

CASE
STUDY

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*From Lumber to Foundries to Revitalization:
The Muskegon Lake Story*

From Lumber to Foundries to Revitalization: The Muskegon Lake Story

By Kathy Evans, West Michigan Shoreline Regional Development Commission; Paul Isely, Grand Valley State University; and Al Steinman, Grand Valley State University

The name *Muskegon* derives from the Ottawa Indian word *masguigon*, meaning *marshy river* or *swamp*. This Michigan city is located along the eastern shoreline of Lake Michigan in Muskegon County. At its northern edge lies Muskegon Lake, a 4,150-acre (1,679-hectare) inland coastal lake. The Muskegon River, the state's second longest, originates at Houghton Lake and flows southwest 227 miles (365 kilometers) into Muskegon Lake before flowing into Lake Michigan.

These surrounding freshwaters sustained Native Americans and inspired all generations who followed. During the fur trade era, the Hudson Bay Company found riches in the area's furs. When the Great Fire of 1871 devastated Chicago, the city was rebuilt with lumber from this area. During the lumber era (roughly 1860-1910), Muskegon Lake had 47 saw mills along its shoreline, and Muskegon boasted, at one time, more millionaires per capita than any town in America. During World War II, Muskegon's Continental Motor Company produced tank,

aircraft, and automobile engines as part of the war effort that led to its reputation as a foundry town. Historical development along Muskegon Lake supported waterfront-dependent industry and commerce, leaving behind a legacy of contaminated sediments, habitat loss, and environmental degradation.

Remedial Action Plan Development to Restore Impaired Uses

In 1985, the International Joint Commission's Great Lakes Water Quality Board identified Muskegon Lake as an Area of Concern (AOC). The Michigan Department of Natural Resources (1987) committed to developing and implementing a remedial action plan (RAP) to restore impaired beneficial uses (Table 1). A public advisory committee was established to obtain stakeholder input. The initial RAP, developed in 1987, noted that Muskegon Lake had no apparent impacts on Lake Michigan, but

did have localized problems, including elevated contaminant levels in certain fishes, localized contaminated sediments, and degraded habitats (Michigan Department of Natural Resources, 1987).

Overall water quality in Muskegon Lake improved following wastewater diversion from the lake to the Muskegon County Wastewater Management System in 1973 (Steinman et al., 2008). This 11,000-acre (4,452-hectare) land application system has a capacity of 42 million gallons per day and includes extended aeration, lagoon impoundment, slow-rate irrigation, and rapid-sand filtration. Treated wastewater is discharged to the Muskegon River, approximately 10 miles (16 kilometers) upstream of Muskegon Lake. Between 1972 and 2005, lakewide averages of total phosphorus and soluble reactive phosphorus from the water surface declined from 68 to 27 $\mu\text{g/L}$ and from 20 to 5 $\mu\text{g/L}$, respectively (Steinman et al., 2008). In addition, average chlorophyll *a* concentrations declined from 25 to 6 $\mu\text{g/L}$ over the same time period, while average

DATE	ACCOMPLISHMENT
1985	Muskegon Lake designated an Area of Concern and Michigan Department of Natural Resources commits to developing and implementing a RAP; Muskegon Lake Public Advisory Committee established to obtain stakeholder input
1987	Stage 1 RAP completed
Early 1990s	Muskegon Lake Watershed Partnership established
1994	RAP update published
2002	RAP update published
2004	Sediment survey of Muskegon Lake tributaries completed; Muskegon Lake Watershed Partnership engages stakeholders in identifying potential restoration projects
2006	Ruddiman Creek sediment remediation completed under Great Lakes Legacy Act
2008	Michigan Department of Environmental Quality issues guidance for delisting Michigan AOCs; Habitat Committee of Muskegon Lake Watershed Partnership issues plan to accelerate removal of beneficial use impairments and restore habitat
2010	Michigan Department of Environmental Quality issues revised guidance for delisting Michigan AOCs
2011	Michigan Department of Environmental Quality completes Stage 2 RAP; U.S. Army Corps of Engineers dredges navigational channel of Muskegon Lake; "restrictions on dredging" removed as a beneficial use impairment
2012	Division Street Outfall sediment remediation completed under Great Lakes Legacy Act
2013	"Restrictions on fish and wildlife consumption" and "restrictions on drinking water consumption" removed as beneficial use impairments
2015	"Beach closings" removed as a beneficial use impairment
2019*	Zephyr Refinery sediment remediation completed; all management actions identified in the RAP for use restoration completed
2020*	Completion of all identified management actions required for restoring impaired beneficial uses

Table 1. A timeline of significant activities related to the restoration of impaired beneficial uses in the Muskegon Lake AOC. *Anticipated

