FOUR LAKES TASK FORCE

The Four Lakes Watershed Status Report

Report Prepared by Spicer Group

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Chapter 1: Introduction

The Edenville and Sanford dam failures had a significant impact on the Four Lakes watershed. Research and studies have historically been conducted on this watershed, with a heightened focus since 2020. This report provides a baseline of the understanding of the current status of the watershed post dam failure, and the plans going forward.

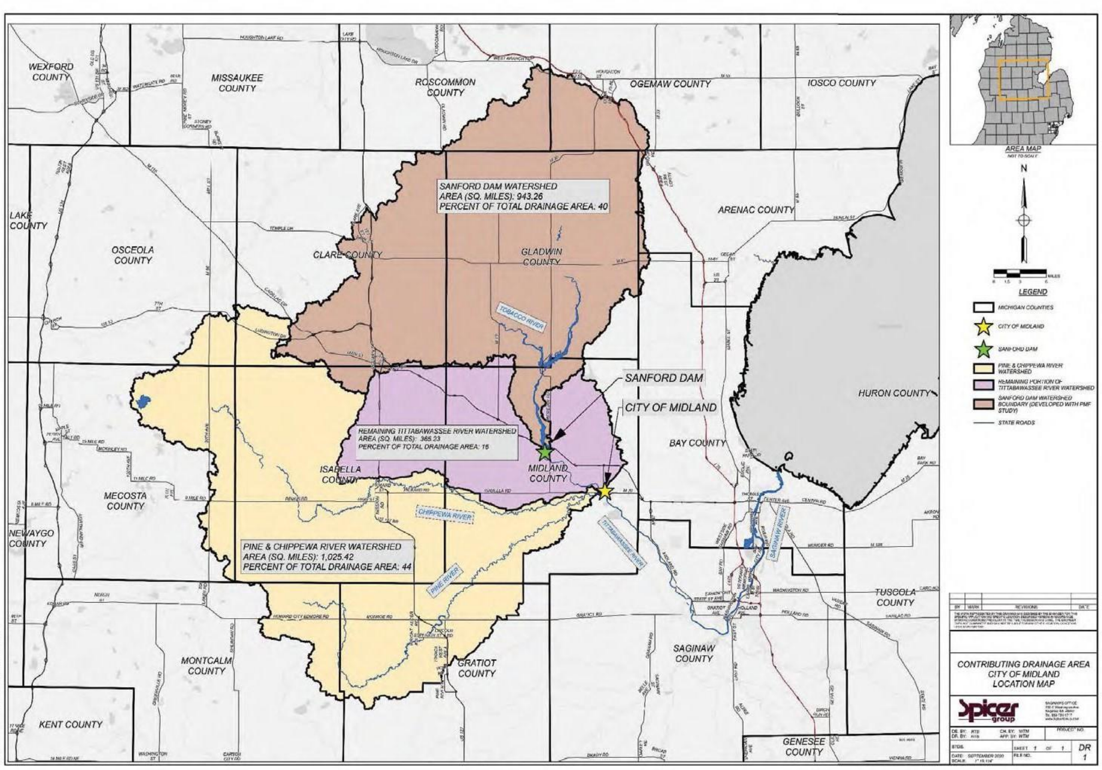
EPA Definition

A watershed is the area of land that contributes runoff to a lake, river, stream, wetland, estuary, or bay. A watershed management plan defines and addresses existing or future water quality problems from both point sources and nonpoint sources of pollutants. Experience over the past decade has shown that effective watershed management includes active participation from stakeholders, analysis and quantification of the specific causes and sources of water quality problems, identification of measurable water quality goals, and implementation of specific actions needed to solve those problems.[1]

Chapter 2: Four Lakes Watershed

The Tittabawassee River is the largest tributary to the Saginaw River, with the Tobacco River as a main subsidiary. The main stem of the Tittabawassee River is 91 miles long with a network of contributing tributaries totaling 621 miles. The river generally flows in a southerly and southeasterly direction to its confluence with the Shiawassee River to form the Saginaw River. The Tittabawassee River has a tributary watershed of 2,471 square miles, the fifth largest in

Figure 1: Four Lakes Watershed



[1] EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters, March 2008

Michigan. The Four Lakes watershed[2] (also referred to as the Sanford Dam Watershed) is 943 square miles and represents only 40 percent of the tributary drainage area to the City of Midland. It is part of the Saginaw Bay Watershed which is nearly 8,700 square miles. The Four Lakes Watershed is home to nearly 10,000 people. The watershed provides habitat for many species of wildlife.

