

Target for Delisting the Degradation of Benthos Beneficial Use Impairment in the Muskegon Lake Area of Concern

Introduction

Muskegon Lake is a 16.8 km² drowned river mouth lake located in western Michigan. The lake was listed as an Area of Concern (AOC) by the Environmental Protection Agency in 1987 because of severe environmental impairments related to the historic discharge of municipal and industrial wastes. The Beneficial Use Impairment (BUI), Degradation of Benthos, was listed because of sediment toxicity related to heavy metals and organic chemicals and impacts to species diversity from the discharge of municipal sewage. Data from 1972 (Evans 1976) showed that pollution tolerant oligochaete worms comprised 89% of the total benthic population, chironomid numbers were low (< 200/m²), and species diversity was only 0.68 (Shannon Weaver). In 1974, the direct discharge of municipal and industrial wastewater to Muskegon Lake was eliminated by the construction of an advanced tertiary treatment facility. In addition, industrial pretreatment programs, hazardous waste site remediation projects, and numerous conservation and non point source reduction efforts have resulted in large improvement in water quality. In 1999, Shannon Weaver diversity improved to 1.66, oligochaetes were reduced to 68% of the total population, and chironomid numbers increased to over 600/m² (Carter 2002; Rediske et al. 2002).

In addition to problems in Muskegon Lake, the 1987 Remedial Action Plan identified Ruddiman Creek, Ryerson Creek, the Division Street Outfall, Bear Lake, Little Bear Creek (including the unnamed tributary) and the Muskegon River (South Branch near Teledyne and North Branch at the mouth) as having degraded benthic communities.

Available Guidance

The International Joint Commission (IJC) criteria for listing the Degradation of Benthos are provided below:

“When the benthic macroinvertebrate community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics. In addition, this use will be considered impaired when toxicity (as defined by relevant, field-validated, bioassays with appropriate quality assurance/quality controls) of sediment associated contaminants at a site is significantly higher than controls”

The Michigan Department of Environmental Quality (MDEQ) provides the following guidance for delisting:

“This BUI will be considered restored when:

An assessment of benthic community, using either MDEQ's SWAS Procedure #51 for wadeable streams or MDEQ's pending rapid assessment procedure for non-wadeable rivers yields a score for the benthic metrics which meets the standards for aquatic life in any 2 successive monitoring cycles (as defined in the two procedures).

OR, in cases where MDEQ procedures are not applicable and benthic degradation is caused by contaminated sediments, this BUI will be considered restored when:

All remedial actions for known contaminated sediment sites with degraded benthos are completed (except for minor repairs required during operation and maintenance) and monitored according to the approved plan for the site. Remedial actions and monitoring are conducted under authority of state and federal programs, such as Superfund, Resource Conservation and Recovery Act, Great Lakes Legacy Act, or Part 201 of Michigan's National Resource and Environmental Protection Act (NREPA) of 1994."

Delisting Target

The MDEQ provides two options for target development: using SWAS Procedure #51 and completing all necessary remedial actions. SWAS Procedure #51 is applicable to Ruddiman Creek (stream channel), Ryerson Creek, Little Bear Creek (including the unnamed tributary) and the Muskegon River (South Branch near Teledyne and North Branch at the mouth). Sediment contamination in Ruddiman Pond was remediated in 2006 and will be monitored according to the approved plan for the site. Since SWAS Procedure #51 is not applicable to lakes, specialized targets need to be developed for Bear Lake and Muskegon Lake. Evans (1981) described the benthic community in Bear Lake as degraded, due to the abundance of pollution tolerant organisms present in the sediments (primarily oligochaete worms). Benthic invertebrates will be collected in the spring of 2007 as part of a Total Daily Maximum Load (TMDL) evaluation for the lake. The MLPAC will consider a decreasing trend in the % oligochaetes and an increasing trend in the % chironomids as an indication of benthic community recovery. Bear Lake is scheduled for a nutrient TMDL in 2007 and a program will be developed to improve water quality. Since the status of the benthic community is linked to water quality, improvements to the structure of the macroinvertebrate community should result from the TMDL. While completing sediment remediation projects at individual sites is important, Muskegon Lake has been impacted on a system-wide basis by chemical and nutrient pollution. Because of the importance of Muskegon Lake as a recreational resource and public concern related to sustaining the current trend of improving water quality, the Muskegon Lake Public Advisory Council (MLPAC) voted to adopt a target for delisting the Degradation of Benthos BUI that exceeds the State of Michigan criteria. The target is presented below:

The **Degradation of Benthos BUI** will be considered restored when SWAS Procedure #51 yields a score for the benthic metrics which meets the standards for aquatic life in 2 successive monitoring cycles for Ruddiman Creek (stream channel), Ryerson Creek, Little Bear Creek (including the unnamed tributary, and the

