest Activity Near the Tower and Kleber Dams (MDNR, 2016)**

Some community members have described a decline in sense of community over time. This has to do with the overall economic decline, a shift in demographics, and a disappearance of community gathering places and events.

The area is attractive to residents because it is affordable, beautiful, peaceful, and full of recreational opportunities. These translate into reasons why many individuals from other parts of the state, such as Southeast Michigan, like to retire in this area. An increasing number of older individuals have been moving there to spend their retirement or have transitioned from living there seasonally to living there permanently or year-round. On the other end, fewer and fewer young people are staying in or moving to the area, which alters the community structure and could have implications for its future. Overall, while the influx of retirees has assisted in improving some of the economic conditions of Tower, it, in combination with the outflow of younger individuals, has also resulted in an older population with many retired households and potentially more limited opportunities for economic growth in non-recreational sectors.

# DEMOGRAPHICS AND CURRENT ECONOMIC CONDITIONS

For the purpose of understanding the broader macroeconomic conditions of the Black River watershed, we have profiled below three different units of jurisdiction: Cheboygan County, Forest Township, and Tower Village. While there are other counties, townships, cities, and towns that have interests in this decision-making process, these three overlap the dams most directly, and the information provided may also be illustrative of other nearby geographies.

## Cheboygan County

### History

Cheboygan County was established in 1853, getting its name from the nearby Cheboygan River, which was named after an Indian word meaning “the river that comes out of the ground” (Cheboygan County, 2016; MIGenWeb Project, 2012a). The area was developed around a variety of natural resource-based extraction, such as furs and timber (MIGenWeb Project, 2012a). By the early 1900s, however, much of the valuable timber had already been logged, resulting in a decline in the regional economy. Today, the tourism economy has helped to revitalize much of the area.

### Current Conditions

Cheboygan County consists of nineteen total Townships, two Villages, and the City of Cheboygan (Cheboygan County, 2016). Cheboygan County has a total population of 26,152, amounting to approximately 11,133 households (US Census Bureau, 2010). The median age in the county is 47.1, with a relatively even split across all five-year age groups (Figure 2). The kink between the 15 to 19 and the 20 to 24 age groups is likely indicative of the area’s younger population leaving to pursue advanced education or other opportunities outside Cheboygan County. Economically, the US Census Bureau estimates that 17.8% of the population in Cheboygan County are in poverty and that the median household income is $39,486 (US Census Bureau, 2014).

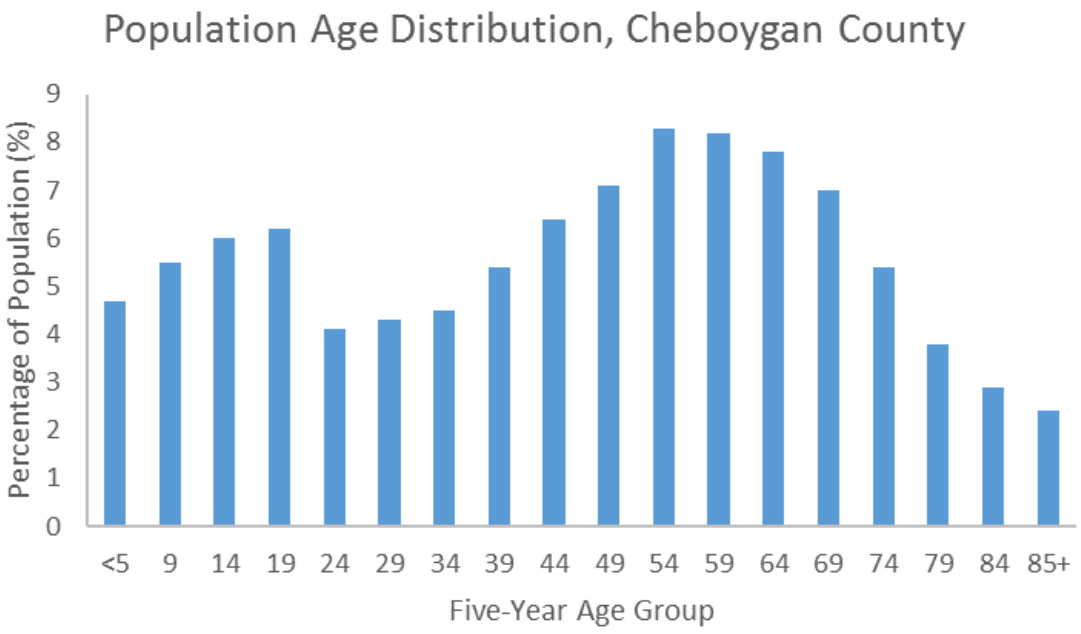


**Figure 19. Population Age Distribution for Cheboygan County in 2010 (Source: US Census Bureau, 2010)**

## Forest Township

Forest Township encompasses the entire Tower Pond area, the majority of the Black River upstream of the dams, as well as a southern portion of the Kleber Pond. As such, Forest Township includes both the town of Tower and nearby unaffiliated residents.

### History

The name of this township has roots in its importance to the timber industry beginning in the 19th century.

### Current Conditions

The US Census Bureau places Forest Township's population at 1,045 in 2010 (US Census Bureau, 2010). The median age of this population is 48.7 with a similar age distribution to the broader Cheboygan County population. There are a total of 450 households in Forest Township. Economically, the US Census Bureau estimates that 15.3% of the population in Forest Township are in poverty and that the median individual income is $24,778 (US Census Bureau, 2014). The most important industries in terms of employment appear to be retail, manufacturing, education and health care services. There are very few people employed in natural resource-related professions.

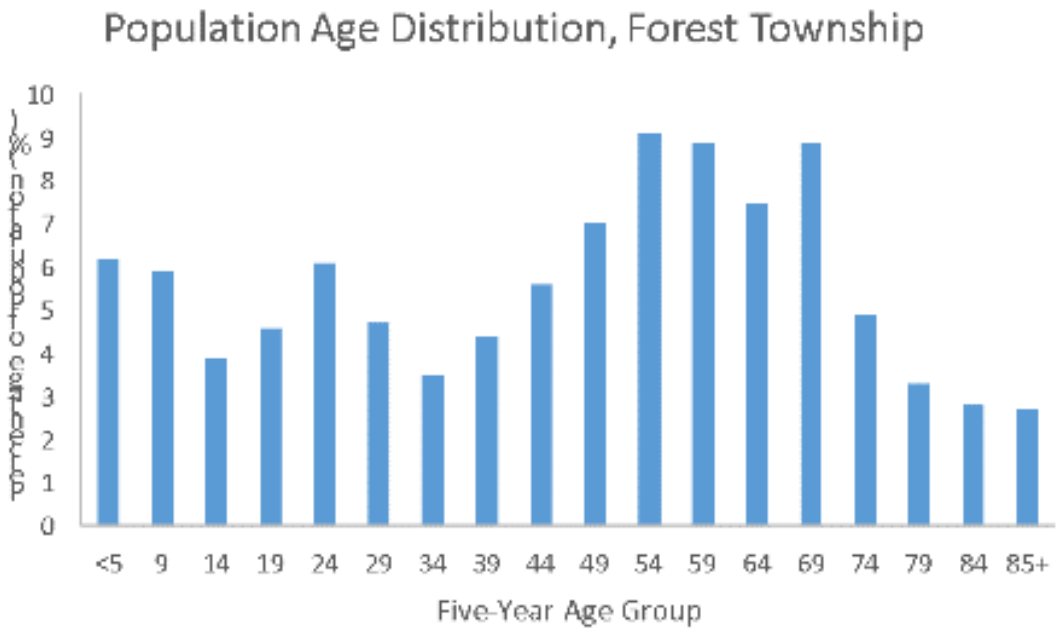


**Figure 20. Population Age Distribution for Forest Township in 2010 (Source: US Census Bureau, 2010)**

## Tower Village

As stated previously, the city of Tower sits right on the shores of Tower Pond (include map here) and is likely to be directly impacted by whatever decision is made to Tower Dam. From our interviews with some local residents, Tower Pond is a prominent facet of the area. Several of Tower's parks are located along the shores of the pond, and residents use the pond for a variety of other recreational activities as well. In addition, having developed alongside the pond, a significant number of residents live along the shores of the impoundment.