[2] Historically, the four lakes, created by the four dams fell under the jurisdiction of the Federal Energy Regulatory Commission (FERC) so the lakes were defined more by the impoundments. Since they now fall under the jurisdiction of the Michigan Department of Environment, Great Lakes, and Energy, focus is on the watershed, recreation and properties in the watershed.

Chapter 3: Developing a Plan

In the last five years, there has been extensive study of this watershed, and there are many studies that preceded the 2020 dam failures. All can be input into a basin study, which will not be as detailed as the work done for the lake restoration, but will become a framework for the assessment, monitoring, and other data collection requirements to inform future improvement efforts. The report establishes a baseline based on prior work.

Chapter 4: Pre- Failure Ecosystem Review

FLTF's Feasibility Study[3] assessed the viability of the restoration of the Four Lakes to their legal levels, ensuring long-term stability and sustainability. It addressed the legal framework and history related to the restoration, as well as the transition of the hydroelectric dams from private ownership to public ownership. The study also evaluated the impact of the catastrophic flooding that occurred in May 2020, and the subsequent actions taken by the counties to acquire the dams and manage the lake levels. This extensive review of the pre-failure ecosystem as well at the changes observed following the failure has been a huge asset to working towards restoration as the end goal is to restore the ecosystem to the maximum extent practicable to the pre-failure conditions or further enhanced system.

4a. Wetlands

To identify pre-disaster potentially impacted wetlands, the ArcGIS Zonal Statistics Tool was used using the pre-disaster LiDAR. For this study, potentially impacted wetlands were identified at three different levels including 1-, 2-, and 3-foot elevation differences from the pre-disaster surface water elevations. Identifying potential wetlands at these three intervals provides a range of potential impacts. According to the Michigan Department of Environment, Great Lakes, and Energy's (EGLE) Wetland Mitigation Banking Agreement Example, wetlands require saturation within the upper 12 inches of the soil surface for varying periods during the growing season. Therefore, this analysis accounts for potential ranges in soil saturation at varying assessment levels. If any point of the wetland was within this elevation difference, the entire wetland was being considered potentially impacted to some degree. The area of pre-disaster wetlands potentially impacted by the disaster ranges from 2,046.9 to 9,726.2 acres. The types and acres of wetland impacts agreed upon by EGLE that required mitigation are shown in the table below.

Table 1. Summary of Wetlands Impacts

Impoundment Watershed	**Total (Acres)**	**Wetland Type (Acres)**				
		PEM	**PSS**	**PFO**	**PUB**	**Submergent**
Impacted Pre-Disaster Wetlands						
Wixom Lake	1,483	120	93	1,263	8	278
Sanford Lake	980	70	83	819	8	74
Totals	2,463	190	176	2,082	15	352

[3] Four Lakes Task Force Plan for the Restoration of the Four Lakes

4b. Inland Lakes and Streams

Shoreline

As part of the Federal Energy Regulatory Commission (FERC) license, bank erosion surveys on all four lakes were required. Surveys were completed in 1994, 2000, and 2013. The 2013 survey identified five erosion sites around Sanford Lake, 19 sites on Wixom Lake, 29 sites on Smallwood Lake, and 23 sites on Secord Lake[4]. The severity of the erosion was classified as minor, moderate, or severe. Surveys were scheduled for 2020, however they did not occur due to the failure of Edenville and Sanford dams. The shorelines of these lakes are highly developed. Most of the properties around the lakes are privately owned with hardened shorelines such as seawalls or riprap. Shoreline management has been and is the responsibility of the property owner.

Water Quality

Annual water quality reporting was required at each dam to meet the requirements of the FERC licenses. These reports included information on dissolved oxygen and temperature at the dam sites. The FERC licenses also outlined the acceptable limits for each metric. These reports were shared with the Michigan Department of Natural Resources (MDNR) annually as well. Improvements were made from initial reports to the last report completed by Boyce in 2019[5] that positively impacted the water quality and worked to minimize the impact that dam operations had on downstream water quality.