Muskegon River (South Branch near Teledyne and North Branch at the mouth) and in cases where MDEQ procedures are not applicable and benthic degradation is caused by contaminated sediments, this BUI will be considered restored when all remedial actions for known contaminated sediment sites with degraded benthos are completed (except for minor repairs required during operation and maintenance) and monitored according to the approved plan for the sites. The known contaminated sediment sites in the Muskegon Lake AOC are the Division Street Outfall, Ruddiman Creek, and Ryerson Creek. In addition, average benthic macroinvertebrate populations in Muskegon Lake and Bear Lake should reflect the following conditions:

Muskegon Lake	
Indicator	Target
Sediment Toxicity	Amphipod Survival >60%
<i>Hexagenia</i>	Present in river mouth littoral zone
% Oligochaeta	< 75%
Chironomidae (#/m²)	> 500
Diversity (SW)	> 1.5
Bear Lake	
% Oligochaeta	Decreasing Trend from 1972
% Chironomidae	Increasing Trend from 1972

For Muskegon Lake, compliance with the sediment toxicity indicator will be determined by review of pre and post remediation toxicity and benthic invertebrate data for Ruddiman Creek, Ryerson Creek, and the Division Street Outfall. Compliance with the indicators for Muskegon Lake will be based on a benthic survey conducted at a group of the same stations sampled in 1999 (Figure 1). If any station shows an indication of significant degradation ($> \pm 3$ standard deviations), the area will require resampling and analysis to determine the source of the problem. Benthic invertebrates will be collected in Bear Lake in the spring of 2007 as part of the approved work plan for the TMDL evaluation. Compliance for Bear Lake targets will be determined by a comparison of the data sets from 1972 and 2007. For the remaining tributary sites, compliance with SWAS Procedure #51 will be determined by 2 successive monitoring cycles that yield a score for benthic metrics which meets the standards for aquatic life in Ruddiman Creek (stream channel), Ryerson Creek, Little Bear Creek (including the unnamed tributary) and the Muskegon River (South Branch near Teledyne and North Branch at the mouth.)

Functional Equivalence

The proposed targets for the Muskegon Lake AOC are functionally equivalent to the MDEQ guidance in that it requires that all remedial actions at Ruddiman Creek, Ryerson Creek, and the Division Street Outfall are completed (except for minor repairs required during operation and maintenance) and monitored according to the approved plan. No other locations in the AOC are currently being considered for the removal/remediation of contaminated sediments. In addition, the targets require that SWAS Procedure #51