### History

Broadly, many of the settlements in this region were established in conjunction with the timber industries expansion of activities into the area (MIGenWeb Project, 2012b). In fact, several interviewees have noted that the historical roots of their family in the area was tied to one family member or another working for the timber industry. Tower was originally established in May 20, 1899 and at its height in 1910 had a population of about 800 (MIGenWeb Project, 2012b). However, on July 11, 1911, a large portion of the town burnt down in the Au Sable-Oscoda Fire, which marked the end of the regional timber industry, and Tower never regained its prominence.

**Current Conditions**

Tower is an unincorporated community and administered by the broader Forest Township governmental unit. The sentiment voiced by several interviewees familiar with Tower and the broader area is that there is little in the way of economic opportunity or growth in the area. Many noted a recent influx of families from southern Michigan into the area for retirement. While this has assisted in improving some of the economic conditions of Tower, it has also resulted in an older population with many retired households. Interestingly, one resident noted during an interview that timber is once again an important component of the local economy.

# Appendix IV

## SCIENTIFIC BACKGROUND ON STURGEON

### Life History

Lake sturgeon (*Acipenser fulvescens*) are long-lived and late-maturing partly cartilaginous fish, aging up to 100 years and reaching sexual maturity at 15-20 years for males and 20-25 years for females. Once at sexual maturity, the males spawn every other year and the females spawn every four years on average (Peterson, 2007). Lake sturgeon can grow up to 260 pounds and 2.4 m in length over their lifetime. Typical lengths for females are between 140-160 cm and between 120-140 cm for males. Early stage and juveniles grow more rapidly in length than in weight, but adult sturgeon tend to grow in weight rather than length (Peterson, 2007)

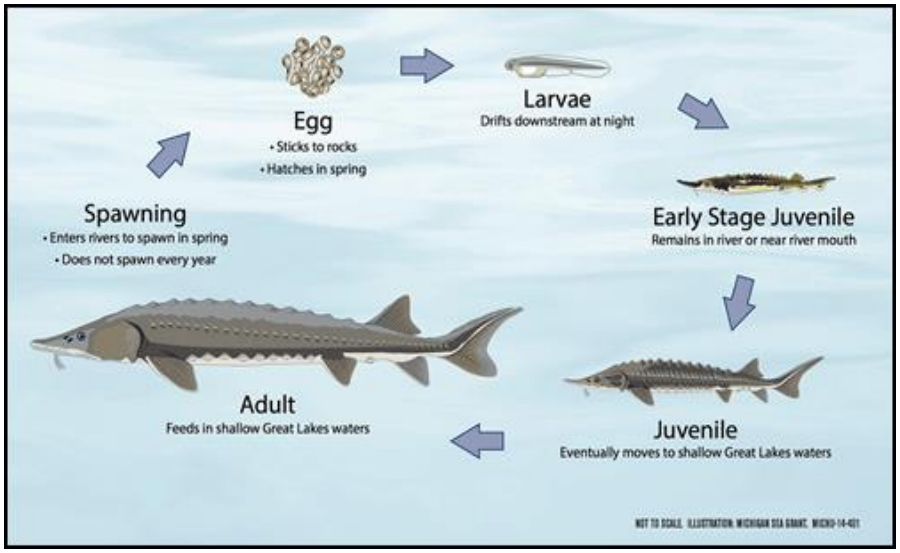


**Figure 21. Lake sturgeon Life Cycle (FWS)**

### Reproduction

Adult lake sturgeon migrate into rivers to spawn from April to June and searches out favorable temperatures and gravel substrate or rapids in order to optimize reproductive success (Auer, 1996). Water temperature serves as an environmental cue for migration into the river reach and

**Potamodromous**: migrating short distances for spawning purposes, typically lake to stream.

spawning behaviors to begin. Along with the energy required to move upstream, the sturgeon must also dedicate a large proportion of energy to gamete production before a spawning event. Due to the variation in reproductive cycles and the high energy requirement, the spawning population each year represents about 10-20% of the population in a given area (see Figure 22).

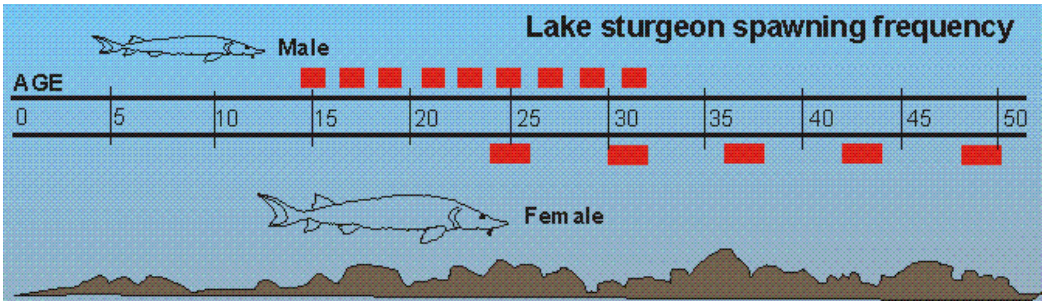


**Figure 22. Adult sturgeon spawning frequency (WI DNR)**

During a spawning event, a group of male sturgeon will gather upriver in pools close to shallow, rocky, rapids-type areas and wait for ripe females to arrive. This behavior is referred to as staging and conserves energy for reproduction. When the female arrives, spawning bouts begin at a rocky site, during which a single female will release 4,000 to 7,000 eggs per pound of body weight into a cloud of sperm released by two to eight males (Bruch and Binkowski, 2002). The eggs become sticky when exposed to water, allowing for eggs to adhere to the underside of clean rock, rock crevices, or clump together. Each spawning site will be utilized for two to four days, depending on the number of females utilizing the site. The eggs hatch in five to eight days, depending on the water temperature. In 12 to 14 days, the fry (newly hatched fish) are one-inch-long and have fully developed mouths and barbels (Peterson, 2007). Sturgeon will remain in their natal river for the first summer (FWS, 2016) developing from larvae to early juvenile stages while drifting along the reach.

**Early Life Stage**

Early life stages are the most vulnerable for lake sturgeon. From hatching until scutes have developed, the young sturgeon are vulnerable to predation (Auer and Baker, 2002). Predation avoidance behaviors include drifting at dusk and remaining in gravel during sunlight hours. The mottled appearance of the juveniles is to camouflage with the sandy bottom. During this vulnerable life stage, the larvae will be preyed upon by many opportunistic feeders, with rock bass as the major predator. Juvenile lake sturgeon are more active at night, which serves as predator avoidance and may increase their foraging success (Chiasson, 2011). In addition to being

sensitive to substrate type, juvenile sturgeon are also vulnerable to stress in increasing heat regimes. Activity and foraging behaviors decrease with temperatures much above their tolerance zone (Wilkes, 2011).

## Feeding Behavior

Lake sturgeon are benthivorous, meaning they feed on small invertebrates, insect larvae, crayfish, snails, and bloodworms found in sand and clay substrate. Since sturgeon feed on some macroinvertebrates known to be sensitive to water quality, declining water quality would have a direct impact on lake sturgeon growth. While they are opportunistic feeders, sturgeon will primarily forage for macroinvertebrates such as bloodworms (Annelids), midges (Diptera), mayfly larvae (Ephemeroptera), stonefly larvae (Plecoptera), and caddisfly larvae (Trichoptera). Their barbels—four sensory organs before their mouths—allows for navigation and locating food through olfactory, tactile, and chemosensory cues. They can then suck up food like a vacuum with their protruding mouths and prehensile lips (NOAA, 2009). Considering that foraging behavior is closely tied to substrate type, cobble and wood type substrates make foraging difficult for sturgeon (Chiasson, 2011).

## Tolerance and Habitat Needs

The tolerance range for any species describes the zone of favorable conditions for various abiotic environmental factors such as temperature, nutrient availability, sunlight, dissolved oxygen, etc. The combination of these tolerance ranges defines the acceptable range for a given species to survive. Alternatively, the “tolerance” for any factor also refers to the ability to endure unfavorable conditions. Tolerance curves are developed for species at differing life stages, as well as various behaviors. The tolerance curves for lake sturgeon are included below (Figure 23 and Figure 24) for adults and during spawning. Suitable habitat for adult lake sturgeon is generally deeper than 3 meters and slow, as in a lake, with sand or gravel substrate. When spawning, however, the suitable habitat is approximately 1.25 meters deep with a velocity of 25 cm/sec over boulders.