Outside of this reporting, minimal water quality surveys were done within the lake reservoirs. It is known that sediment is a primary pollutant with erosion being a major cause of turbid water and excessive sedimentation in Wixom and Sanford lakes.

4c. Biota

Fisheries

The historic fish community within Wixom and Sanford lakes, prior to the dam failures of 2020, contained a diversity of native cool- to warm-water fishes, as described in the Tittabawassee River Assessment (Schrouder et al. 2009). Sunfishes, including black and white crappie (*Pomoxis nigromaculatus* and *Pomoxis annularis*), bluegill, pumpkinseed (*Lepomis gibbosus*), green sunfish (*Lepomis cyanellus*) and rock bass (*Ambloplites rupestris*) dominated the fish community.[6] Top predators in these systems were black bass (largemouth and smallmouth), northern pike, muskellunge (northern strain; *Esox masquinongy*), walleye (*Sander vitreus*) and channel catfish (*Ictalurus punctatus*). Sanford Lake also supported a resident white bass (*Morone chrysops*) population. Both impoundments also had sizable populations of a variety of redhorse sucker species (*Moxostoma* sp.), white sucker (*Catostomus commersonii*), carp (*Cyprinus carpio*) and black, brown and yellow bullhead (*Ameiurus* sp.). In Sanford Lake, age distributions for the predator species were balanced with good survival to older ages, resulting in desirable numbers of large individuals to attract fishing activity. Periodic stocking of walleye and muskellunge by MDNR supported the fisheries for those predatory species.

Walleye are one of the most popular sport fish species in the state and are widely stocked in Michigan inland lakes and impoundments. Walleye stocking has been an important component of fishery management activities by the MDNR in all four of the lakes for many years. To successfully

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[4] See “Streambank Erosion Inventory” by Boyce Hydro LLC in the Appendix.

[5] See the 2019 Water Quality Monitoring Report provided by Boyce Hydro Power LLC to the Federal Energy Regulatory Commission in the Appendix.

[6] For more information, view the following documents in the Appendix: “Lake Restoration: The Natural Resources and Environmental Plan” by Four Lakes Task Force; “Wixom Lake Restoration – Fishery Scoping Report” by Streamside Ecological Services; “Sanford Lake Restoration – Fishery Scoping Report” by Streamside Ecological Services.

spawn and survive to maturity, walleye require specific conditions that are not found in most Michigan lakes and rivers, thus the need for the ongoing statewide stocking program. In some cases, suitable spawning habitat may be lacking. In other cases, the abundance and species composition and timing of zooplankton available for walleye fry to feed on may be wrong, resulting in poor fry survival. Predation on walleye larvae and fry by other fish species can also impair self-sustainability of inland Michigan walleye populations. If suitable spawning habitat is the limiting factor, it is possible to artificially improve walleye egg deposition and hatching by adding gravel and rock to riverine habitat (Crane and Farrell 2013; Katt et al 2011; Dustin and Jacobson 2003). However, it should be noted that other factors may continue to bottleneck walleye survival and population self-sustainability.

Reptiles and Amphibians

Many amphibians and reptiles rely on the aquatic environment for habitat, reproduction and food. They are also an important food source for a variety of vertebrate species including fish (bass, pike, muskellunge), mammals (mink, otters, foxes, raccoons, skunks, shrews) and birds (herons, bitterns, hawks). Amphibian and reptile populations are threatened by several human activities including alteration, fragmentation and loss of wetland habitats (Harding 1997). Shoreline hardening can also restrict the movement of some amphibians and reptiles, particularly for turtles, between aquatic and terrestrial habitats.

Schrouder et al (2009) reported that 11 frog and toad species, seven salamander species, ten turtle species, one lizard species and 15 snake species occur within the Tittabawassee River watershed. A search of the Michigan Natural Features Inventory (MNFI) county element data for Midland and Gladwin counties resulted in the addition of one more turtle (wood turtle; *Glyptemys insculpta*). In total, three turtle species, Blanding's turtle (*Emydoidea blandingii*), wood turtle and eastern box turtle (*Terrapene carolina carolina*) and three snake species, queen snake (*Regina septemvittata*), Butler's garter snake (*Thamnophis butleri*) and eastern massasauga (*Sistrurus catenatus*) are listed as state special concern; and one turtle (spotted turtle; *Clemmys guttata*) and one snake (eastern fox snake; *Pantherophis gloydi*) species are listed as state threatened. Eastern massasauga is also listed as federally threatened.[7]