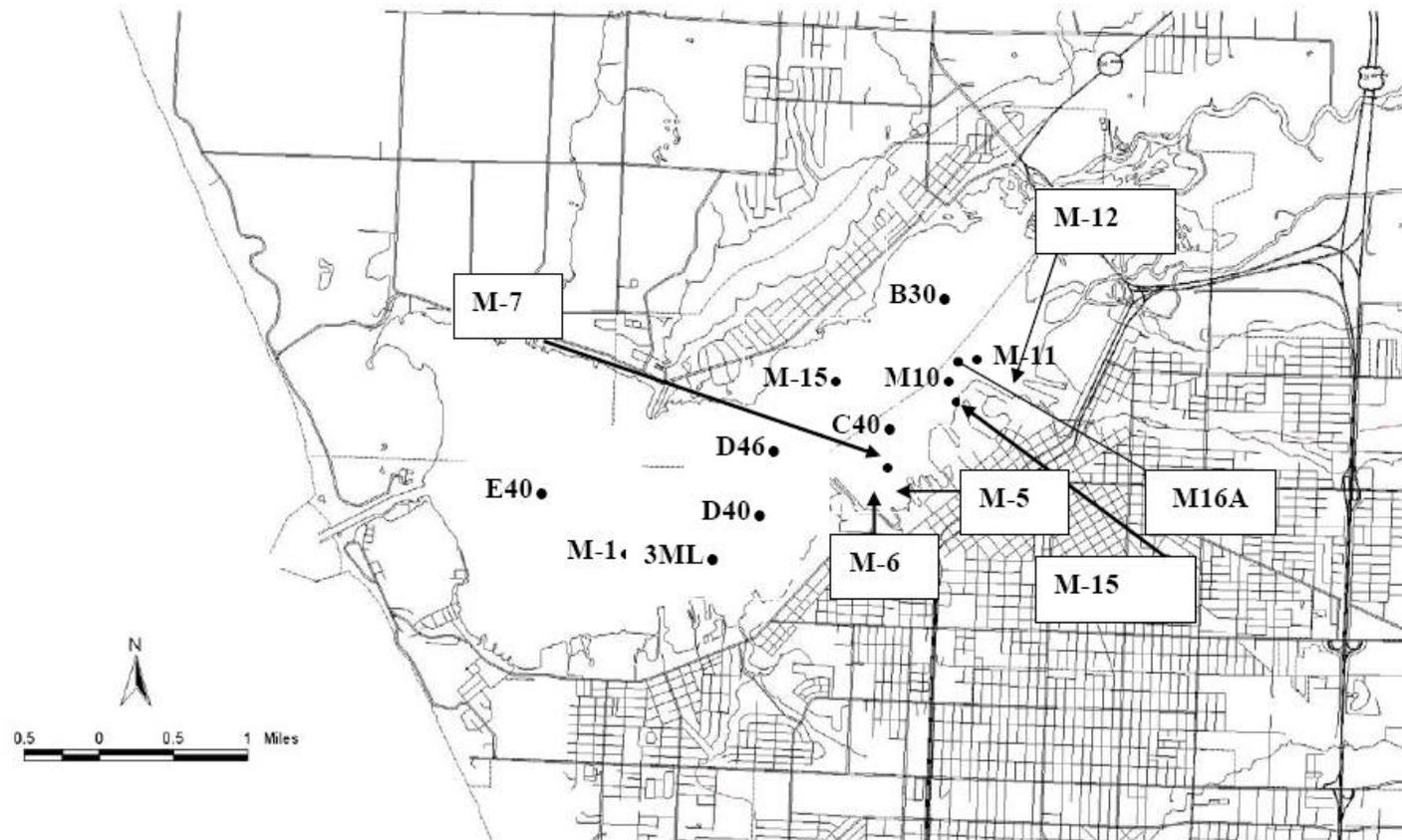


Figure 1. Muskegon Lake Benthos Sampling Locations.

scores meet the standards for aquatic life for 2 consecutive monitoring cycles in Ruddiman Creek (stream channel), Ryerson Creek, Little Bear Creek (including the unnamed tributary) and the Muskegon River (South Branch near Teledyne and North Branch at the mouth.) The targets exceed the MDEQ guidance as they require specific conditions in the benthic macroinvertebrate community of Muskegon Lake and Bear Lake be achieved prior to delisting.

Programs for Monitoring and Assessing Restoration Success

The MDEQ will conduct the monitoring of Ruddiman Creek (stream channel), Ryerson Creek, Little Bear Creek (including the unnamed tributary) and the Muskegon River (South Branch near Teledyne and North Branch at the mouth.) using SWAS Procedure #51. The MLPAC and/or the Annis Water Resources Institute (AWRI) will obtain funding for the monitoring of Muskegon Lake and Bear Lake by the submission of grants and requests for assistance from the following sources:

- Michigan Department of Environmental Quality Clean Michigan Initiative (CMI) Fund Local Monitoring Grants
- Environmental Protection Agency Great Lakes National Program Office (GLNPO) and the Great Lakes Legacy Act.

The Annis Water Resources Institute (AWRI) will conduct the monitoring and assessment of Muskegon Lake in 2006 as part of the program developed for a CMI grant. AWRI will prepare a Quality Assurance Project Plan for Muskegon Lake monitoring activities and obtain MDEQ approval for the methods and data quality objectives associated with the program. If the data show that additional monitoring is required to achieve the Muskegon Lake targets, the MLPAC and/or AWRI will submit a supplementary grant request to the above agencies. Monetary support for the monitoring and assessment of Ruddiman Creek, Ryerson Creek, and the Division Street Outfall will be provided by the EPA and the MDEQ as part of the Great Lakes Legacy Act and other agency funds allocated to the individual projects. Benthic invertebrates will be collected in the spring of 2007 (by AWRI?) in Bear Lake as part of a Total Daily Maximum Load (TMDL) evaluation for the lake. If necessary, additional funds will be solicited by the PAC and/or AWRI from the MDEQ CMI Program and GLNPO for supplemental monitoring and outreach programs. Quality Assurance Project Plans will be prepared for all supplemental assessment activities and agency approval will be obtained for all monitoring programs. Tributary monitoring will be conducted by MDEQ as part of their 5 year basin cycle.

The MLPAC will submit a status report and request for formal delisting of the Degradation of Benthos BUI to the MDEQ when:

- post remediation monitoring at Ruddiman Creek, Ryerson Creek, and the Division Street Outfall show that sediment toxicity is not present at these locations,
- the tributaries listed above yield a scores for benthic metrics that meet the standards for aquatic life in 2 successive monitoring cycles life, and
- the results of benthic macroinvertebrate monitoring in Muskegon Lake and Bear Lake meet the proposed targets.

The report will include the monitoring data, numerical analyses, and quality assurance information demonstrating that the data quality objectives of the project QAPPs and delisting targets were achieved.

References

- Carter G. 2002. *Environmental Assessment of the Benthic Macroinvertebrate Community of Muskegon Lake and Evaluation of Changes Since 1972*. M. S. thesis, University of Michigan. Ann Arbor, MI.
- Evans, E. 1976. Final report of the Michigan Bureau of Water Management's investigation of the sediments and benthic communities of Mona, White, and Muskegon Lakes, Muskegon County, Michigan, 1972.
- Evans, E. 1981. Mona, White, and Muskegon Lakes in Muskegon County, Michigan (The 1950s to 1980s) MDNR Draft Report.
- Rediske R., Thompson C., Schelske C., Gabrosek J., Nalepa T. F., and Peaslee G. 2002. *Preliminary investigation of the extent of sediment contamination in Muskegon Lake, MI*. U. S. Environmental Protection Agency, Great Lakes National Program Office, Chicago IL. GL-97520701-01. <http://www.epa.gov/glnpo/sediment/muskegon/index.html>