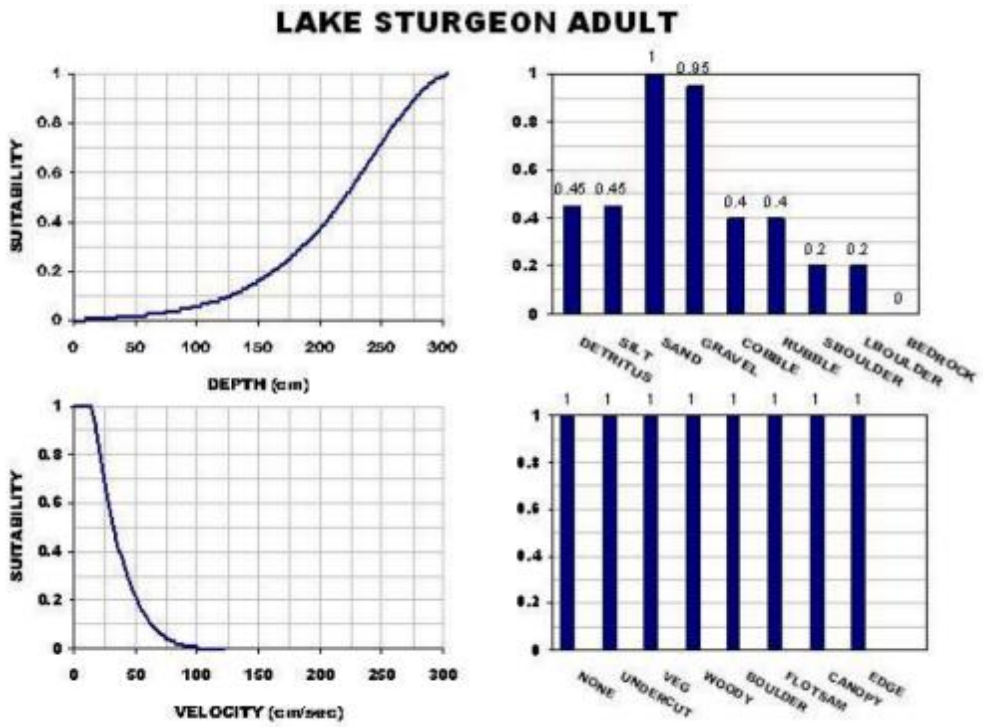


**Figure 23. Tolerance curves of adult lake sturgeon (Minnesota DNR)**

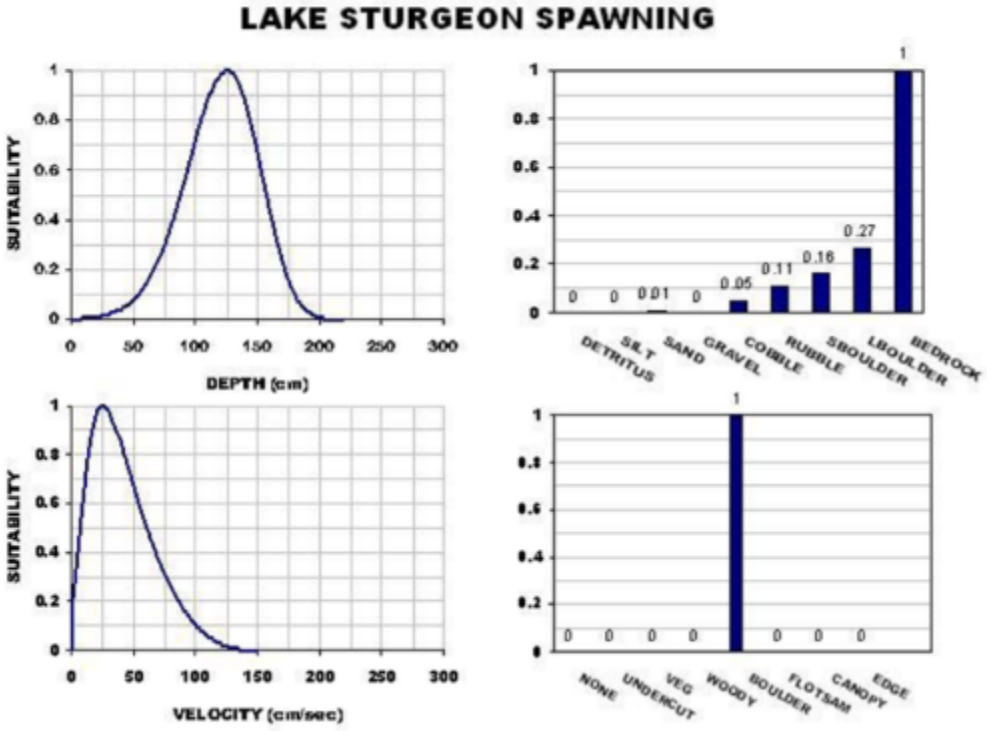


**Figure 24. Tolerance curves of spawning lake sturgeon (Minnesota DNR)**

To understand the limits on sturgeon, a number of studies have explored the impact of several environmental factors on sturgeon such as: dissolved oxygen, light, temperature, flow regime, and substrate. However, this understanding is complicated by the fact that tolerance ranges changes for different life stages and behavior.

- Dissolved Oxygen: Typically, sturgeon are sensitive to decreases in dissolved $O_2$ concentration; hypoxic conditions impair their respiratory metabolism, foraging activity, and growth rates (Cech and Doroshov, 2005).
- Light: Daily light cycles appear to regulate growth and reproduction similar to salmonids (Cech and Doroshov, 2005). Light input in shallow waters is related to foraging effort; sturgeon species generally prefer dimly lit, moderately turbid water, which reduces defensive actions by invertebrates.
- Temperature: Low response to temperature change implies they are relatively tolerant to temperature ranges; adult lake sturgeon prefer warm-water in the range of 10-16°C, and juveniles show more activity and growth at 19°C than 6°C (Peake, 1999). Juvenile sturgeon are vulnerable to stress with temperatures outside their tolerance range, leading to decreased activity and foraging behavior (Wilkes, 2011).
- Flow Regime: Adult sturgeon prefer nearshore habitats around 15-30 feet deep and natural hydrograph regimes typically encourage more spawning behavior (Auer, 1996).
- Substrate: Preference for substrate type is related to foraging, spawning, and predator avoidance behavior. Juvenile lake sturgeon significantly prefer a sand substrate, compared with rock or gravel substrates, to avoid predators (Peake, 1999). For spawning, lake sturgeon migrate into rivers and seek favorable temperatures and gravel substrate or rapids where they can have the best chance of reproductive success (Auer, 1996); gravel substrate provides a surface for sticky sturgeon eggs to adhere and temperatures should be adequate for larvae stages during development.

**Human-induced Mortality**

Although an evolutionarily old fish, the lake sturgeon populations have declined throughout their historic range; 19 out of 20 states in the original range for lake sturgeon now list the species as endangered, threatened, or special concern. This decline is attributed to overharvest, barriers to migration, and disturbance of habitat through pollution (Rochard et al., 1990). Prior to the 1900s, lake sturgeon were caught and killed as a nuisance fish because they would get caught in fishing gear set for other species. When their caviar, meat, and isinglass (a type of gelatin) became specialty products, the lake sturgeon populations were fished heavily, both commercially and

though poaching until collapse in the mid-1900s (Peterson, 2007). A black market was established to sell local lake sturgeon eggs as caviar, which is usually made from Russian beluga sturgeon. Subsistence-based lifestyles historically considered sturgeon as a significant food source in areas with access to sturgeon populations. Due to economic shifts and lifestyle changes harvest and nuisance killing has subsided. The Sturgeon Guard program was also largely responsible for helping to curtail poaching (MDNR, 2017h).

**Restoration Efforts**

Remnant populations in the Great Lakes basin are slowly rebounding under protection and restoration efforts. The current focus on improving the status of the lake sturgeon is driven by Michigan's Lake Sturgeon Rehabilitation Strategy, which details goals for sturgeon populations in Michigan waterways, management strategies available to fishery managers, and a scheme for prioritization of management actions (MDNR, 2012). The strategy addresses mortality and recruitment limitations, indicating that degradation of spawning and nursery habitat and reduction in habitat connectivity due to hydroelectric dams are major concerns. Rehabilitation efforts and research often consider issues related to hydroelectric dams such as connectivity and habitat restoration.