Avian Community

A variety of waterfowl species historically used the impoundments, but the commonly found species are the Canada goose (*Branta canadensis*), mallard duck (*Anas platyrhynchos*) and wood duck (*Aix sponsa*).[8] Diving ducks, such as bufflehead (*Bucephala albeola*), were seasonally present. Canada geese can be an annoying nuisance for riparian property owners and should not be intentionally attracted to the impoundments. Mallards and wood ducks are both desirable ecologically and rarely create nuisance issues with lakefront property. Both species are known to use artificial nesting structures when available. Nesting tubes for mallards and nesting boxes for wood ducks can easily be installed in shallow water areas after the lakes are refilled, to ensure predators are unable to reach the nests. Natural shorelines and wetlands benefit wading birds such as herons and bitterns. Ospreys (*Pandion haliaetus*) and bald eagles (*Haliaeetus leucocephalus*) are fish predators and can provide an attraction for birders. Bald eagles were observed at Wixom Lake in 2019 and 2020. Osprey were not observed.

Mussels

Hoeh and Trdan (1984) documented 13 native freshwater mussel species alive and one species that was only found as a shell from 1979-1981 in the Upper Tittabawassee watershed.[9] MNFI

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[7] See "Lake Restoration: The Natural Resources and Environmental Plan" by Four Lakes Task Force in the Appendix.
[8] See "Lake Restoration: The Natural Resources and Environmental Plan" by Four Lakes Task Force in the Appendix.
[9] See "Lake Restoration: The Natural Resources and Environmental Plan" by Four Lakes Task Force in the Appendix.

(2021) has documented five state-listed mussel species (four special concern and one threatened) in Gladwin County and 11 listed species in Midland County (four additional special concern, one state endangered species – black sandshell (*Ligumia recta*) – and the snuffbox mussel (*Epioblasma triquetra*) that is state and federally endangered). A total of 11 state or federally listed mussel species have been reported from the counties of the Four Lakes region. Michigan Mussels Web App (MMWA 2021) highlights the regions of the Four Lakes mussel fauna including four species of concern in the Secord Lake headwaters of the Tittabawassee River as well as the same four species of concern in the Tobacco River/west arm of Wixom Lake and three species of species concern in Smallwood, Wixom and Sanford lakes and portions of the Tittabawassee River.

Mulcrone and Rathbun (2020) gives an up-to-date account of mussel species distribution across Michigan, and they document all species of native mussel presence (common and rare). In the area encompassing the Four Lakes region, the presence of 22 species has been documented, including the state and federally endangered snuffbox, state endangered black sandshell and lilliput (*Toxolasma cylindrellus*), state threatened slippershell (*Alasmidonta viridis*), as well as eight species of special concern. This suggests that 22 species are likely the maximum number of native freshwater mussels to be found in the Four Lakes region. Past data may not reflect true distribution of mussels since much of Michigan’s lakes and rivers have not been thoroughly surveyed using standardized methods (Strayer and Smith 2003). Evidence has shown that in areas where species of mussels are thought to have been extirpated, with increased search effort rare species may still be found alive (Metcalfe-Smith et al. 2000).

Chapter 5: Mitigation Summary

5a. Wetlands

As discussed in chapter six of the Four Lakes Task Force Plan for the Restoration of the Four Lakes[10], the focus of wetland mitigation was on the restoration of hydrology to surrounding wetlands that were negatively impacted with the loss of Wixom and Sanford lakes. Four Lakes Task Force submitted a Pre-Disaster Wetland Impact (Wetland Rehydration) Monitoring Report[11] and follow-up data which includes the methodology and results of the first two years (2022-2023) of studying impacts the drawdown had on wetlands adjacent to Wixom Lake.[12] This monitoring is proposed to continue for a minimum of five years following the restoration of hydrology (lake refill). A monitoring report, which compiles and summarizes all data collected during each year’s monitoring period, will be prepared annually by FLTF and submitted to EGLE. This report will include the measures of inundation and saturation via staff gauges and monitoring wells, vegetation monitoring, photographic documentation, and written summary of the results as discussed in the previously submitted monitoring reports. EGLE will determine if the performance standards of the wetland mitigation monitoring have been met.