Secchi disk depths (i.e., water transparency) increased from 4.9 to 7.2 feet (1.5 to 2.2 meters). Overall, by the mid-2000s eutrophication targets for Muskegon Lake (i.e., 30 ug/L total phosphorus, 10 ug/L chlorophyll *a*, and a Secchi disc depth of approximately two meters) were

being met or exceeded. However, major environmental challenges remained, including contaminated sediments and loss of natural habitat. These environmental challenges would be dealt with under the RAP. In the early 1990s, the Muskegon Lake

Watershed Partnership was established to ensure a community-based, volunteer, partnership organization to coordinate all activities to restore Muskegon Lake and its watershed, and to help promote use of an ecosystem approach and build capacity (Table 1). The RAP was updated

in 1994 and 2002, and a Stage 2 RAP, identifying necessary remedial and preventive actions, was completed in 2011 (Michigan Department of Environmental Quality, 2011).

The first beneficial use impairment (i.e., “restrictions on dredging activities”) was removed in 2011. “Restrictions on fish and wildlife consumption” and “restrictions on drinking water consumption” were removed as beneficial use impairments in 2013 and “beach closings” was removed as a beneficial use impairment in 2015. All management actions identified to restore impaired beneficial uses in the RAP are projected to be implemented by 2020, with a goal of delisting as an AOC when monitoring data confirm use restoration.

Contaminated Sediment Remediation

Contaminated sediment was a long-standing issue in the Muskegon Lake AOC because of historical industrial activities. Through the RAP, and with critical financial support from the Great Lakes Legacy Act (started in 2002) and the Great Lakes Restoration Initiative (started in 2010), substantial contaminated sediment remediation has been completed or is underway in the AOC, including remediation of 89,869 cubic yards (68,710 cubic meters) of contaminated sediment in Ruddiman



Veterans Memorial Park during and after habitat restoration. Credit: GEI Consultants of Michigan.

Creek in 2006 (\$14.2 million), remediation of 43,463 cubic yards (33,230 cubic meters) of contaminated sediment at the Division Street Outfall in 2012 (\$10.8 million), and remediation of 33,640 cubic meters (44,000 cubic yards) of contaminated sediment and soil in the vicinity of the Zephyr Oil Refinery that is underway now and projected to be completed in 2019 (\$17 million). In addition, all investigative work has been completed for contaminated sediment remediation in Ryerson Creek and a Great Lakes Legacy Act project application is being developed to secure necessary funding for cleanup.

Habitat Restoration and Conservation

Through the RAP and with critical financial support from the Great Lakes Restoration Initiative and Great Lakes Legacy Act, substantial habitat restoration and conservation work has been completed or is underway in the AOC. Table 2 highlights four major projects, totaling \$22 million.

Economic Benefits

In 2009, the Great Lakes Commission and the West Michigan Shoreline Regional Development Commission were awarded \$10 million from



North Muskegon High School students assisting with fish relocation for the Bear Creek wetland restoration. Credit: GEI Consultants of Michigan.

the American Recovery and Reinvestment Act to remove 24.7 acres (10 hectares) of historical, unnatural fill, restore 27 acres (11 hectares) of wetlands, and soften 1.9 miles (3 kilometers) of shoreline along the south shore of Muskegon Lake. As part of this restoration effort, economic benefits were measured via hedonic property values and a travel cost survey for lake-based recreation (Isely et al., 2018).

This socioeconomic study measured the economic value before, during, and after

restoration. The hypothesis was that habitat restoration would increase the economic value of ecosystem services associated with restored wetlands (Steinman et al., 2017), which local governmental and economic development authorities could then use to promote local tourism and commerce. This required a survey of lake users, a survey of possible users of the lake, and housing sales information. These data were then used to quantify the value of recreation, the number of new visitors, and the increase in

Project Name	Description	Cost	Date Completed
Bosma and Willbrandt land acquisitions	Acquisition of 95 acres (38.4 hectares) of two former celery farms for restoring wetlands and connectivity to Bear Creek, Muskegon Lake, and Muskegon River	Bosma - \$198,000; Willbrandt - \$303,000	2018 Willbrandt/ Bear Creek; 2019 Bosma/ Lower Muskegon River
Lumber mill debris removal and aquatic habitat restoration	Removal of 122,673 tons of historical lumber mill debris and restoration of 11.4 acres (4.6 hectares) of open water and emergent wetland habitats	\$2.8 million	2017
Veterans Memorial Park fish and wildlife habitat restoration	Reestablish hydrological connection to Muskegon River and restore open water (5.3 acres or 2.1 hectares), shoreline (2,257 feet or 78 meters), riparian (6.8 acres or 2.8 hectares), and wetland (3.3 acres or 1.5 hectares) habitats	\$2.6 million	2017
Bear Creek fish and wildlife habitat restoration	Restore 36 acres (14.6 hectares) of wetlands, remove approximately 182,735 tons of phosphorus-rich sediment from wetlands, restore 2,015 feet (614 meters) of stream bank, improve water quality and restore connectivity with Bear Lake	\$7.9 million	2018
Lower Muskegon River fish and wildlife habitat restoration	Restore 53 acres (21.4 hectares) of wetlands, remove unnatural fill, soften 2,739 feet (835 meters) of shoreline and restore connectivity with Muskegon River	7.9 million	2019