Since the lake sturgeon are not federally listed under the Endangered Species Act and qualify for conservation status in select states, management plans are largely state efforts. Sturgeon rehabilitation plans have been developed in Ohio, Wisconsin, Minnesota, New York, Michigan, and Ontario (Welsh, 2004). The MDNR Fisheries Division first created a Sturgeon Rehabilitation Strategy in 1997, and updates the strategy every fifteen years (MDNR, 1997). The rehabilitation strategy first identifies the objectives for sturgeon population; conserve self-sustaining populations and rehabilitate depressed populations to be self-sustaining. Then it describes management options through reducing mortality, stocking, and habitat rehabilitation. Management tools focus on: minimizing harvest of populations smaller than 750 adults and maintaining fishing mortality at or below 2%-5% per year; improving habitat conditions, access, and connectivity; supplemental stocking; managing invasive species; and educating the public. Next, the strategy identifies possible site-specific barriers to achieving these objectives, such as fish passage, hatchery needs, and an analysis of the genetic stock (MDNR, 2012).

Furthermore, the Great Lakes Fishery Trust sponsored a workshop in 2011, to bring together forty representatives from natural resource agencies and identify knowledge gaps about sturgeon

status and constraints (GLFT, 2012). The proceedings from this workshop are used to inform strategic funding for research to enhance fish passage at hydroelectric facilities. The Trust is a nonprofit organization, the result of a settlement agreement to mitigate fish loss at the Ludington Pumped Storage Hydroelectric plant, that answers to a Board of Trustees comprised of representatives from state agencies and tribal nations. It provides funding through grants to projects that enhance, protect, and rehabilitate fisheries in the Great Lakes. The goal of the workshop was to refocus research efforts for sturgeon rehabilitation and foster collaboration among resource managers, scientists, planners, and industry. Discussion touched on ways to mitigate the effects of dams on sturgeon, such as blocked migration to spawning habitat and degradation of suitable nursery habitat, but it was clear that current fish passage and knowledge were not sufficient.

# Appendix V

## THE GRAND TRAVERSE BAND OF OTTAWA AND CHIPPEWA INDIANS' RESOLUTION FOR DAM REMOVAL (GTB, 2015)[7]

**WHEREAS:** The Grand Traverse Band of Ottawa and Chippewa Indians (GTB) became federally-recognized as an Indian Tribe having a government-to-government relationship with the United States effective May 27, 1980 (see 45 Fed. Reg 18321-322 (March 25, 1980); and

**WHEREAS:** GTB is organized under a Tribal Constitution approved by the Secretary of the Interior on March 29, 1988; and

**WHEREAS:** GTB has a full Tribal Council currently consisting of Alvin V. Pedwaydon, Tribal Chairman; JoAnne Cook, Vice Chair; Thomas P. Shomin, Treasurer, Councilor; and Mark L. Wilson, Councilor; and

**WHEREAS:** the Tribe, in honor of its traditional and cultural heritage places a high priority on the preservation and responsible use of its natural resources in the 1836 Treaty Ceded Territory; and

**WHEREAS:** the Tribal Council, in awareness of the human, industrial, and commercial impact on the environment, realizes the significant role of protecting the forest, wildlife, fisheries, and water resources for the cultural, spiritual, and continued exercise of Treaty Reserved Rights under the terms of the Consent Decree entered in United States v. Michigan, in 2007 and

**WHEREAS:** the Black River is located in Cheboygan County which is within the 1836 Ceded Territory; and

**WHEREAS:** there are three dams located on the Black River: 1) Alverno Dam - Built in 1903 and located downstream in the lower portion of the Black River, 2) Kleber Dam - Built in 1949 and

[7] The Little Traverse Bay Bands of Odawa Indians' motion contains almost identical language, the primary differences stemming from it being a motion as opposed to a resolution and LTBB's later date of recognition by the United States Congress.

located up stream in the up portion of the Black River, 3) Tower Dam - Built in 1918 and located up stream in an upper most portion of the Black River; and

**WHEREAS:** Tower and Kleber dams (FERC No. 10615) were relicensed 5-11-1994 with a 30 year term to end 4-30-2024 and Alverno dam (FERC No. 11730) was licensed 12-4-2001 for 40 years to expire 11-30-2041; and

**WHEREAS:** the dams are owned by Nelson Turcotte; and

**WHEREAS:** the Black Lake System (Black Lake and its out flows and tributaries including Black River) has historically supported a vibrant and robust Lake Sturgeon population; and

**WHEREAS:** the Black Lake System currently supports a diminished lake sturgeon population almost entirely composed of individuals of hatchery origin; and

**WHEREAS:** scientific literature, peer-review publications, and Tribal-, state-, and federal-authored technical reports overwhelmingly implicate dams as a primary impediment to lake sturgeon reproduction and recovery; and

**WHEREAS:** The Upper Black River is 57 Miles long and lake sturgeon only have access to 6.8 miles (or 12%) of the river (From mouth to Kleber Dam) and available habitat for sturgeon and has not allowed for meaningful natural recruitment for more than three decades; and

**WHEREAS:** the federally entered 2007 Inland Consent Decree states in Section 17.3 that “The state and the Tribes shall discuss strategies for rehabilitating sturgeon populations…”; and

**WHEREAS:** the State of Michigan and Tribes have established a work group to develop a Black Lake Sturgeon Management Plan in which the Black River dams have been identified as an impediments to a self-sustaining and naturally reproducing Lake Sturgeon population in the Black Lake system; and

**NOW THEREFORE BE IT RESOLVED,** that the Grand Traverse Band of Ottawa and Chippewa Indians requests that the FERC not relicense the dams upon their expiration dates; nor shall

entertain any proposals requesting an extension of said license beyond the current dates of expiration.

**BE IT FURTHER RESOLVED,** that the Grand Traverse Band of Ottawa and Chippewa Indians hereby requests that the State of Michigan, the 1836 Treaty of Washington Signatory Tribes, and the owner, begin developing a plan to decommission and remove the dams within one month of the signing of this resolution.

**BE IT FURTHER RESOLVED,** that the Grand Traverse Band of Ottawa and Chippewa Indians hereby calls for the removal of the dams prior to or immediately upon the expiration of their FERC operating licenses.

# Appendix VI

## TRIBAL TREATIES

These motions also reference important historical and recent agreements between the five tribal nations (GTB, LTBB, the Sault Ste. Marie Tribe of Chippewa Indians, the Bay Mills Indian Community, and the Little River Band of Ottawa Indians), the federal government, and the State of Michigan as standing for their motions. The 1836 Ceded Territory is in reference to the Treaty of Washington wherein the United States federal government obtained legal title to the land from the headmen of the GTB and LTBB as part of its process of granting Michigan statehood (Bzdok et al., 2008). The boundaries, which cover 13,837,207 acres of lands and inland waters, are formally defined in Article 1 of the Treaty of Washington (Kappler, 1904; MDNR, 2007). This ceded territory is delineated in orange in the map in Figure 7.


**Figure 25. Map of 1836 Ceded Territory (Zaid, 2015)**

The 2007 Inland Cultural Consent Decree was negotiated in order to resolve one main point of contention related to the 1836 Ceded Territory, which was the question of whether the Ottawas and Chippewas also ceded their right to continue using the land and waters within the ceded boundaries (United States v. Michigan, 2007). The controversy related to the 1836 Ceded Territory was that, although the tribal nations gave the US title to the land, they believe that they had not ceded their right to use the land's natural resources. While a 1979 court decision in US v. Michigan addressed tribal nations' claims to resources in the Great Lakes, it left inland rights unresolved (United States v. Michigan, 1979). In September of 2003, the State of Michigan filed a claim in court to resolve the inland disputes, which eventually concluded on November 2, 2007 with the Consent Decree (GTB NRD, 2008; MDNR, 2007). Broadly, the agreement allows for a more cooperative form of management over joint resources, such as lake sturgeon populations in Black Lake (United States v. Michigan, 2007).

In addition to these agreements between the State of Michigan and the five tribal nations, the United States Federal Government also has policies governing their engagement with tribal governments. On November 5, 2009, President Obama released a memorandum on tribal consultation that charges executive agencies and departments "with engaging in regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications" (Obama, 2009). In relation to the Tower and Kleber Dams, since the impetus for a decision is related to the FERC license, FERC will need to engage the five tribal nations in a meaningful dialogue as it proceeds in that process.