Based on the results of these studies, it is estimated that the amount of wetlands negatively impacted by the disaster are greater than those developing on the Wixom Lake and Sanford Lake bottomlands. See Table 2 below.

[10] Four Lakes Task Force Plan for the Restoration of the Four Lakes
[11] See “Pre- and Post-Disaster Wetland Analysis” by Merjent in the Appendix.
[12] See “Pre-Disaster Wetland Impact Monitoring Report” by Merjent in the Appendix.

Table 2. Summary of Wetlands Impacts

Impoundment Watershed	Total (Acres)	Wetland Type (Acres)				
		PEM	PSS	PFO	PUB	Submergent
Created Wetlands						
Wixom Lake	447	165	282	0	0	0
Sanford Lake	165	70	95	0	0	0
Totals	612	235	377	0	0	0
Impacted Pre-Disaster Wetlands						
Wixom Lake	1,483	120	93	1,263	8	278
Sanford Lake	980	70	83	819	8	74
Totals	2,463	190	176	2,082	15	352

For impacts to wetlands directly from dam construction, FLTF purchased 8.5 acres of wetland mitigation bank credits (4.45 acres of emergent credits and 4.05 acres of forested credits) with all documentation provided to EGLE within the Secord, Smallwood and Edenville Dam permit applications to mitigate for impacts. There were no direct impacts to wetlands from the construction of Sanford Dam.

5b. Inland Lakes and Streams

Shoreline

FLTF will develop natural shoreline stabilization education and outreach materials for Four Lakes property owners, as part of the Edenville permit requirements. FLTF will also host at least one natural shoreline training event for Four Lakes property owners and facilitate or implement other natural shoreline projects where feasible. This will be in conjunction with the private property shoreline implementation program. The training will be conducted in coordination with other appropriate organizations, such as the Michigan Natural Shoreline Partnership, or others. Education on the benefits of native vegetation buffers/soft shoreline incentive projects and recommendations for implementation are proposed to be posted on FLTF's website and will provide guidance on how private property owners can create these buffers and reduce the impact their property has on the lake.

Water Quality

No specific requirements for water quality are included in the mitigation plans for Sanford and Edenville dams; however, many of the proposed projects will have a positive impact on water quality. The restoration of adjacent wetlands, natural shoreline stabilization, native vegetation buffers and low impact development (LID) projects will all directly impact water quality in the lakes. Additionally, FLTF will provide educational opportunities for property owners as to how they can improve water quality through management of their property.

Historically, the Tabacco River water quality has impacted the water quality and clarity of Wixom and Sanford lakes because of agricultural runoff and erosion. FLTF will be looking for funds for projects required under the U.S. Fish and Wildlife Service Habitat Control Plan for the snuffbox mussel to address water quality on the Tobacco River.

5c. Biota

Fisheries

FLTF will construct a fish habitat project that is approximately 590 linear feet, and approximately 2.16 acres downstream of Sanford Dam, as well as dedicate $150,000 to other fish habitat projects approved in Sanford Lake. The money is proposed to be spent on a project near US-10 and will include submerged woody structures. Monitoring the fish habitat projects within Sanford Lake will occur for a minimum of three years following construction to ensure they are functional and have not been removed or damaged. In Wixom Lake, FLTF will restore and enhance shallow and deep-water habitat areas for fish in approximately 198.5 acres of Wixom Lake bottomland, in approximately eight locations. Monitoring the fish habitat projects will occur for a minimum of three years for Sanford Lake and five years for Wixom Lake following construction to ensure they are functional and have not been removed or damaged[13].

Since restoration of the impoundments will result in aquatic conditions that approximate those from pre-dam failure, a restoration target of fish communities like those present prior to May 2020 appears logical and reasonable. While it is anticipated that all the species naturally present prior to dam failure will repopulate Wixom and Sanford lakes at some point in time, strategies for a more controlled repopulation may be considered. Ultimately, Fisheries Division of the MDNR is the agency charged with overseeing the management of the fishery resources in Wixom and Sanford lakes. Any management activities such as fish stocking or habitat improvement should be led and or endorsed by MDNR Fisheries Division.

Reptiles and Amphibians

Mitigation was focused on the impacts to wetlands and inland lakes and streams. These projects will have a positive benefit on the reptile and amphibian community. Additionally, projects will help to improve water quality and connectivity thereby providing important habitat for these animals.