Table 2. Major habitat restoration projects completed with Great Lakes Restoration Initiative, Great Lakes Legacy Act, and American Recovery and Reinvestment Act funding in support of delisting Muskegon Lake as an AOC.

housing value from the ecosystem improvements.

This study found that the \$10 million Muskegon Lake restoration project will generate nearly \$60 million of economic benefits for the Muskegon area over a 20-year period, or a six-to-one return on investment (Isely et al., 2018). These economic benefits included a \$12 million increase in property values; up to \$600,000 in new tax revenue annually; over \$1 million in new recreational spending annually in Muskegon; and nearly 65,000 additional visitors annually.

This compelling economic benefits study underscores the substantial return on federal investment in Great Lakes cleanup. Further, such economic benefits assessments are important tools to help sustain long-term momentum in urban environmental restoration work and attract champions and advocates for sustaining funding from governments, foundations, and businesses to help finish the job of cleaning up AOCs.

Concluding Remarks

Considerable progress has been made in restoring Muskegon Lake over the past three decades. Progress in remediating contaminated sediments and restoring fish and wildlife habitat has accelerated with funding from the Great Lakes Legacy Act and the Great Lakes Restoration Initiative. Approximately \$40 million from the



Berm removal to restore hydrological connection to Bear Lake. Credit: GEI Consultants of Michigan.

Great Lakes Legacy Act and the Great Lakes Restoration Initiative was invested in restoration of Muskegon Lake between 2002 and 2014. From 2015-2020, an additional \$33 million from the Great Lakes Restoration Initiative and Great Lakes Legacy Act will implement the remaining projects for restoring the remaining impaired beneficial uses in Muskegon Lake. Of particular interest is that these restoration projects were based on sound science and followed by rigorous monitoring programs to assess their success.

All management actions identified in the RAP will be implemented by 2020 with a goal of

delisting as an AOC when monitoring confirms use restoration. The Muskegon Lake Watershed Partnership has developed a Muskegon Lake Ecosystem Action Plan to facilitate the continuation of coordinated, natural resources stewardship of Muskegon Lake and Lower Muskegon River Watershed from 2018 through 2025. It builds upon the restoration progress made under the Muskegon Lake RAP and through other voluntary and regulatory cleanup programs. In essence, the Ecosystem Action Plan will seamlessly replace the RAP as the watershed community's guiding document for ecosystem-

based management of the Muskegon Lake watershed and for the protection of its natural resources, with a goal of continuous improvement and long-term sustainability (Muskegon Lake Watershed Partnership, 2018).

Together, the Ecosystem Action Plan and the Muskegon Lake Watershed Partnership will ensure that there is life after delisting as an AOC. The partnership and plan will ensure a concerted and coordinated effort to achieve the goal of Muskegon Lake serving as an economic engine, while improving public access, increasing housing value, and maintaining the integrity of natural resources as articulated in Muskegon Lake Vision 2020 (West Michigan Shoreline Regional Development Commission 2016). Indeed, all citizens, community leaders, elected officials, and the private sector must work together to achieve sustainability.

The socioeconomic study of Isely et al. (2018) has raised awareness of the substantial economic benefits of Muskegon Lake restoration. Further, the documentation of a six-to-one return on restoration investment is providing compelling rationale for continued investment in restoring and protecting Muskegon Lake, consistent with the vision of a healthy and sustainable environment and natural resources, outdoor recreation, commerce and port activities, and residential development.

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Cover photo shows aerial view of Muskegon Lake. Credit: GEI Consultants of Michigan.

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Contacts

Kathy Evans
Environmental Program Manager
West Michigan Shoreline Regional
Development Commission
kevans@wmsrdc.org

Paul Isely
Grand Valley State University
iselyp@gvsu.edu

Al Steinman
Grand Valley State University
steinmaa@gvsu.edu

John Hartig
Great Lakes Science-Policy Advisor
International Association for Great Lakes
Research
johnhartig1@gmail.com



The Muskegon Lake case study is part of a larger project to evaluate achievements and lessons learned from 32 years of efforts to clean up Great Lakes AOCs. Case studies will be used to help sustain support for cleaning up AOCs and to inspire and motivate others to restore other degraded aquatic ecosystems.

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