# Appendix VII

## LESSONS FROM DAM REMOVAL CASE STUDIES

There is a growing body of literature that details examples of dam removal scenarios, as well as several studies which summarize learnings from dam removals in recent decades (Oliver, 2017; Grant, 2015). In addition to looking at the ecological impacts of dams and dam removal, certain cases demonstrate the respective planning processes and social impacts.

Below, we highlight characteristics of dam removal processes by looking at the following factors: impetus for decision-making process; process structure and parties involved; result of the decision-making process including outcome, costs, and how responsibility was assigned; and subsequent impacts to the ecosystem, amenities, and community perception. An effort was made to describe dam removal processes that addressed similar concerns that were expressed regarding Tower and Kleber dams.

A table, on the following page, highlights some of the key takeaways from each of the dam removal case studies. More in-depth discussions are provided on the subsequent pages.

| | Reason for removal | Engagement Processes | Public Support | Ecological Considerations | Who Paid? | Lesson Learned |
|---|---|---|---|---|---|---|
| *Bear River Valley Recreation Area Project* | Create parks & whitewater, revitalize community | City planners, public meetings | Much community support, voted use of tax dollars | Restore multi-dam area & add enhancing features | City of Petoskey, with tax increment financing | Whitewater can be an exciting & widely valued asset |
| *Song of the Morning Dam, Pigeon River* | Dam breach with sediment release & fish kills | Lawsuits, out-of-court settlement, partnerships | Little public support; active opposition by state, Trout Unlimited, residents | "Ugly" transition period & revegetation | Matched funding Golden Lotus Inc. (dam owner) & state grants | Loss of public support led to negative view of dam removal |
| *Menominee/Sturgeon River* | Improve sturgeon spawning, create whitewater | Wilderness Shores Settlement Agreement; Menominee River Fish Passage Partnership | Whitewater rafters support; Willing to pay for tradeoffs: hydroelectricity & fish passage | Sturgeon spawning access via fish passage | We Energies (dam owner); MDNR | Retaining dams can also be successful with fish passage |
| *Saunders Dam* | Improve brook trout habitat | MDNR acquired land; Partnership formed | Local businesses, Huron Pines, USFWS | Coldwater fish habitat & surrounding State Forest | Matched funding by MDNR & partnership | General support & low cost for small-scale dam removal |
| *Klamath River Dam Removal Project* | FERC relicensing process | Public meetings, dedicated website | Large stakeholder engagement | Salmon & steelhead restoration | PacifiCorp ratepayers & the State of California | Good stakeholder involvement & public transparency can allow for buy-in despite conflict and disagreements |
| *Boardman River Dams Project* | Owner-initiated due to cost concerns | Multi-agency & organization workgroups, dedicated website | Broad stakeholder engagement, but some critics | Habitat restoration for coldwater species (brook trout, dace, sturgeon) | State & federal agencies, private foundations | MDNR may still play an important role despite not being the final decision-maker for the process |

## Bear River Valley Recreation Area Project

### City-run, publicly supported dam removal and whitewater creation

The dam removal process in Petoskey serves as an example of a City- and resident-initiated project whose purpose was to transform the river into a community asset especially featuring whitewater opportunities. Five dams were built along a quarter-mile stretch of the Bear River through Petoskey's industrial downtown. The largest of these dams was the Mitchell Dam, built in 1901 and upgraded for electricity generation in 1933. By 1973 hydroelectric production on the Mitchell Dam had ceased, three of the five dams had been removed, and the City created a comprehensive master plan for the river valley including a whitewater park. City residents were on board with the plan and voted approval for a Tax Increment Financial Plan to use taxes to help pay for the project. The City removed the remaining dams by 1992 and the $2 million project to create a park and whitewater area, planned with several public meetings, was completed in 2010-2011 (City of Petoskey).


City of Petoskey: T. Knusten

The 36-acre Bear River Valley Recreation Area is a natural park that includes a quarter-mile whitewater boating area, natural forests, trails including the North Country Trail, boardwalks, two shelters, two restrooms, five parking access points, many access points to surrounding neighborhoods, and stormwater improvements (City of Petoskey). The Bear River has more fall than any river in Michigan's Lower Peninsula, and the .25 miles in the new Bear River Valley Recreation Area drops 80 feet and reaches 3-4 class rapids. The new stretch of river was restored after dam removal and enhanced with added features like boulders, logs, rollovers, and ledges (Visit MI Up North). It has become a popular recreation destination for both Petoskey residents and visitors from across the country. The Northern Michigan Paddling Club formed around this new whitewater, and now shares whitewater kayaking safety and opportunities in the area (City of Petoskey). Reviews of the park reveal active tourism and five-star ratings. The City of Petoskey

calls their park a “gem” and the director of Petoskey Parks & Recreation says “it is an asset to our parks system” (Dewey, 2013).

## Song of the Morning Dam, Pigeon River

**Process initiated by operational failure; Still ecologically transitioning**

Song of the Morning Dam removal is an example of a process that left people skeptical toward dam removal. The removal of the Song of the Morning dam on Pigeon River was completed in September of 2016. The project was an agreement between Huron Pines, Pigeon River Country Association, Golden Lotus Inc., Michigan Trout Unlimited, Michigan Department of Natural Resources, and the Great Lakes Fisheries Trust, and was reported to cost $570,000 (Breen, 2016). The removal was jointly funded in equal proportion by the dam owner and through state grants. Pigeon River is a designated Blue Ribbon trout stream and is located near Pigeon River Country State Forest.

However, the impetus for the collaborative project was a response to a failure in dam operation that resulted in release of sediment and fish kills. The public and downstream landowners took notice and the State of Michigan filed suit against the dam owner, with Trout Unlimited and Pigeon River Country Association. Coming to an agreement outside of court proceedings, the collaboration allowed for state funded grants to support the removal.


Huron Pines

Public perception of the sediment release event, court proceedings, and post-removal transition period have left a negative view of dam removal. The drawdown of the 45-acre impoundment released black silt and revealed bottomlands that had been inundated for nearly a century. According to a Huron Pines representative, drawdown is “not going to be pretty; just like any surgery, there’s a little bleeding at first” (Breen, 2016). Plants that vegetate within the first season will have shallow root structure that serve to stabilize the exposed soil until later successional plants can take root (Breen, 2016).

## Menominee/Sturgeon River

### Rapids for habitat and whitewater; Fish passage alternatives considered

As a result of the Wilderness Shores Settlement Agreement, the removal of Sturgeon Dam is part of a mitigation effort made by the owners, We Energies, federal and state resource agencies, and the Michigan Hydropower Reform Coalition in 2001 (MDNR, 2017d). Sturgeon River Dam, located on Sturgeon River near Norway, MI, was a 45-foot hydropower dam that was removed to provide access to sturgeon spawning habitat and create new recreational whitewater. The removal process was started summer of 2003 and completed autumn of 2005 (MDNR, 2017d).

The removal of this structure occurred in phases over 2003-2005 and opened spawning habitat for lake sturgeon coming up from Menominee River. Phasing the removal allowed for the reservoir to drain and sediment transport to stabilize, reducing impacts to fish and wildlife. Additionally, removal of the Sturgeon Dam has resulted in a new paddling destination, in proximity to other paddling favorites (American Whitewater, 2017). Yielding approximately 0.3-0.6 miles of whitewater located in a scenic gorge, this reach could offer class III and IV rapids during early season and class II and III in summer months.

Downstream of the confluence of Sturgeon River and the Menominee, a series of five dams were recently reevaluated in a relicensing process with a focus on fish passage (MDNR, 2017d). Although these dams, called the Menominee and Park Mill Hydroelectric Projects, had a FERC license that ended in 2015, the decision-making process began ten years prior with the formation of the Menominee River Fish Passage Partnership in 2005. The implementation team, including fish biologists, engineers, ecologists, economists, and regulatory specialists, identified fish passage alternatives and performed a feasibility study with an emphasis on lake sturgeon. Alternatives were screened for effectiveness, efficiency, and acceptability, and now allow for sturgeon to reach historic spawning sites 82 miles upstream while the dams remain in place (FWS, 2015).