In Michigan, eutrophic lakes[14] typically have the largest number of associated amphibians and reptiles (Holman 2012). Wixom and Sanford lakes were considered to be eutrophic or mesotrophic, indicating they should support diverse populations of frogs, turtles and snakes. Nearly all salamanders and some frog species rely primarily on vernal ponds (seasonal temporary pools) for reproduction because these ephemeral pools are free from fish predation on eggs and larvae (Holman 2012). Forested wetlands in the immediate vicinity of the impoundments are likely to support a diverse community of these animals as well, when water tables are high enough to create the vernal pond habitats they require for successful reproduction. Simply re-filling the lakes will restore many of these wetland habitats.

Avian Community

Mitigation was focused on the impacts to wetlands and inland lakes and streams. The restoration of these resources will provide restored habitat for the avian community surrounding the Four Lakes.

Mussels

Projects directly associated with the mitigation of loss of native mussels were not included directly in the EGLE permits for the reconstruction of the dams. Due to the presence of the endangered

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[13] View the Michigan Department of Environment, Great Lakes, and Energy Water Resources Division Permits for Sanford and Edenville in the Appendix.

[14] A eutrophic lake is a body of freshwater characterized by high nutrient levels, primarily nitrogen and phosphorus, leading to excessive plant growth and, consequently, oxygen depletion. This nutrient enrichment fuels a cascade of ecological changes that often result in reduced water quality, altered biodiversity, and potential harm to aquatic life.

snuffbox mussel found withing Wixom Lake, a Habitat Conservation Plan (HCP) was developed by FLTF during the process of obtaining an Incidental Take Permit (ITP) for the refilling of the lake and future dam operations. The ITP conditions outline the efforts FLTF will undertake over the next 30 years to improve mussel habitat within the ecosystem. In addition, the mitigation project will have a positive indirect impact on the quality of mussel habitat within the ecosystem by improving water quality and reducing sedimentation.

Chapter 6: Gap Analysis and Opportunities for Future Improvements

Four Lakes Task Force believes it is in the best interest of the community to help restore the Four Lakes ecosystem, beyond just the restoration of the lake levels and permit requirements. The dam failure has left the current system in flux and Four Lakes would like to work with partners and those in the community to be good stewards of the environment. FLTF has been vigilant in working to permit all four dam projects and ensure the lake levels are restored properly. That said, the environmental restoration over the next several years cannot fall on one entity and will need to be a collaborative effort as the Four Lakes Special Assessment District (FLSAD) cannot fund all the opportunities for ongoing improvement.

6a. Wetlands

Significant wetland acreage is anticipated to be restored after the restoration of the lakes. Monitoring of the rehydration is required for the mitigation of impacts from the lake refill. Further enhancement of the restored wetlands would be beneficial. This could include invasive species treatment and native vegetation plantings or purchase of the land for conservation.

6b. Inland Lakes and Streams

Shoreline

Sediment is a primary pollutant to watercourses everywhere and uncontrolled lakeshore erosion was a major cause of turbid water and excessive sedimentation in Wixom and Sanford lakes. Over the years, landowners have hardened the shoreline with various forms of bank protection to protect their property from river currents, boat wakes and other erosive forces. Unfortunately, from exacerbating erosion on neighboring properties to eliminating connections to northern pike spawning marshes, negative ecological impacts associated with widespread construction of seawalls are well-documented. Portions of all Four Lakes historically experience heavy boat traffic on summer weekends, leading to high wave energy striking shorelines in many areas. On those weekends, the shorelines are impacted by short period waves 2 feet or more in height (peak-to-trough) for many hours. Any plans for future implementation of soft shorelines will need to be balanced with realization that some shoreline areas are not suitable for such treatment and will need hardening to avoid shoreline protection failures leading to increased soil erosion and consequently increased sediment in the lake water.

Natural shorelines are critical for a myriad of aquatic or semi-aquatic wildlife including fish, reptiles, amphibians and waterfowl, to name a few. Natural shorelines often contain vegetative communities, undercut banks and other microhabitats, stable substrates and easily traversed transitions from aquatic to terrestrial habitats, all which are to the benefit of native wildlife.