## Saunders Dam, East Branch of the Upper Black River

### Brook Trout Management

The Upper Black River is a well-known Blue Ribbon Trout Stream managed for brook trout; removal of Saunders Dam provides an example of dam removal specifically intended to improve conditions for brook trout, a species that needs cold, oxygen-rich water to thrive. Saunders Dam

impounded a 12-acre area that warmed the river and created an obstruction for trout passage (Engle, 2015).

Removal of the dilapidated 5-ft hydropower dam was completed in 2013 after a 517-acre parcel of land was acquired by MDNR for the purpose of dam removal, habitat improvement, and addition to Pigeon River Country State Forest (MDNR, 2017). Funding for the project, $65,000, was raised and matched by a partnership which included U.S. Fish and Wildlife Service, Huron Pines, Michigan Department of Natural Resources, Upper Black River Watershed Council, and local businesses (Engle, 2015).

## Klamath River Dam Removal Project

### Good stakeholder engagement and public transparency and involvement

The decision-making process for the Klamath River Hydroelectric Project provides an example of good stakeholder involvement as well as public engagement and transparency. In 2004, PacifiCorp submitted an application for relicensing of the Klamath River Hydroelectric Project, a seven-dam system in California and Oregon (PacifiCorp, 2017). In doing so, they also began to engage in discussions with a wide variety of stakeholders to help resolve long-standing conflicts of water and other natural resources in the Klamath Basin (Oregon Department of Justice, 2016). The resulting negotiations engaged more than 50 different organizations representing conservation groups, Indian tribes, farmers, fishermen, irrigators, counties, and state and federal agencies (KlamathRestoration.gov, “FAQs”). These negotiations resulted in two separate agreements, the Klamath Hydroelectric Settlement Agreement (KHSA) and the Klamath Basin Restoration Agreement (KBRA). These two agreements, in conjunction, formed the framework of questions and goals through which 1) the Secretary of the Interior, would determine whether removal of four dams would be appropriate, and 2) stakeholders would work to restore the basin and ensure all interests were addressed (KlamathRestoration.gov, “FAQs”).

There are several noteworthy characteristics of the Klamath Dam process that can inform discussions of Tower and Kleber dams. First, the dam owner initiated the broader negotiations alongside the relicensing process. This allowed it to leverage other stakeholder interests to reduce costs and risk to itself and its customers (PacifiCorp, 2017). Second, the process engaged a wide variety of stakeholders and therefore a broader set of issues and concerns that had to be negotiated. This, however, was critical in ensuring the longevity of the agreement and preventing future litigation challenges, since many of those interests were addressed and represented in the

process. Finally, the Klamath process did a great job at ensuring transparency to the general public so that the voice of non-organized interests were also represented in final decisions. In addition to more traditional public engagement as required by the National Environmental Protection Act (NEPA), the U.S. Department of Interior also developed a website wholly dedicated to the project, KlamathRestoration.gov. This website serves as a repository for any and all actions related to the projects, such as with formal scientific reports and meeting notes (KlamathRestoration.gov, "Home"). The website also functioned as a way for the public to submit written comments about the project (Klamath Settlement, 2010).

## The Boardman River Dams Project

### Role of the Michigan Department of Natural Resources in dam removal processes

The Boardman River Dams Project "is the most comprehensive dam-removal and watershed-restoration effort in Michigan's history and represents a model for how diverse organizations can collaborate effectively to work through complex issues that span multiple jurisdictional boundaries" (MDNR, 2017d). A goal of the removal was to restore habitat for cold water species, such as brook trout, dace, and lake sturgeon. This project, in addition to serving as a model of collaborative decision-making that the Tower and Kleber dams process can learn from, is also informative as a demonstration of the role that MDNR has played in past dam removal negotiations.

With Boardman, MDNR served as just one of many members of the "diverse organizations" involved in the Boardman River Dams Project. After the dam owners initiated the process due to economic concerns (the revenue of hydropower production was outweighed by the potential costs of repair and maintenance, $8 million vs. $16 million), MDNR was represented as one of eight members of the "Implementation Team," which provides oversight over the overall process and consists of key government agencies at local, state, and federal levels, as well as other non-governmental stakeholders (The Boardman River Dams Project, "Participation"). Therefore, although MDNR played a key role in the process, they were not an initial decision-maker. Instead, the decision rested in the hands of the dam owners themselves, in this case the City of Traverse City and the Grand Traverse County (The Boardman River Dams Project, "Dam Project"). As of 2009, however, the City of Traverse City and Grand Traverse County passed resolutions to allow the Implementation Team to make recommendations and decisions about the planning and direction of the dam removal project (The Boardman River Dams Project, "Participation").

# Appendix VIII

## INTERVIEW GUIDE

[Probing questions are provided below in brackets]

**A. First, I would like to get a sense of your experience living in the Black River area.**

1. Tell me about your connection to this area.
    a. How long have you lived here?
        i. [Tell about your family's history in this area.]
    b. [What sort of activities do you do for work there?]
    c. [What sort of activities do you do for fun there?]
2. Now I'll ask a few questions to see how the community interacts from your perspective. Tell me about the general feel of the community.
    a. What are some things you like about your community?
        i. Can you tell me about any big changes or turning points in your community?
3. We'd like to hear about your relationship with the environment in the area. You mentioned [fun outdoor activity] earlier, could you tell me more about the outdoor activities you do in the area?
    a. We know many people in this area are passionate about fishing. How about you?
        i. [Tell me about what a normal day of fishing is like.]

**B. Now that I know a little about your background and perspective, I'd like to narrow in on Black River and the Tower and Kleber Dams.**

1. How do you use or otherwise experience Tower Pond? and Kleber Pond?
2. From your perspective, what do you think are some impacts of the dams?
    a. What do you think are some benefits from the dams?
    b. What do you think are some consequences from the dams?
    c. What impacts do you think other community members might see relating to the dams?
        i. Which groups in the community would be particularly affected by the decisions about the dams?
3. The lake sturgeon is considered threatened in Michigan.
    a. How do you feel about the harvest limits?
    b. How do you feel about the rearing facility? Is it worth the money or effort?
    c. How actively involved are you in events related to the lake sturgeon?

**C. Now I would like to talk a bit more about the future of the Black River and the Tower and Kleber Dams.**

1. A decision about the future of the dams may be made in the next several years. As a member of the community who will have to live with the outcome, what do you want to see considered in that decision?
    a. What other issues do you see in the situation?
    b. What are some of your concerns about addressing the issues?
    c. Where do you feel like your community might disagree on this decision?

2. If the dam(s) were removed, a river fishery might reestablish itself. How would that affect you? How would you feel about that?
3. If a decision is being made, what concerns might you have with the process of making that decision?
    a. How would you like to be involved?
    b. What might stop you from being involved?
    c. Who else should definitely be involved?
4. The Tower and Kleber Dams are up for relicensing in just a few years. If you were the dam owner, what options would you consider for the future of the dams?
    a. What information would you want to know before making that decision?
        i. We are currently in the process of compiling information to give to the public. What would you want us to include?

a. [What alternatives, if any, would you want to see investigated?]
    i. Alternatives could mean managing the sediment, fish passage, or other bypass structure…

**D. That about covers my questions, let me see if I got this right:**

1. We're trying to understand the full range of opinions; who else do you feel we could talk to about this decision?

# Appendix IX

## PUBLIC MEETING NOTICE FLYER

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# Upper Black River Dams Meeting

**Where**: Forest Township Hall (located at 9511 M-68)
**When**: 2 to 5 pm on February 11, 2017


## Exploring Impacts of the Tower & Kleber Dams

Come to Forest Township Hall, located at 9511 M-68, on February 11, 2017 from 2 to 5 pm to take part in an important town hall meeting to have your voice heard! If you are not already aware, the license for Tower and Kleber dams is up for renewal in the next several years, and we want to hear your issues and concerns related to the dams at this early phase of the process. The conversation that begins at this meeting will help inform the evaluation of the relicensing effort.

### Meeting Goals

- Provide a **brief summary of results** from a University of Michigan scoping effort to examine values and opinions from around the community.
- **Answer clarifying questions** and **get your input** on findings, concerns, and issues to be addressed.
- **Begin a community conversation** that will guide the decision-making process over the next several years.

### Topics to be Covered

- Fishing
- Sturgeon
- Impoundment Property
- Dam Infrastructure
- Economy, Recreation, & Tourism
- Black Lake Water Levels
- Ecological Health
- Sedimentation

This meeting is being co-sponsored by the Michigan Department of Natural Resources and the Grand Traverse Band of Ottawa and Chippewa Indians. A team of graduate students affiliated with the University of Michigan School of Natural Resources and Environment is conducting this preliminary phase to inform decision makers about immediate and long-term concerns related to Tower and Kleber dams.

For more information, please email our team at: ***UMBlackRiver@umich.edu***

# Appendix X

## PUBLIC MEETING COMMENTS AND NOTES

This document provides a list of the key questions and comments posed during the public meeting hosted by the University of Michigan team and MDNR at the Forest Township Hall on February 11, 2017. These notes are based on conversations during the full presentation and the smaller flipchart breakout sessions as well as written comments. These comments were used to inform our final report.

As feasible and appropriate for the scope of our project, comments were directly incorporated into our preliminary findings report. Comments outside the scope of our project, such as questions for future research, inform our recommendations for future stages of the decision-making process.

A recording of our presentation was produced by Sunrise Cable Network's David LaClair and is available online here: https://vimeo.com/203940534.

### Tower and Kleber Dams

#### Dam Ownership

- What is the progress of the sale of the dams since the dam owner has put it on the market? Is there information that is available to the public?
- If the dam owner "walks away" from the dams, would they be operated? Would the County take over ownership and just open the gates and let "mother nature" take over?

#### Dam Operation

- What is the level of stratification (thermal) in the impoundments? Is there data available? Are they top draw dams?
- Want more information on the cost of repair for the dams relative to the cost of removal

#### Electricity Generation

- Attendees were concerned about the impact of removing this source of electricity generation on the regional utility.
- The current hydro-electrical generation is great. It saves them from having to deal with future increases in energy prices, they never have power outages

## Alverno Dam

- [Written comment] A former Consumers Energy employee also wanted a record of the Alverno meeting and was concerned about what would happen if Alverno was removed or failed.
- [Written comment] A meeting attendee wanted to know about how Alverno dam would affect lake levels in Black Lake.

## Dam Removal

### Future Scenarios

- Attendees were concerned about the timing of the transition from pond to river
- How much do we know about the historic hydrology in the impoundments? What course would the river take? What is the historic floodplain and would it affect landowners or the public?
- Want more information on the cost of repair for the dams relative to the cost of removal

### Example Removal Projects

- Other dam drawdown example: Oneida River in WI
- Suggestion to talk to people at Conservation Resource Alliance (CRA) about the Boardman Experience
    - What were unexpected things that came up?
    - What were the landowner reactions like?

## Governance

- Concerned about who will manage the decision and implement what is decided
- [Written comment] “Remember part of Black Lake is in Presque Isle County.”
- Want to know who are all the interested groups in this process: federal, state, tribal, etc.

## Tribal Interests

- Concerned about the interests of tribal nations in Tower and Kleber dams due to past experience in Emmet County and perception that they are trying to take over all of the land

    - "Finely define tribal interests [...] The tribes are trying to take all of Emmet County right now [...] Those treaties were so poorly written and poorly defined. It all boils down to who gets the best attorney."
    - Also an associated suspicion or skepticism of the weight and legal standing of treaties
- Local resident expressed concern about renegotiating hunting and fishing rights
    - General tone of skepticism and confusion
- It would be good to have a deep understanding of treaties and legal implications
- Perception that the tribes are one of the main reasons this process is starting and are concerned that they will "kick up dust" if it doesn't go their way
    - "I can't fault them. They may have very legitimate ground to stand on, but my concern is can they do that here? If they are the ones that go this started and it doesn't go their way the first time, you gotta anticipate the next step. Where would the opposing party go next?"

**Land Ownership**

- Interested about who currently has property rights to different parts of the bottomlands (land underneath Tower and Kleber ponds)
- Want to know exactly what the Tower Kleber Limited Partnership owns
- Want more specifics (property-by-property boundary changes) on who will own what pieces of newly exposed bottomlands if dams are removed
    - Wanted to know who would know that information
    - Interested in having a central location for that information for property owners to look to see what would happen to their land if dams were removed
- Very important to determine where the water line would be and check facts on property extension; whether landowners would get new property to waterline or if the utility would retain it because they own the bottomland of the ponds
- [Written comment] "If removal of dam(s) significantly reduce property ownership-or-increase it… What law(s) govern the change? I.e. lake ownership and trespassing on property or natural waterline is already confusing for inland lakes. Can this be clarified before measures are taken that would alter property and access to public use."
- "The rights of the property owners are extremely important"
- Potential new park property on Tower Pond--how would that be impacted by water line/property ownership changes

**Property Value and Aesthetic Concerns**

- Concerned about loss of property value if the dams are removed, resulting in muddy areas in their backyards
    - Pointed to instances in the past when ponds were drawn down, resulting in exposed lands that were muddy and buggy: "Last year when they drained the pond, or two years ago, the flies were so horrendous. You couldn't stand it. [...] It was nothing but a mud pit."
- Skeptical of long-term benefits of moving towards riparian ecosystem
    - But also concerned about timing, since if trying to sell property during transition time to fund retirement, reduced aesthetics in the backyard would be problematic: "I've worked 45 years. I want to retire. How am I going to retire if my whole asset went downriver? [...] That is whole my livelihood. What's going to happens to me? If I become ill, I have nothing to sell."
- If the positive impacts of moving towards a riverine system are associated with improved green spaces (due to newly exposed lands), who would be responsible (paying for and maintaining) for restoring that green space?
    - How much would it cost to improve that green space? Concerned about costs since the area is economically depressed
- Since waterfront landowners are currently paying higher taxes since their property values are higher (due to living on the water), would they receive tax reparations if the dams were removed due to loss of property value (or at least loss of the property characteristics they paid for)?
    - "Will they [waterfront residents] get their taxes back? Because they paid for this piece of land that is waterfront property. [...] They pay more because they're on the water and they should be able to get them back because they no longer get waterfront property"
- "Did you get local real estate agents in the area to determine what our property values would increase by by draining that pond?" Want to see a property value assessment by a local realtor for a dam removal scenario
    - Generally skeptical of other studies and would trust the assessment by a local realtor
    - Also want specifics on how much, exactly, property values would change
- "I really question the slide that said property values would remain the same. I totally disagree with that. The real estate community locally has to be consulted, and you have

to have a statement from them saying what they think. They know. It's easy for everybody to get emotional about it, but I can't see property values remaining the same if those ponds [go away]."

- Edge of Tower pond property will probably benefit with increases in beauty, clarity, rapids, but Kleber pond property will decrease in beauty etc.
- Look into the realities of the mud situation
- "This is already a really depressed area. What does it cost per square foot to increase your property value by landscaping it? [...] So I want to put in this whole big green space. Say I gain 50 feet, and I have 750 feet of water frontage. What is it going to cost me?" Concern about the cost associated with improving/restoring the newly exposed lands

## Water Levels

### Hydrology

- How will the overall hydrology of the watershed be affected if Tower and Kleber dams removed? Would Burt and Mullett lakes be affected in terms of lake levels?
- Attendee wanted to know about how Alverno dam would affect lake levels in Black Lake.
- How would removing Tower and Kleber dams affect the water levels in Black Lake?
- [Written comment] "What is the impact to the water level management throughout the Cheboygan watershed? Kleber and Tower are not major players, but the incremental effect of their lake level management is impactful downstream and upstream. Even through Mullett, Burt, Crooked… Not much. But we need a hydrology engineer :) and spring run-off and fall rain storms especially."
    - Generally trying to get an understanding of how the Tower and Kleber decision will impact the broader watershed's flow regime, especially as it relates to changes in flow during storm events
- Where specifically does the water come from? Only precipitation, or groundwater coming up, bubbling through the sand like a spring?
- What would be the new river depth?
- Concern about the river's water level--right now it's shallow, would it get even more shallow?
    - How would the channel change? What would be the river's velocity? Depth?
- Concern about water levels posing a challenge for kayaking and canoeing