Where desired by stakeholders, plantings of native shrubs and herbaceous vegetation will be installed to prevent sediment erosion along the shoreline. Bioengineered shorelines will provide many benefits to the landowners and lake ecosystems by absorbing wave and wake energy, reducing erosion, providing habitat for fish and wildlife, and filtering out nutrients from surface runoff prior to entering the lakes. Given the private ownership of most of the shoreline and the installation of projects on available public property, the continued improvement of the shoreline will be the responsibility of the property owners. FLTF will continue to provide educational resources on its website after the provided trainings and provide guidance to residents on appropriate shoreline stabilization.

Water Quality

Many of the required mitigation projects will have a positive effect on water quality, however these benefits will not be instantaneous with lake refill. To better gauge the long-term improvement of water quality, FLTF would like to see a monitoring program implemented. To aid in dam operations, FLTF is collecting readings of water temperature, dissolved oxygen, water surface elevation, and flowrate at each of the four dams. Further in-lake monitoring would be beneficial to track the changes in the ecosystem after refill and better manage the Four Lakes system for ongoing recovery to the previously thriving ecosystem.

6c. Biota

Fisheries

Wixom and Sanford lakes have historically supported thriving fish communities[15]. It is believed that since Secord and Smallwood lakes were not completely drawn down, the fish populations will recover to pre-drawdown levels. A key measure of the long-term success of restoration will be the ability of the fish community to sustain a balanced and diverse fishery. The surest way to meet the objective is through maintenance, protection and/or creation of high-quality habitat for reproduction, growth and recruitment of the fish species within the community.

Different species of fish may have unique habitat requirements, and each life stage of a fish may have unique habitat requirements. Some fish, such as bluegill, are prolific and have very general habitat requirements; they can be successful nearly anywhere they occur, and the primary limiting factor is reduced growth rates associated with overpopulation. Northern pike, on the other hand, require shallow, flooded marshes for spawning; this species has probably been more adversely affected by shoreline development than any other. A common theme for most of the fish known to occur in Wixom and Sanford lakes is that they are heavily dependent on high-quality shoreline habitats, during some stage in their life history.

Developed impoundments often contain less than desirable fish habitat due to factors such as removal of logs, brush and vegetation for boating and swimming and armoring of the shorelines. Deficiency of submerged habitat can limit fish abundance, ecological diversity and fisheries (Wills et al. 2004). The importance of coarse woody debris in lake ecosystems is well known to fisheries managers (Everett and Ruiz 1992, Chau 2015, Wolter undated). From providing spawning substrates and cover for certain fish species, to improving macroinvertebrate communities, the merits of coarse woody debris are discussed throughout the literature. Restoration goals are typically associated with increasing carrying capacity by improving spawning success, juvenile survival, growth rates and recruitment to the fishery. In addition to creating healthier fish populations, habitat projects can also be used to increase angler success by concentrating fish over structure in otherwise barren areas. Though somewhat rare in Michigan, fish attractant-type structures (e.g., rock piles, log cribs, brush bundles) are commonly used to create fish-holding habitat. Structure can be added near public access and fishing piers to increase the catch for shore-bound anglers.

The mitigation projects for the installation of fish habitat will benefit a variety of fish species however it is different habitat than what was within the lakes prior to the failure. FLTF is supportive of initiatives and projects to install additional fish habitat. It is anticipated that with continued support with stocking from, the MDNR and others, that the fisheries can be restored to a thriving fishery over time.

Reptiles and Amphibians

Amphibians and reptiles benefit when the water/land interface is maintained in a natural form. These animals need unrestricted movement between the water and upland areas and hardened vertical shorelines, like steel or concrete seawall, can be a barrier to their movements. Fallen

[15] See “Lake Restoration: The Natural Resources and Environmental Plan” by Four Lakes Task Force in the Appendix.

trees along shorelines are a habitat component that many amphibians and reptiles utilize, particularly turtles for basking in the sun. Installation of tree trunks along shallow natural shoreline areas and shallow wetlands will promote reptiles and amphibians, as well as fish.

Vernal ponds, often found in wooded wetlands, are critical breeding habitats for many species of salamanders and some frogs. These species will benefit greatly from restoration of the impoundments and rehydration of associated wooded wetlands in the adjacent riparian zones. Without fish-free spring vernal pools, many salamanders and some frog species have very poor reproductive success.

Wetlands and fish habitat will benefit reptiles and amphibians. There are no anticipated gaps for restoration of a healthy reptile and amphibian community within the ecosystem.

Avian Community

A variety of avian species known to use the impoundments in the past are expected to return after refill. In fact, many bird species that existed prior to the flood never completely abandoned the lakes including Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchos*), and great blue herons (*Ardea herodias*), among others.

The literature provides little information that identify avian species using the Four Lakes prior to the dam breaches. However, past observations by residents, members of the Four Lakes Task Force, and other anecdotal information indicate many waterfowl, wading bird, shore bird, and raptor species have been noted in the past such as Canada goose, mallard, teal (*Anus* spp), wood duck (*Aix sponsa*), common merganser (*Mergus merganser*), mute swan (*Cygnus olor*), great blue heron (*Ardea herodias*), green heron (*Butorides virescens*), bald eagle (*Haliaeetus leucocephalus*) and common snipe (*Gallinago Gallinago*). Diving ducks, such as bufflehead (*Bucephala albeola*), were also seasonally present, as were common loons (*Gavia immer*). These species would be expected to return after refill. While some species such as Canadian geese can be a nuisance for some riparian owners, the compliment of water dependent species expected to return provide an integral part of the ecology and restoration of the ecology of the lakes. In fact, the presence of some of these species, such as great blue herons, can be used as indicators of a healthy environment.

Additional avian species, although not recorded as using the lakes in the past, would also be expected to use the Four Lakes for resting, nesting and/or feeding. Additional species would likely include additional diving and puddle ducks, a variety of shorebirds, wading birds such as snowy egrets (*Egretta thula*) and sandhill cranes (*Antigone canadensis*), osprey (*Pandion haliaetus*), and songbirds (possibly including a variety of neotropical migrants). Many of the habitat improvement projects implemented by FLTF, such as natural shoreline enhancement, wetland restoration, and habitat structures, will benefit not only fish and herpetofauna, but also wading birds, diving birds, and shore birds as well as other avian species that feed off wetland vegetation and the insects that use the water and vegetation for reproduction.

Residents and visitors prone to birding and bird hunting will benefit from the restoration and residents have the opportunity to promote development of the avian populations through activities such as installation of nesting boxes for wood ducks and hooded mergansers, and osprey nesting platforms.

Mussels

In 2022, Central Michigan University researchers conducted 69 surveys that detected 17 live species and, most notably the federally endangered snuffbox and the State of Michigan endangered Black Sandshell.[16]

Rapid dewatering, whether due to natural fluctuations in waters, human-induced changes, or extreme events, is likely to lead to mortality of mollusks due to the water requirements of these organisms, as well as the inability for them to escape to an area that has not dewatered. The proposed work included in the ITP will provide benefit to the mussel communities in the lakes for years to come. Additionally, FLTF feels it is valuable to continue surveys of the mussel communities at key habitat locations within the system to fully understand the recovery after lake refill.

[16] View Central Michigan University's interactive report on the FLTF website here.

Appendix

All appendices can be accessed on the FLTF website here.

Chapter 1 Appendix

Handbook for Developing Watershed Plans to Restore and Protect Our Waters by the Environmental Protection Agency, March 2008

Chapter 4 Appendix

Restoration Path Forward: Feasibility Study of the Four Lakes of Gladwin County and Midland County by Four Lakes Task Force, May 2021

Streambank Erosion Inventory by Boyce Hydro LLC, September 2013

2019 Water Quality Monitoring Report provided by Boyce Hydro Power LLC to the Federal Energy Regulatory Commission, November 2019

Lake Restoration: The Natural Resources and Environmental Plan by Four Lakes Task Force

Wixom Lake Restoration – Fishery Scoping Report by Streamside Ecological Services

Sanford Lake Restoration – Fishery Scoping Report by Streamside Ecological Services

Chapter 5 Appendix

Pre- and Post-Disaster Wetland Analysis by Merjent, March 2021

Pre-Disaster Wetland Impact Monitoring Report by Merjent, January 2023

Permit for Sanford Dam by Michigan Department of Environment, Great Lakes, and Energy Water Resources Division, October 2023

Permit for Edenville Dam by Michigan Department of Environment, Great Lakes, and Energy Water Resources Division, March 2025