**Control over Flooding**

- Even if the Tower and Kleber dams are not important to Black Lake water levels in normal operation, they are important in helping address spring runs and associated flooding, which therefore helps mitigate downstream property damage when there is excessive snow melt. Concerned that removing the dams would make them more vulnerable to flood damage.
    - "If they are gone, then there is no control. And we have been here when Kleber has dumped 8 feet of water, and we did not have a front yard. [...] So if those dams are no longer there and we get very much rain, we have absolutely no protection."
- Dams offer control for stormwater flows
- Concern about stormflow and interest in using the floodplain to attenuate peaks
- Resident expressed belief that ponds offer critical storage and removing the dams would be a loss of control over the river

**Sediment**

- Concerned about silt movement into Black Lake and downriver of the dams
    - Mainly curious about how things would change if the dams were removed
- Want further information about the state-run bi-annual sedimentation management
    - What happens when the sand traps fill up?
- Concern about fish-kill after release of sediment
- Concern about the deposition of sand load at the river mouth (into Black Lake); perceived as an impact on the health of the river
- Want more information on how the silt behind the dams would be managed if the dams were to be removed
- If the dams were removed, where would all of the sediment go?
- What would be the effect of sediment even once it's "stable"--storm impacts

**Contaminants in Sediment**

- Are there toxic sediments in the impoundments and what is the potential for release of toxic sediments from the impoundments if the dams were removed? Who would pay if there were toxic sediments that needed to be removed?
- What's the state of sediment and potential toxins? What would happen to those if dams were removed? Who deals with it/pays for any management?
- Concern about sediment contamination

- [Written comment] “Will sediment be tested that collects from dam removal for toxins/pollutants. If it must be removed, how and who removes it? Cost of removal is paid by the landowner or ???”

**Recreation**

- Keep in mind swimming happens in the ponds
- Swimming is also an important recreational activity in the impoundments
- “My grandkids swim there. Everybody.”
- Recreational use of ponds have steadily increased over time
- There is a lot of activity on the ponds:
  - Springtime canoe race
  - Sailboats
  - Stand up paddleboards
  - Rafts
  - Swimming
    - Kids jump off the bridge to swim
    - At least 15 kids swim there every day in the summer
  - The ponds are deep, there’s not much sediment
  - Residents and visitors alike use the ponds
  - There is also wildlife and a rich ecological community: loons, eagles, deer, etc.
- How would all of these things change if the dams were removed?
  - It would be great to develop a projection of what the river would look like
    - Could there be engineered whitewater?
- Concerned about retaining public use of the water in a riparian system
- Tower Pond is especially well-utilized
- Need to consider public access to ponds and how that would change
  - Would a public access corridor be developed around the new waterline? Would the public access get past the mud?
- Concern about current state of the river with sand bars, etc. that make kayaking and canoeing difficult in the upper reaches of Upper Black River (water levels too low?)
- Lots of primitive camping at Kleber Pond on all the state land--how would that change? Would the camping just be far from the water or would new camping options be created at new shoreline?

- Concern about the river's water level--right now it's shallow, would it get even more shallow?
    - This impacts the ability to canoe--people say it'd be great to have more canoeable miles without portage, but it doesn't matter if it's too shallow to canoe and people have to get out and drag canoes anyway, which is currently the case much of the time
- Look at boating/canoeing impacts--trade-offs between current portages (which they say aren't that big a deal) and shallow dragging if river/pond levels are/get low
- Concerned that moving to a river would make it more difficult to canoe: already it seems like they have to get out of the canoe and "push it halfway down the river. So if the dam is removed, how much worse is that?"
- The ponds (especially Tower) brings people into Tower and Onaway, they're key for economy and business
    - "There is no economy there other than tourism" and "if you take away the pond [Tower] there would be nothing left" --the one bait/party store in Tower would be sure to close
- [Written comment] "I don't think that this would be good for our recreation or our fish population. We have a great ecosystem for trout, bluegill, pike, perch, and migratory birds. I also believe it would hurt our economy."
- Need to pay attention to the fact that economic tradeoffs are not equal in this decision. For example being able to have a kayak outfitter shouldn't outweigh people's property loss
- The Shanty Rapids might return! People remember them, or remember their parents talking about how they always used to go to them and they were a central part of the community
- Potential new park property on Tower Pond--how would that be impacted by water line/property ownership changes?

## Ecosystem Health

### Historic Conditions

- Since the dams have been there for 70-100 years and the ecosystems have become established, how will that be evaluated?
- Historically, Elm and Ash trees shaded the river, helping to cool the water.
- Concern about the old dump/landfill at the upper edge of Tower Pond which operated from 1920-1980 and was started/managed "before they knew how to do it right" so "it's pretty

bad"--it even was deemed a superfund site because of the contaminants, arsenic, batteries, etc.

    - What would happen with this? Would it impact water quality? Would dam removal/pond changes trigger any kind of contaminant release?
- What is the system-wide impact of storage at the ponds and how does it build on each other/synergy/impact things downstream

**Future Scenarios**

- Hydrology impacts to the larger Cheboygan watershed
- [Written comment] "I have concerns about wood turtles and how the sediment will affect wood turtle habitat."
- If the dams were removed, how long would it take to become a "new ecosystem"? How long would it take new ecosystem dynamics to establish?
- Look into temperature impacts to the river and to trout because the new stretches of river would not be shaded by brush and trees

## Fishing

**Preferred Target Species**

- Desire for better trout habitat in upper reaches of Upper Black River; Concerns for negative impacts on this trout habitat
- Concerns about the impact on species (mentioned: smallmouth bass, trout, pike, and bluegill) found in Tower and Kleber ponds; Interest in *close* proximity to the ponds and access to fishing these.
- Concern for reduced habitat for pike
- How would fishing change on the ponds and creek? Especially pike and baitfish
- "I was born and raised [near Tower pond], lived here all my life. My kids live here as well, grandkids will probably live here as well. They've fished this area, they fish pike, bass, bluegill, trout, everything. They live for that. That's something that they grew up doing. How's that going to affect everything else? Black Lake is one thing but this is our area, this is where we grew up. This is what my kids do."
- The Upper Black River is managed for brook trout. What would the effects of dam removal be on the brook trout population? Don't mess with trout fishing!
    - Desire for a more balanced management strategy; not favoring one species over another

    - Concern for increased predation on trout upstream of ponds, if connectivity is reestablished
- Frustration about the emphasis placed on some species over others (especially sturgeon and trout)
    - Expressed a concern about balancing the needs of other fish; getting the most benefit
- Fishing has been worse on the impoundments and upper Black River recently, what are you going to do about that?
- [Written comment] “I don’t think that this would be good for our recreation or our fish population. We have a great ecosystem for trout, bluegill, pike, perch, and migratory birds. I also believe it would hurt our economy.”

**Impacts of Dams on Fishing**

- Concerns about water temperature related to sand traps filling up; heating water in shallow areas; changing habitat availability for species
    - Would this lead to only creek chub (or similar species)?
- Confusion about stratification in the ponds, and effect on fish
- If Tower and Kleber dams are removed, how would it affect the potential for fishing from the backyard for residents on the riparian areas of the Upper Black River? Would there be a closure?
- Concern about the potential for Lamprey introduction in Black Lake system; What is the management/exclusion like at Alverno and Cheboygan dams? Grateful for protection offered by Alverno
- General debate about what caused the decline in people coming up there to fish
    - Maybe just a cultural change (people want different vacations, etc.) or maybe it really is worse fishing
    - But some perceive an increase in fly fishing in river and bait fishing in Tower pond

**Sturgeon**

- Other creeks emptying into Black Lake offer sturgeon spawning habitat too
- Sturgeon don’t only spawn in Black River; they also spawn in the Rainy River
- Resident shares memory of rapids located between Kleber and Tower ponds; Can sturgeon get above these rapids anyway? Will there really be an increase of access or are they blocked by the rapids?

    - Are they physically able to get above the rapids? Not athletic
- Resident believes poaching of sturgeon has greatly declined with the sturgeon guard; How can they continue to protect the sturgeon if they are more spread out upstream?
- [Written comment] “I favor impoundments in the Sturgeon spawning area; good to add access to the additional 7 miles of spawning ground”
- Concern and confusion about sturgeon quota and fishing rights; Will the hunting and fishing rights of the tribes be renegotiated?
- Belief that sturgeon are culturally significant to locals (not just tribes)
    - Economic benefit - tourism, inflow of funds
    - Sense of place - taking care of the species in the river; feeling of connection and protection

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